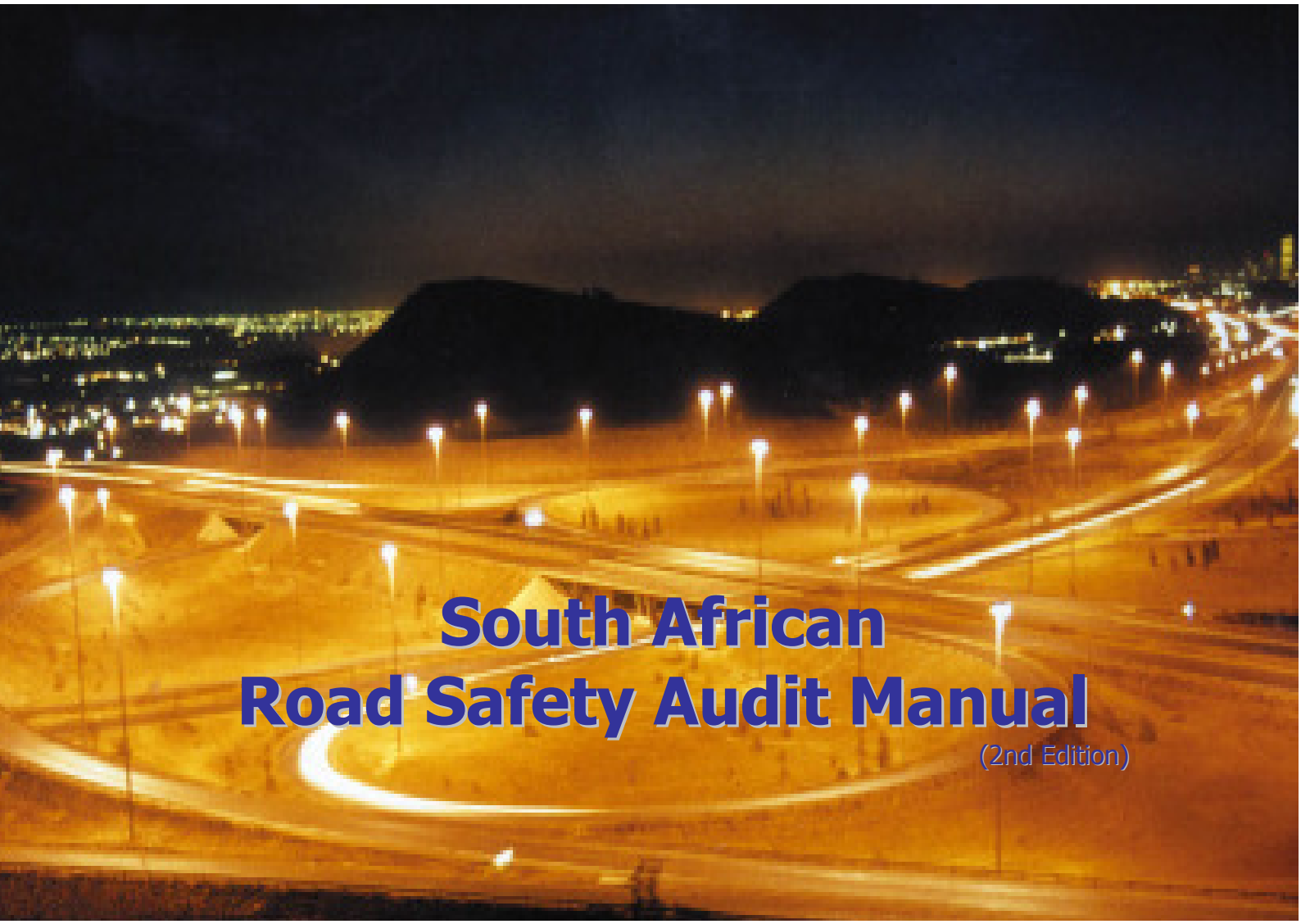
Road Traffic
Management Corporation



South African Road Safety Audit Manual

(2nd Edition)

May 2012

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Foreword

Globally, 1.3 million people are killed on the world's roads each year and 50 million are injured. If no action is taken to address the road traffic carnage, it is estimated that 1.9 million people and 2.4 million people will die through road traffic crashes by 2020 and 2030 respectively. Road traffic injuries are among the three leading causes of death for people between 5 and 44 years of age. South Africa, as a developing country, has an unacceptable high rate of road traffic accidents with more than 14 000 fatalities per year and an estimated 150 000 injuries per year. The economic cost to our country of about 40 fatalities per day combined with the high number of injury crashes is at least R210bn per year and does not even include the extreme levels of human suffering by loved ones affected by this carnage.

The RTMC acknowledges the work done by the First Global Ministerial Conference on Road Safety, November 2009 reported as the Moscow Declaration, which resolved that governments should target casualty reduction within a framework of the Safe System Approach. In its simplest form this approach means "*safe users on safe roads in safe vehicles at safe speed*".

The United Nations General Assembly declared 2011-2020 to be the Road Safety Decade of Action with the goal of first stabilizing and then reducing the numbers killed on the road network. This culminated in the identification of five pillars as the focus of action by all UN member states. These pillars are[1]:

Road safety management;
Safer Infrastructure;
Safer vehicles;
Safer road user behaviour and
Improved post-crash care.

The RTMC has embarked on a project that will focus on infrastructure safety audits to promote safe roads, which is one of the focus areas of action, through the revision of the South African Road Safety Audit Manual Volume 4 into a stand-alone South African Road Safety Audit Manual, the final draft which has been completed and is due for pilot implementation and training of road safety auditors. This manual will be used by road authorities to conduct road safety audits for new road projects and road safety appraisals for existing roads in order to identify potentially hazardous locations and put remedial measures in place to minimize crashes on the road network.

[1] *Implementing the 2011-2020 Decade of Action in sub-Saharan Africa, 2010*

In line with the "**Decade of Action for Road Safety (2011-2020**)", I am calling on all Road and Local Authorities in the country to ensure that in their budgets, safety is integrated in all phases of planning, design, construction, operation and maintenance of road infrastructure in line with Safe Roads for Development. Two key elements of modern road design derived from the goal of increasing road safety are the **"forgiving road"** and the "**self-explaining road**" concepts. I am therefore also calling on our partners from the private sector including Road Designers and Planners to play their part on **Infrastructure treatments** in relation to forgiving and predictable road design.

As part of Make Roads Safe Campaign launched by the Honorable Minister of Transport, Dr S J Ndebele MP and in collaboration with Road Safety Councils and other relevant stakeholders we wish to mobilize community members to take a keen interest in all matters pertaining to road safety in order to become activists for the improvement of road safety, the recognition of the needs of vulnerable road users as a precondition for the construction of new roads in their localities, and demand for road infrastructure maintenance to promote road safety, and that road safety should be prioritized at identified hazardous locations on existing roads.

I am calling on all road authorities, road safety audit practitioners from the private sector, traffic authorities, and Local authorities and other relevant stakeholders to cooperate with the RTMC as we implement the SARSAM in order to change the road conditions on our road network for the better, reducing fatal crashes and road traffic injuries.

Lastly, we will make recommendations to Parliament that road safety audits be made the legislative requirements and that roads authorities must conduct road safety audits regularly as the economic benefit cannot be at the expense of the loss of human life.

Collins Phutjane Letsoalo
Acting Chief Executive Officer: RTMC

LIST OF ACRONYMS

DBFO	Design, Build, Finance and Operate
D&B	Design and Build
FHWA	Federal Highway Administration
IHT	Institution of Highways and Transportation
NDoT	National Department of Transport
NMT	Non-motorised transport
OECD	Organisation for Economic Co-operation and Development
RSA	Road safety audit
RTMC	Road Traffic Management Corporation
SANRAL	South African National Roads Agency Limited
SARSAM	South African Road Safety Audit Manual
SARSM	South African Road Safety Manual
SARTSM	South African Road Traffic Signs Manual
WHO	World Health Organisation

ACKNOWLEDGEMENTS

The Road Safety Manual is a comprehensive guide for the formal road safety audit of road and traffic designs before they are built, and for the road safety appraisal of existing roads.

This manual describes the road safety audit process, together with practical guidance for road safety practitioners. It is recommended reading for all practitioners and decision makers who are responsible for road safety, for designing new road projects and for managing roads.

This Manual is a revision of *South African Road Safety Manual, Volume 4: Road Safety Audits*, Final Draft 29 March 1999 and has been prepared by Siegfried Grosskopf, Road Safety Engineer, for the Road Traffic Management Corporation.

Project Manager: Ndengeza Masangu, RTMC

The participation and input of the following practitioners are gratefully recognised:

E Byker	City of Cape Town	S Pienaar	Mpumalanga Roads
R Cable	SANRAL	R Pyke	SSI
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A Gusha	Gautrans	Dr M Sinclair	Stellenbosch University
F Labuschagne	CSIR	Prof. C Van As	Consultant
S Lötter	Consultant	B Van Biljon	Aurecon
D Lues	Gautrans		

As the science of road safety auditing is constantly developing, this Manual recognises the benefits of standardising road safety audit procedures and practices and has drawn extensively on the experiences of countries where road safety auditing is being done and on the guidelines and procedures in use in these countries. The RTMC would like to recognise and acknowledge the references that had been made to the following international road safety audit manuals:

- AUSTROADS, *Guide to Road Safety Part 6: Road Safety Audit*, Austroads publication No. AGRS06/09, January 2009
- Department of Transport, Abu Dhabi, *Road Safety Audit Guidelines,* 2009, (Unpublished)
- Institution of Highways and Transportation, *Road Safety Audit*, October 2008
- Department for Transport, *Manual for Streets*, First edition, 2007
- FHWA, *Road Safety Audit Guidelines*, Publication No. FHWA-SA-06-06, 2006
- National Roads Authority, Ireland, *Road Safety Audits,* July 2004
- UK Design Manual for Roads and Bridges: *Road Safety Audit*, HD19/03, November 2003
- PIARC Technical Committee on Road Safety (C13), *Road Safety Manual*, Version 1, 2003

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PREFACE

Background to this Manual

On 8 February 2007 the Ministers of Transport and of Health of African States adopted the Accra Declaration that noted the deteriorating condition of transport infrastructure encouraging member States to use the WHO/World Bank *World Report on Road Traffic Injury Prevention*[2] as a framework for road safety and implement its recommendations to substantially reduce the causes and risk factors associated with road crashes. A target was set to reduce crash fatalities by half by the year 2015.

Notwithstanding this noble intention, a total of 13 802 people died on South African Roads in 2010/2011. It is estimated that some 7 500 people are left permanently disabled as a result of road traffic crashes and 60 000 seriously injured annually. The fatality rate of 27,5/ 100 000 population are exceedingly higher than the estimated world average of 18,8/ 100 000 population

During the year 2010/2011, people were being killed

on South African roads at a rate of

1 every 38 minutes

South Africa developed a Road Safety Manual (SARSM)[3] as a "best practice tool" to assist road authorities with the evaluation of traffic operations and assessment of road safety aspects of their road network.

The SARSM was published as a draft document in 1999 and consisted of the following volumes:

- Volume 1: Principles and Policies
- Volume 2: Road Safety Engineering Assessment on Rural Roads
- Volume 3: Road Safety Engineering Assessment on Urban Roads
- Volume 4: Road Safety Audits
- Volume 5: Remedial Measures and Evaluation
- Volume 6: Roadside Hazard Management
- Volume 7: Design for Safety

[2] World Health Organisation, *World Report on Road Traffic Injury Prevention,* Geneva, 2004
[3] National Department of Transport, *South African Road Safety Manual*, 7 Volumes, Pretoria, 1999

The Road Traffic Management Corporation (RTMC) was established in terms of Section 3 of the Road Traffic Management Corporation Act, No. 20 of 1999, for co-operative and coordinated strategic planning, regulation, facilitation and law enforcement in respect of road traffic matters by the national, provincial and local spheres of government. One of the functional areas of responsibility allocated to the RTMC is that of "*Infrastructure Safety Audits*". This corresponds with the subject matter contained in the SARSM, and (by implication) therefore also sets the RTMC as the custodian of the SARSM.

Various South African authorities have used the principles embodied in the SARSM to assess the safety conditions on particular sections of road within their jurisdictions. Volume 2: Road Safety Engineering Assessment on Rural Roads and Volume 4: Road Safety Audits were used in particular. Since the publication of the SARSM extensive developments took place worldwide that all impact significantly on road safety in general and road safety in South Africa in particular. Due to these developments and the time since publication the SARSM was considered to be in need for review and updating.

This document is a revision of the SA Road Safety Manual, Volume 4: Road Safety Audits and is presented to road authorities in South Africa to be used as part of their approach towards the reduction in the number of road crashes and the reduction in the severity of crashes. Although RTMC is in favour of the mandatory application of the principles of road safety audit on all road projects in South Africa, it remains the prerogative of individual road authorities to embrace these principles and include them in the policies of that road authority. It is prudent to also point out that the non-acceptance of these guidelines may expose a road authority to increased risk of culpable liability. These guidelines serve to set out the process which a *diligens paterfamilias* in the position of the road authority should review road environment conditions in establishing the possible foreseeability of hazardous conditions developing on a road and taking reasonable steps to guard against such conditions.

The WHO[4] recommended that States should implement specific actions to prevent road traffic crashes, minimize injuries and their consequences and evaluate the impact of these actions. The WHO discussed road safety interventions and, in particular, their effects on reducing the frequency and severity of crashes, as well as their cost-effectiveness, recognising that relevant data should be available. It recognised that no standard package of interventions was suitable for all countries, but stressed that countries can follow several good practices, including requiring new road projects to be subject to a road safety audit by a road safety specialist independent of the road designer.

Road Safety Audits form an important role in diagnosing the safety of the road network, both as far as existing roads and upgrading projects on the road and transport network are concerned. The review of SARSM Volume 4: Road Safety Audits was considered to be particularly important. This ensures that South African practice remains in line with International Best Practice and that the experience of South African road safety engineering practitioners is utilised in revising and contextualising Guidelines for Road Safety Audits.

[4] World Health Organisation, *World Report on Road Traffic Injury Prevention,* Geneva, 2004

Scope

This Road Safety Audit Manual is structured in four parts as follows:

Part A provides a background to road safety audits and the process of road safety auditing.

- ***Chapter 1*** *(Road traffic safety management) provides an overview of reactive and proactive approaches to road safety improvement.*
- ***Chapter 2*** *(The Road Safety Audit concept) discusses the concept of road safety audits, as well as the purpose and value of undertaking road safety audits. It also introduces the different role players in the road safety audit process and their responsibilities. This chapter specifically addresses the role that checklists or prompt lists play in the road safety audit.*
- ***Chapter 3*** *(The Road Safety Audit Process) explains the process of a typical road safety audit and identifies the responsibilities for each step in the process*.

Part B provides the detail description on conducting road safety audits.

- ***Chapter 4*** *(Road Safety Audits on New Projects) describes the road safety audits that may be conducted on road projects during the planning, design and construction process. It describes Stages 1 to 5 Road Safety Audits ranging from Feasibility/ Preliminary design audits up to Pre-opening stage audits.*
- ***Chapter 5*** *(Road Safety Audits on Existing Roads – Road Safety Appraisals) describes the road safety audit process as applied to existing roads. It explains some deviations to the normal road safety process allowing for crash history and other sources of information and providing for an alternative road safety audit reporting structure*
- ***Chapter 6*** *(Other road safety audits) discusses the conditions that may lead to conducting other road safety audits that may be focused on addressing specific problems or areas.*

Part C describes the legal environment within which road safety audits have to be conducted.

- ***Chapter 7*** *(Legal implications of road safety audits) introduces the legal environment pertaining to the law of delict and negligence on the part of the road authority and the risk of liability on the grounds that the road authority did not comply with a legal duty (or duty to care) to provide or maintain safe road facilities*

The **Appendices** to this Manual form the fourth part and provide references, prompt lists, examples and templates to aid road authorities, design organisations and road safety auditors.

Definitions[5]

Audit brief: The instructions to the audit team defining the scope and details of the project to be audited, including sufficient information for the audit to be undertaken;

Audit team: A team that works together on all aspects of the audit, independent of the design team and approved for a particular project by the Project Manager on behalf of the Road Authority;

Audit team leader: A person with the appropriate training, skills and experience who is approved as the audit team leader for a particular audit by the Project Manager on behalf of the Road Authority;

Audit team member: A person with the appropriate training, skills and experience who is approved as member of the audit team for a particular audit by the Project Manager on behalf of the Road Authority, and who reports to the Audit Team Leader in all aspects pertaining to the audit;

Audit team observer: A person with the appropriate training, skills and experience accompanying the audit team to observe and gain experience of the audit procedure;

Crash: A rare random multifactor event always preceded by a situation in which one or more road users have failed to cope with the road environment;

Crash Investigation: The collection and examination of historical crash data over a period of time in order to identify patterns, common trends and factors which may have contributed to the crashes;

Continuing Professional Development (CPD): The attendance of conferences, courses, workshops and any other training undertaken with the purpose of keeping road safety auditors up to date with the latest developments in road safety audit, crash investigation and road safety engineering;

Design and Build (D&B): A type of contractual arrangement whereby a single entity (contractor/ designer consortium) is responsible for undertaking both the design and construction of a project;

Design, Build, Finance and Operate (DBFO): A type of contractual arrangement whereby the private sector undertakes the delivery and management of a project and services traditionally undertaken by the public sector, including partial or complete finance of the construction and operations of the project;

Design organisation: The organisation(s) commissioned to undertake the various design phases of the project or the construction of the road project in the case of D&B, DBFO or PPP type projects;

Design team: The group within the design organisation undertaking the various design stages of the project;

Design team leader: A person within the design team responsible for managing the road project design and coordinating the input of the various design disciplines;

Director: The Director in the Road Authority with overall responsibility for the road project;

[5] *Largely based on Department of Transport, Abu Dhabi, 2009, Road Safety Audit Guidelines*

Health and Safety: Activities or processes that focus on the prevention of death, injury and ill health to those at work and those affected by the work activities;

Maintaining agent: The authority responsible for maintaining the completed road project, which may be a term contractor employed on behalf of the Road Authority to undertake this action;

Performance Based Maintenance (PBM) contract: An agreement between a government department or state enterprise and a private contractor whereby the private contractor maintains the road to achieve specified condition standards for a certain period of time, in return for an agreed payment stream;

Project Manager: The person within the Road Authority responsible for ensuring the progression of road projects in accordance with policies and procedures of the Road Authority, and ensuring compliance with the requirements of the road safety audit process;

Public-Private Partnership (PPP): A government service or private business venture which is funded and operated through a partnership of government or a state enterprise and one or more private sector companies;

Response report: A report from the Project Manager to the Director on each recommendation in the audit report that the Project Manager proposes should either be: implemented, not be implemented or an alternative or modified action be taken to that recommended in the audit report;

Road Authority: The authority responsible for the operations and maintenance of the road being audited;

Road Safety Appraisal: A systematic examination of an existing road location, in which an independent and qualified team reviews on-site conditions and historical evidence to identify existing or potential road safety problems and suggest measures to mitigate those problems;

Road Safety Audit: A formal examination of a new or upgrading project where interaction with road users takes place, in which an independent and qualified team identifies potential road safety problems and suggest measures to mitigate those problems;

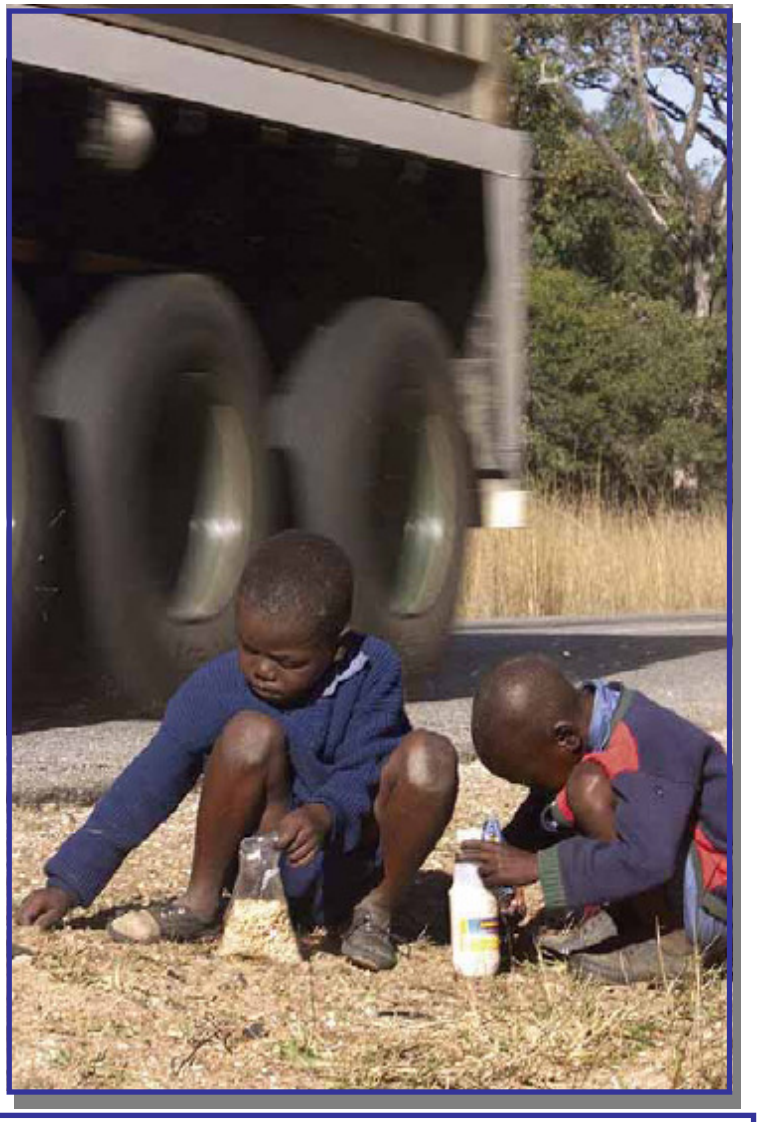
Road Safety Engineering Assessment: The screening process utilised to establish the road safety status of sections of an existing road network resulting in a list of prioritised locations that should be further investigated;

Road Users: All persons with a transportation intent located within the road reserve irrespective of the purpose of their trip or mode of transport. They include the visually and mobility impaired;

Specialist Advisor: A person approved by the client organisation to provide specialist independent advice to the audit team should a project includes complex features outside the experience of the Audit Team members;

Temporary Traffic Management: The arrangement of temporary signs, markings and other devices to guide road users safely through road works, whilst also ensuring the protection of works personnel;

Vulnerable Road User: A Road User with little or no external protection, or with reduced task capabilities, or reduced physical capabilities. They include pedestrians, cyclists, motorcyclists and wheelchair users.



Intolerable risk of vehicle/ vulnerable road user conflict
Source: Red Cross, 2007

PART A: INTRODUCTION TO ROAD SAFETY AUDITS

1 ROAD TRAFFIC SAFETY MANAGEMENT

1.1 The Role of Road Safety Engineering

Road safety engineering plays a vital role in influencing driver behaviour as engineering measures like traffic control, for example, rely heavily upon the driver to see, interpret, respond to and obey that measure. In this sequence, the road environment should assist the driver in making a series of correct decisions and, if not correct, provide a forgiving road environment to reduce the severity of the crash.

A safe road environment should provide no surprises to road users, adequate guidance throughout the route, controlled release of information – not too much at a given point or over a short length of road, repeat information where necessary to reinforce the message, and forgive road users if these principles fail.

- *The road should WARN road users of any possible hazards;*
- *The road should INFORM road users of the type of unexpected conditions that are likely to be encountered;*
- *The road should GUIDE road users through sections of a route with sometimes unexpected conditions;*
- *The road should CONTROL road users through conflict points or areas of conflict;*
- *The road should FORGIVE errant vehicles and behaviour of road users involved*.

Figure 1.1 Example of an unforgiving road environment

1.2 The Road Traffic System

Road traffic can be considered as a system that consists of three basic components that interact with each other, namely, the road user, the vehicle and the road environment. A crash occurs when one or a combination of these components fails. Road safety practitioners are unanimous in recognising the importance of understanding the interaction between these components in developing countermeasures for improving safety.

Three important models have been developed to guide practitioners in analysing road traffic safety. These are the 3–E's Model, Haddon Matrix and Safe Road System approaches.

1.2.1 The 3 E's Model

The 3 E's model is based on the interaction of three components to improve road safety. Measures to improve road safety were traditionally categorised as belonging to Education, Engineering or Enforcement, thus allocating remedial measures to different functionaries for the development and implementation. Two additional E's have been recognised as having an important influence on improving road safety:

Emergency response recognises the role that efficient post crash treatment of road traffic injuries play in improving road safety;

Evaluation recognises the role that data collection and analysis play in establishing the extent of the road safety problem and the effectiveness of remedial measures.

1.2.2 The Haddon Matrix

The Haddon matrix is a two dimensional matrix that maps the vehicle, road environment and road user to a timeline before during and after a crash occurred, as shown in Figure 1.2.

		SAFER ROAD USERS	**SAFER VEHICLES**	**SAFER ROAD ENVIRONMENT**
BEFORE CRASH	Crash prevention			
DURING CRASH	Injury prevention			
AFTER CRASH	Life sustaining			

Figure 1.2 The Haddon Matrix

Each of the nine available cells in the matrix may contain a strategy particularly focused on achieving an improvement of road safety. The Haddon Matrix is therefore an invaluable tool in assessing the extent to which road safety strategies succeed in providing an all-encompassing approach towards improving road safety.

1.2.3 Safe Road System

The Safe Road System recognises the complexity of the interaction between components of road traffic and the processes between them that all contribute towards safer travel. In particular the Safe Road System recognises the role played by lower speeds in reducing the severity of the outcome of a crash. The framework for the Safe Road System is shown in Figure 1.3.

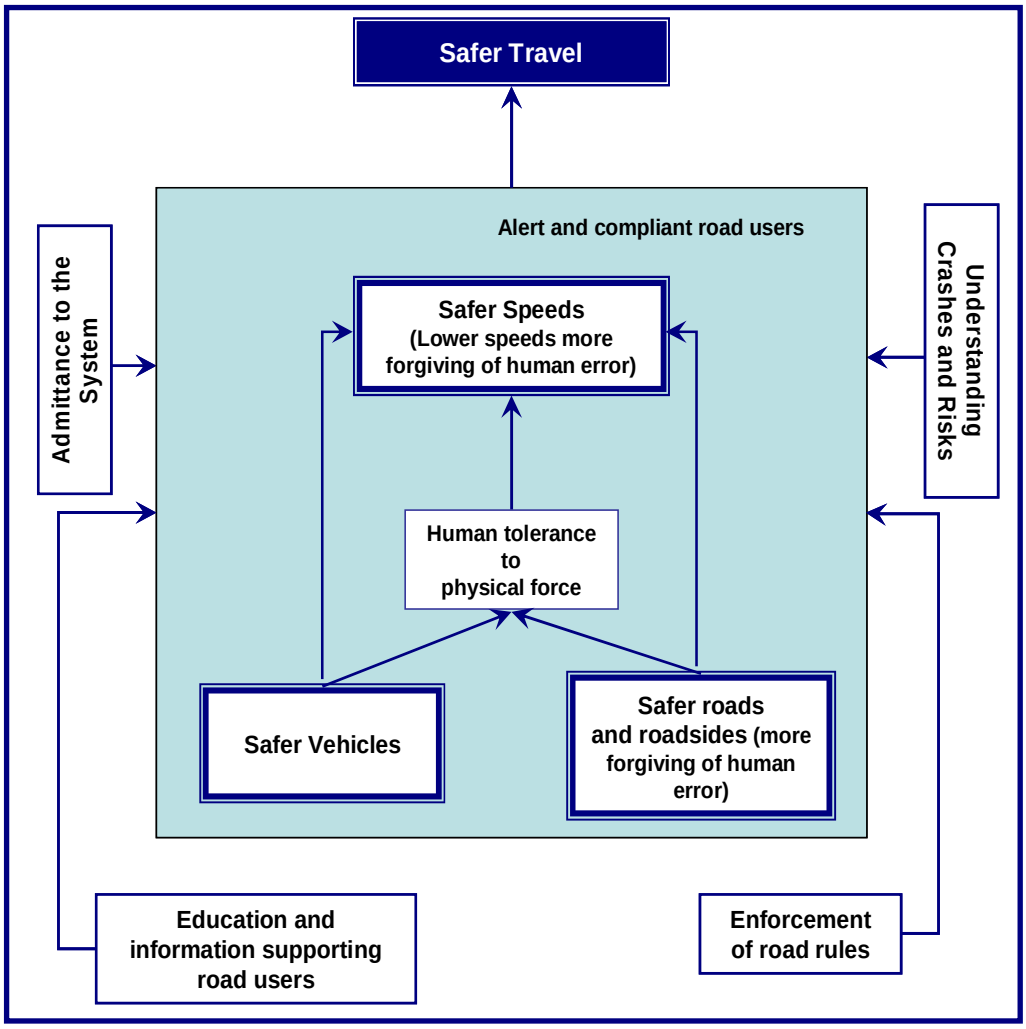


Figure 1.3 Safe System Framework
Source: Austroads 2009, Guide to Road Safety Part 6: Road Safety Audit

Crash
A rare random multifactor event always preceded by a situation in which one or more road users have failed to cope with the road environment.

1.3 Road Traffic Safety Management

1.3.1 Objective of Road Traffic Safety Management

The objective of Road Traffic Safety Management is to integrate all activities affecting road safety. This includes the direct effects of road safety programs as well as the indirect effects of road safety, and other policies/systems that need to be included as part of the Road Traffic Safety Management System.

The Organisation for Economic Cooperation and Development (OECD)[6] identified five reasons why road traffic safety management is necessary:

- " *There is a multiplicity of safety problems to deal with*;
- *Safety measures are more effective if they form part of a comprehensive safety policy; to ensure maximum impact, complementary measures of such a policy should be identified and co-ordinated;*
- *Traffic safety is often not a leading priority issue for local policy-makers or citizens; therefore, as well as direct safety initiatives, there is a need for embedding safety measures in other policies;*
- *Crashes are usually distributed widely over an urban area; therefore, it would be misleading to design countermeasures for individual crash sites only;*
- *Integrated safety programs help local authorities in getting a complete picture of existing problems before defining priorities for action.*"

1.3.2 Principles of Road Traffic Safety Management

A Road Authority can realise the potential for reducing fatalities, injuries and damage in crashes on the road network, and making people feel safer in traffic, by applying the following principles:

- *Consider all kinds of road users, especially those who are the most vulnerable, such as pedestrians;*
- *Consider the function and use of different kinds of road, and demarcate manageable areas within the jurisdiction of the particular road authority;*
- *Prepare a road safety plan for each area;*
- *Set up a Road Safety Committee or Working Group and encourage all professional groups to harmonise their efforts towards the achievement of road safety objectives;*
- *Translate strategy and objectives into implementation of road safety plans for each area;*
- *Monitor progress towards road safety objectives*.

[6] Organisation for Economic Co-operation and Development, 1990, *Integrated traffic safety management in urban areas,* Paris, France.

For road traffic safety management to be effective, it is of the utmost importance to pursue integration. In any road traffic safety management system there should be integration and co-ordination between:

- *The safety measures;*
- *The safety and other related objectives for policies;*
- *The various authorities and organisations involved*.

An integrated program results in:

- *Achieving a wider range of objectives;*
- *Involving a wider range of sectors of activity and expertise*.

1.3.3 Key Components of Road Traffic Safety Management

The key components of a road traffic safety management system include:

- *Joint participation by all the major authorities and organisations that manage and influence road traffic safety;*
- *A unified mission statement by the authorities and organisations towards a common goal of improving road traffic safety;*
- *Goals and objectives set by national, provincial, metropolitan and local government that are compatible with the mission to improve road traffic safety;*
- *The implementation and management of actions and processes to ensure that the mission, goals and objectives are effectively implemented.*

1.4 Reactive and Proactive Road Traffic Safety Management Strategies

The strategies implemented in road traffic safety management can be reactive or pro-active in nature.

- *A* **reactive approach** *to road safety is associated with the identification of locations experiencing safety problems (screening), problem definition (diagnosis), and the identification and implementation of countermeasures (cure).*
- *A* **proactive approach** *to road safety is associated with the prevention of safety problems before they manifest themselves in the form of a pattern of crash occurrences.*

Both prevention and cure should be inherent elements of an overall road traffic safety management system.

A **reactive approach** to road safety is based on the analysis of existing crash data. Road safety improvements are proposed in reaction to identified safety problems brought to light by crashes that have occurred after the road has been designed, built, and opened to the travelling public. Traditional reactive road safety engineering processes include activities such as:

- *Information collection and management (crash information systems);*
- *Identification of hazardous locations on the road network;*
- *Analysis, development and implementation of remedial measures*.

Limitations of the reactive approach are as follows:

- *It requires the identification of locations with extraordinary crash history before improvement plans can be developed and implemented;*
- *The supporting crash data is often dated, incomplete and/or insufficient to support accurate diagnosis and intervention; and*
- *It may also be more costly, since improvement plans are necessarily implemented on roads already built and open to public*.

Despite these limitations, no road traffic safety management system can be considered complete without a reactive component as it is a powerful tool for addressing existing safety problems.

A **proactive approach** focuses on the evolving "Science of Safety", that is, what is known about the evolving specific safety implications of highway design and operations decisions. The proactive approach applies this knowledge to the roadway design process or to improvement plans on existing roads to diminish the potential of crashes occurring prior to the road being built or reconstructed. Conducting road safety audits is an example of a proactive road safety strategy.

The advantages of a proactive approach include:

- *Crash prevention: It is not necessary for crashes to occur before prevention measures are taken; and*
- *Lower costs: Changing plans is easier and less costly than to implement an improvement plan on a road open to the public.*

Effective road safety management programs should provide an optimal balance between reactive and proactive strategies.

In both these approaches it is necessary to identify safety deficiencies that need to be actioned to diagnose the safety problems, and then identify and implement countermeasures to remedy the deficiencies. The process to be followed to identify the safety deficiencies is summarised in Figure 1.4

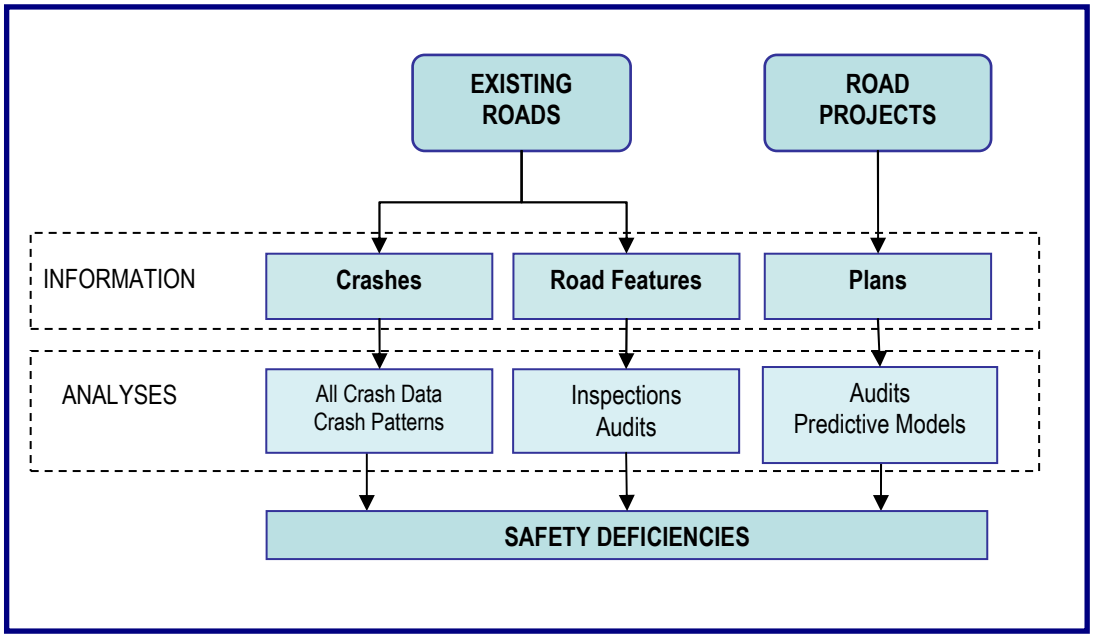


Figure 1.4 Safety Deficiency Identification Process
Source: Adapted from: PIARC, 2003, Road Safety Manual

1.5 Road Safety Audits in the Road Safety Strategy

Road Safety Audits can be utilised effectively as a crash prevention measure during the preliminary and design stages of any road or transportation project. It allows the identification of potential crash-causing road elements which can be removed before implementation. It also acts as a crash reduction tool on existing facilities by reporting on the safety performance and crash potential of the facility, again identifying safety deficiencies in the face of incomplete crash information.

For Road Safety Audits to be effective, commitment is required from a road authority. The road authority should bear in mind and support the fact that the Road Safety Audit process provides "specialist safety advice to the design team". Road Safety Audits should be an integral part of the overall program of an authority as it will otherwise mistakenly be perceived as a process that "*questions the competence and professionalism of the designer or road builder*". The process therefore also requires a spirit of "*cooperation and mutual respect among affected functional areas*"[7].

Prior to the publication of SARSM, South African road safety practitioners have been conducting road safety inspections for a number of years already. The Road Safety Audit as described hereafter, however, is different, since it is:

- *A formal process;*
- *An independent process (i.e. it is not an employee of the Client or a member of the Design Team that checks the design/ facility);*
- *A process that can easily be incorporated as a phase/ phases in the lifecycle of a road project;*
- *A process with focus on crash prevention rather than on remedying an existing road safety problem*.

[7] *Ogden K, 1996, Safer Roads: A guide to road safety engineering*

1.6 International experience of road safety audits

Road safety audits have been introduced in the UK as an independent checking of roads with the goal of improving the operational safety of projects in the Kent County Council during the 1980's. Road safety audits became mandatory for all national trunk roads and motorways in the UK in 1991.

Road safety audits were introduced in Australia and New Zealand in 1990 and have since become standard practice in many countries around the world, often also being required as an inherent part of projects being funded by international aid agencies in developing countries.

The increased utilisation of road safety audits as a road safety improvement tool is supported by the economic benefits that stems from the implementation of remedial measures. The cost and benefits of conducting road safety audits has been the subject of much debate internationally. Some of these findings are as follows[8]:

In the case of design stage audits the following were found:

- BCR for implementing the recommendations for individual audits ranged from 3:1 to 242:1
- BCRs of individual recommendations within a single audit ranged from 0,06:1 to 2600:1
- Over 90% of all implemented recommendations within the design stage audits had BCR > 1
- About 75% of all implemented recommendations had BCR > 10
- The majority of design audit findings required very low-cost responses (65% of recommendations had a cost < AU$1000); Of these low cost responses 85% had BCRs > 10

In the case of audits on existing roads the following were found:

- Implementing the proposed actions on a range of RSAs indicated BCRs between 2.4:1 and 84:1
- The BCRs of individual proposed actions within existing road safety audits ranged between 0.003:1 and 460:1
- Over 78% of all proposed actions had BCRs >1.0
- Approx 47% of all proposed actions had BCRs>5
- Approx 95% of proposed actions with a cost less than AU$1000 had BCR>1

Other studies also reported:

Europe: The cost of a road safety audit is significantly less than 1% of construction cost

Surrey County Council: Comparison of audited schemes with a similar not-audited schemes suggested that the audit could save at least one casualty per audited scheme per year.

Other studies (Denmark and UK) indicated that First Year Rate of Return ranged between 149% and 600%. This equates the first year benefits comparison with the cost of the remedial measure. This can also be interpreted that the payback period of the cost of the remedial measures could be far less than one year

[8] *Macauley J & McInerney, R, 2002, Evaluation of the proposed actions emanating from road safety audits, AP-R209/02, Austroads, Sydney NSW, Australia*

2 THE ROAD SAFETY AUDIT CONCEPT

2.1 Purpose

The South African road network ranges from very low traffic volume roads that primarily give access to remote areas, to extremely high traffic volume freeways that are essential to provide mobility facilities in the densely populated urban areas. The South African road network also resorts under the jurisdiction of widely differing road or local authorities. These roads have been designed and built using standards that vary appreciably and which have changed over the years. As a result of insufficient attention to maintenance and the ever-increasing traffic volumes, the condition of the roads deteriorated extensively over the years. Their condition is often blamed for deteriorating safety performance. Furthermore these roads traverse areas where the level of roadside development also varies significantly and where pedestrians and non-motorised transport exist in parallel and in conflict with vehicular traffic, creating potentially hazardous conditions.

The operation of the road network may be described as a system comprising the interaction of three main components: the road user (human), the vehicle and the road environment. Factors contributing to crashes can be attributed to any one of these components or any combination thereof, as shown in Figure 2.1.

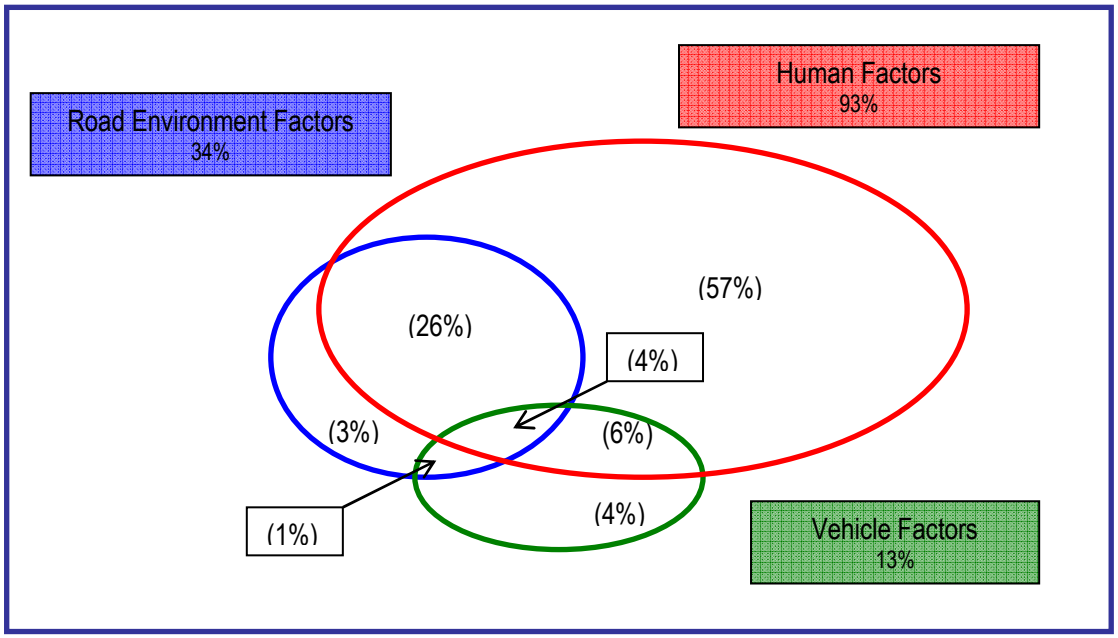


Figure 2.1 Factors contributing to road traffic crashes
Source: Treat et al., 1979, in: PIARC, 2003 Road Safety Manual

Although human factors contribute to the majority of crashes, changes to behaviour are often slow and require a sustained effort, whilst improvements to the road environment that influence the human response can be implemented quicker and may have an immediate and longer lasting effect. Road safety auditing is a process that may be used on both existing roads and new road projects to systematically assess the road or a proposed project to detect any defects that are likely to influence the safety of the road and result in a crash. Road safety audits can thus contribute to the overall enhancement of the safety of the road network.

Road safety auditing may be used on both existing roads and new road projects

The purpose of this Manual is to act as a best-practice guideline document that describes the steps that should be followed and the elements that should be considered when undertaking road safety audits.

These guidelines:

- *Describe the road safety audit process;*
- *Provide guidelines for conducting road safety audits in a standardised manner;*
- *Provide prompt lists to assist in road safety auditing;*
- *Support safer road designs*;

2.2 Road Safety Audit Terminology

The SARSM (1999)[9] used two terms to describe road safety investigations, namely road safety engineering assessment and road safety audit. It defined these two types of investigation as follows:

> *A road safety engineering assessment is the process utilised to establish the road safety status of an existing road network. It is performed on all the road network elements, using a set of pre-defined key indicators. The road safety engineering assessment process provides a list of prioritised locations that should be further investigated.*
>
> *A road safety audit is a formal examination of a future or existing road/traffic project/ any project were interaction with road users takes place, in which an independent, qualified examination team reports on the crash potential and safety performance of the project.*

SARSM (1999) described road safety engineering assessment as a network screening process to determine sites with promise, resulting in a *list of prioritised hazardous locations* on which more costly and detailed examinations could be conducted.

[9] *National Department of Transport, 1999, South African Road Safety Manual (Draft), 7 Volumes, Pretoria*

SARSM (1999) described road safety audit as a study at a particular location to identify the potential safety problems at the particular site, resulting in a report *stating all potential safety problems at the particular site.*

In this Manual the terminology that had been used in the SARSM (1999) is used and/or revised in line with the following descriptions:

- ***Road safety engineering assessment**: This is a screening process to establish the road safety status of sections of an existing road network. It is a network based process performed on selected sections of the road network using a set of pre-defined key indicators to determine the feasibility of safety improvement of such a section. The road safety engineering assessment process provides a list of prioritised locations that should be further investigated.*
- ***Road Safety Audit:** This is a formal examination process of a new or upgrading project where interaction with road users takes place, in which an independent and qualified team identifies potential road safety problems and suggest measures to mitigate those problems. The road safety audit process results in a report describing potential safety concerns that should be reconsidered prior to advancing to the next stage of the design process or to physical construction or taking over completed construction works.*
- ***Road Safety Appraisal[10]:** This is a systematic examination process of an existing road location, in which an independent and qualified team reviews on-site conditions and available historical evidence to identify existing or potential road safety problems and suggest measures to mitigate those problems. The road safety appraisal process results in a report describing potential safety concerns on-site and suggested remedial measures.*

2.3 The Definition of a Road Safety Audit

> *A **Road Safety Audit is** a formal examination of a new or upgrading project where interaction with road users takes place, in which an independent and qualified team identifies potential road safety problems and suggest measures to mitigate those problems.*

The essential elements of this definition are as follows:

- ***Formal examination**: The road safety audit is a formal and systematic examination process that ensures a regular and uniform application.*
- ***New and upgrading projects**: Road safety audits focus on the examination of new road projects or upgrading projects to detect defects or features that may contribute to casualty crashes or to the severity of such crashes.*

  An upgrading project is a project that complies with the Development category of works as used by SANRAL[11].

[10] This is referenced as a Road Safety Audit Review (RSAR) in US literature or Road Safety Inspection in European literature.

[11] *South African National Roads Agency, 2002, Geometric Design Guidelines, Version 1.0, November 2002*

This category is subdivided in two classes as far as existing roads are concerned, namely Strengthening and Improvement, which are described in Figure 2.2.

- ***Independent audit team:*** *All the members of the audit team shall be independent of the design team responsible for the new project. This ensures a balanced (impartial) audit that does not favour issues which the design team may be keen to either implement or avoid, thereby possibly compromising safety. No member of the audit team shall have any line management responsibility for the work that is being audited. This independence allows the audit team to examine the road design with "fresh eyes".*
- ***Qualified audit team****: The audit team shall be suitably qualified and experienced, which includes crash investigation and road safety engineering experience, previous road safety audit experience or skills, and knowledge of the latest developments in road safety engineering.*
- ***Focus on road safety issues****: Road safety audits are focused solely on detecting potentially hazardous features or design flaws that may negatively impact on the safety of the road-user. Road safety audits are not audits of design standards and are not health and safety reviews*.

2.4 The Objectives of a Road Safety Audit

The objectives of the road safety auditing **process** are:

- *To minimise the severity and crash risk of road traffic crashes that may be influenced by the road facility or adjacent environment;*
- *To minimise the need for remedial measures after the opening of a new road project;*
- *To reduce the full life-cycle cost of a road project by reducing its crash cost;*
- *To create and maintain an awareness of safe design practice during all stages of a road project.*

The objectives for any road safety audit are therefore:

- *To identify and report on the crash potential and safety problems of a road project;*
- *To ensure that road elements with an increased risk potential are removed or that measures are identified to reduce the risk thereof;*

IHT (2008)[12] explains that it will be necessary for the road safety auditor to ask and report on two key questions pertaining to the project being audited:

- "*Who can be hurt in a crash on this part of the road/ project and how might that happen?" and*
- *"What can be done to reduce the potential for that crash, or to limit its consequences?*"

[12], *Institution of Highways and Transportation, 2008, Road Safety Audit*

Strengthening (S)

Strengthening typically includes maintenance treatments such as the addition of thick surfacings, or the removal of part of the existing pavement structural layers and the addition of layers to restore or improve structural integrity and to increase the strength of the pavement. It is normally applied at the end of a pavement's structural life, when the pavement's problems are only structural of nature and no quality of service problems is anticipated in the medium to long term.

Strengthening works are divided into the following works types:

1. REHABILITATION (R): Rehabilitation is most effective on pavements that are exhibiting signs of structural deterioration (crocodile cracking and rutting, in particular) but not to such an extent that complete reconstruction (removal and replacement of the base and/or sub-base) will be more economical. Rehabilitation could include the reworking (but not removing) of the top 150 mm of the existing pavement to form a uniform platform for the addition of new pavement layers. Rehabilitation increases the structural capacity of the pavement to a condition that is very near or equal to that of an equivalent new pavement.

2. RECONSTRUCTION (C): This is the removal of part or all of the existing pavement layers (both bound and unbound layers) and the construction of a new pavement. Reconstruction is appropriate when the pavement has structurally failed and the sub-grade requires strengthening (including sub-drainage construction) in order for the new pavement to perform properly. Since reconstruction consists of the removal of the structure of the existing pavement, it offers the opportunity to correct sub-grade or base deficiencies, to slightly adjust the vertical geometry, to add drainage structures, etc. These options are not viable when the pavement is only rehabilitated. Reconstruction increases the structural capacity of the pavement to a level that is required for the medium to long term.

3. BRIDGES (B): This refer to the works related to strengthen a under designed bridge to enable it to carry the required design loads.

Improvement (I)

This comprises works that aim to improve the quality of service on roads with adequate remaining pavement structural life, but with an unacceptable quality of service. Improvements are normally applied to roads experiencing an unforeseen growth in traffic due to i.e. change in use of the road. These include measures of improving quality of service on existing roads such as relieving traffic congestion, road safety, road passability, etc.

Improvement works are divided into the following works types:

1. LEVEL OF SERVICE (L): This comprises works that retain the existing pavement structure, but increases the width in selected areas (i.e. addition of climbing lanes) throughout the length of the section to improve passability.

2. CAPACITY (C): This comprises works that retain the existing pavement, but increases the width over the total length of the section. These include partial widening and lane addition.

3. ALIGNMENT (A): This comprises works that change the road geometry for part of a section, but that retain some of the existing pavement structure. These include local geometric improvements, and intersection improvements.

4. BRIDGES (B): This comprises works that retain the existing bridge, but increases the width over the total length of the bridge. It also include all work related to improve the horizontal and vertical clearances over and under the bridge.

Figure 2.2: Upgrading Projects Subject to Road Safety Auditing

Source: SANRAL, 2002

2.5 The Benefits of Road Safety Audits

Road safety auditing is a recognised crash prevention road safety tool that has the following benefits:

- *A reduction in the likelihood of crashes on the road network;*
- *A reduction in the severity of crashes on the road network;*
- *An increased awareness of safe design practices among traffic engineers and road designers;*
- *A reduction in the need to modify projects after they are built;*
- *A reduction in the life-cycle cost of a road;*
- *A more uniform road environment that is more easily understood by road users;*
- *A better understanding and documentation of road safety engineering;*
- *Eventual safety improvements to standards and procedures;*
- *More explicit consideration of the safety needs of vulnerable road users.*

2.6 Key Requirements for Road Safety Audits

The following aspects are key requirements for successful Road Safety Audits:

- *Adequate time and information to conduct the road safety audit*[13]*;*
- *Commitment from management;*
- *A recognised and agreed Road Safety Audit process;*
- *An independent road safety audit team or auditor;*
- *Prompt lists for the various stages of a road project;*
- *The development of expertise;*
- *Evaluation and* monitoring of the Road Safety Audit Process[14].

Adequate time should be provided during the process to allow for:

- *An appropriate number of site visits, including a night-time inspection;*
- *The scrutiny and evaluation of safety related aspects of all drawings and related project documents;*
- *The collection of any additional information required to carry out the Road Safety Audit;*
- *The preparation of a formal Road Safety Audit Report.*

[13] *Transit New Zealand, 1996, Safety audit policy and procedure*
[14] *Jordan PW & Barton EV, 1992, Road safety audit: What is it and why do we need it?*

2.7 The Role Players in Road Safety Audits

The role players forming part of the road safety audit are:

- ***The Client:*** *The road authority or organisation responsible for a road project which appoints a person or body to engage in the design, construction or investigation of a road project;*
- ***Audit team:*** *The group of one or more individuals with the necessary training as road safety auditors, having skills and experience in road safety auditing, road safety engineering, crash investigation and prevention, traffic engineering or road design that undertake the road safety audit;*
- ***Audit team leader:*** *The lead auditor that is responsible for compiling the road safety audit report and representing the audit team in liaising with the client;*
- ***Audit team member:*** *Possible additional auditor that assists in and contributes to the road safety audit;*
- ***Design team:*** *The group of one or more individuals responsible to plan, design or supervise the construction of a new road project within the organisation appointed by the client for these tasks*.

2.8 The Use of Prompt Lists

Prompt lists are provided in the Appendices for each stage of a road project for which a Road Safety Audit may be conducted. These lists are not intended to be exhaustive. They provide a prompt for checks that the audit team should make during the road safety audit and are intended to help the auditor identify potential safety deficiencies. They should be used in a way that best meet each auditor's needs. There is no single best way to identify safety issues and no single best way to utilise prompt lists. These lists should always be treated as prompts only; they are not a substitute for knowledge and experience. Many of the items in a prompt list may not even be relevant for a particular project and some items may also appear repetitive.

NOTE that these lists:

- *Should be used as a "memory prompt"* [15] *and a form of guidance to ensure that all issues are considered;*
- *Does not restrict the Road Safety Auditor that will make extensive use of his/her knowledge and prior experience to carry out the Road Safety Audit;*
- *Forms part of the formalisation of the Road Safety Audit Process that will ensure that Road Safety Audits carried out all over the country consider the same aspects in the audit process;*
- *Can be used by the Designer / Design Team to review a design and increase the safety thereof prior to the formal Road Safety Audit Process*.

[15] *Ogden K, 1996, Safer Roads: A guide to road safety engineering*

A successful audit is not achieved by ticking off a checklist. Checklists or prompt lists are a means to an end, not an end in itself[16]. These lists should therefore not be appended to the road safety audit report. The written report should contain sufficient explanation of the findings and recommendations without any need to refer to notes on checklists.

2.9 Types of Road Safety Audits

Road safety audits can be conducted at any stage in the life cycle of a road. A road safety audit conducted early in the life cycle has the greatest opportunity of realising positive crash prevention and the benefits associated therewith. As the design develops further towards implementation, the opportunity to positively influence crash prevention becomes more difficult and costly and the implementation of remedial measures more time consuming. Figure 2.3 shows the main types of road safety audits described in this Manual.

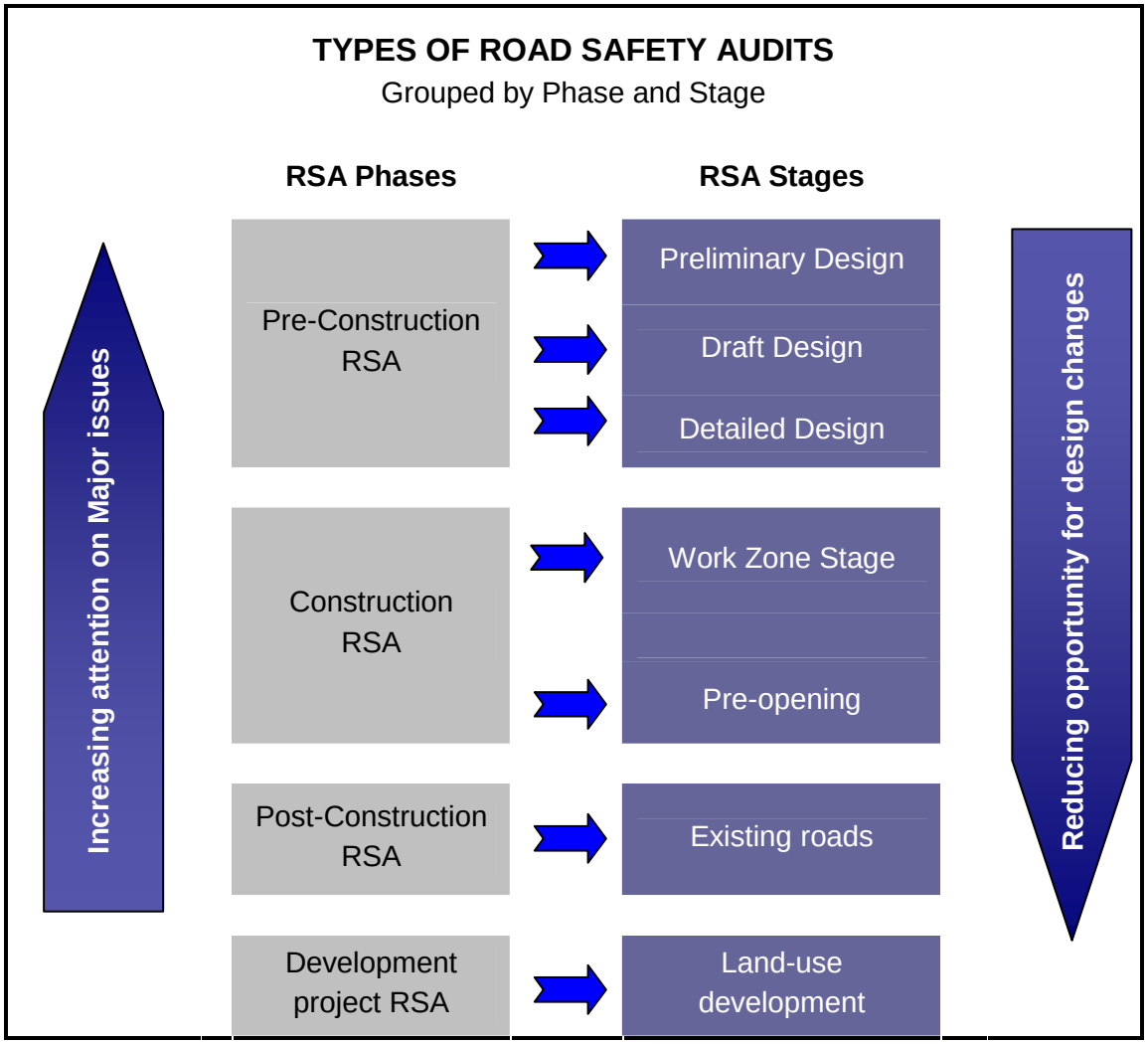


Figure 2.3: Types of Road Safety Audits

Source: Adapted from: FHWA Road Safety Audit Guidelines, 2006

[16] *Austroads, Guide to road safety Part 6: Road safety audit, January 2009*

2.10 A Road Safety Audit Policy

Internationally, it has been shown that a road safety audit is a highly successful road safety tool that may be used both during planning projects and on existing roads. It is a proactive tool, which means that one does not need to wait for the accumulation of crashes and casualties before positive steps can be taken to reduce or prevent crashes and casualties.

One of the most positive ways to ensure that road safety audit will become firmly established in a road authority is to establish a road safety audit policy. Road safety audits may be done at all stages in the life cycle of a road but the resources to conduct such audits may be restricted, both as far as the financial resources and trained road safety auditors are concerned. It is therefore necessary that a clear policy be established to detail when road safety audits should be conducted to gain maximum benefit of the audit process.

It is recommended that every road authority and municipal or local authority accepts a basic road safety audit policy statement that reads:

> " **All road projects under the jurisdiction of …….. (Department/ Municipality) shall be road safety audited at the following stages according to the class of road, in accordance with the procedures contained in the South African Road Safety Audit Manual:** "

AUDIT	FREEWAYS	ARTERIALS/ NUMBERED ROUTES	COLLECTORS/ UNNUMBERED PROVINCIAL ROADS	LOCAL STREETS/ DISTRICT ROADS
Stage 1: Feasibility/ Preliminary Design	√	√	N/A	N/A
Stage 2: Draft Design	√	√	**Optional**	N/A
Stage 3: Detail Design	√	√	√	√
Stage 4: CWZ Traffic Management	√	√	**Optional**	**Optional**
Stage 5 Pre-opening	√	√	√	**Optional**
Number of Audits	5	5	Min 2	Min 1

Figure 2.4: Road Safety Audit Policy

2.11 Evaluation of Road Safety Audits

Road Authorities introducing Road Safety Audits should implement an evaluation program for road safety audits.

The evaluation of road safety audits should be done for two major reasons, namely the improvement of the road safety audit process, *per se*, and the utilisation of the road safety audit results to revise and update planning and design applications.

The evaluation of the administrative process for road safety audits should address the following aspects:

- *"Procedures, problems encountered and effectiveness of the system;*
- *Critical appraisal of the prompt lists and their use; and*
- *Evaluation of costs and resources by scheme type and stage"* [17]

The evaluation of the findings and recommendations of road safety audits may lead to updated advice on the standardisation of design practices. In a UK study[18] where 925 audits covering a very wide range of projects had been analysed, common problems had been found pertaining to the following aspects:

- *Road users at risk:*
  - *People with disabilities*
  - *Pedestrians*
  - *Pedal cyclists*
  - *Motorcyclists*
- *Scheme features*
  - *Road traffic signs*
  - *Road markings*
  - *Street lighting*
  - *Road surfacing*
  - *Surface water drainage*
  - *Vehicle restraints (Safety fence/ guard rail)*
  - *Pedestrian guard rails*
- *Junction types*
  - *Traffic signals*
  - *Roundabouts (normal and mini)*
  - *Priority junctions*
  - *Pedestrian or cycle crossings*

The evaluation of road safety audit findings to identify and publicise common problem areas and the main reasons for increased risks would therefore provide an opportunity to review existing design practices and improve these for future application.

[17] *Sabey BE, 1993, Safety audit procedures and practice*
[18] *Belcher, M., S. Proctor and P. Cook, 2008, Practical Road Safety Auditing, 2nd edition*

3 THE ROAD SAFETY AUDIT PROCESS

3.1 Introduction

This chapter describes the road safety audit process step by step in terms of the flow chart shown as Figure 3-1.

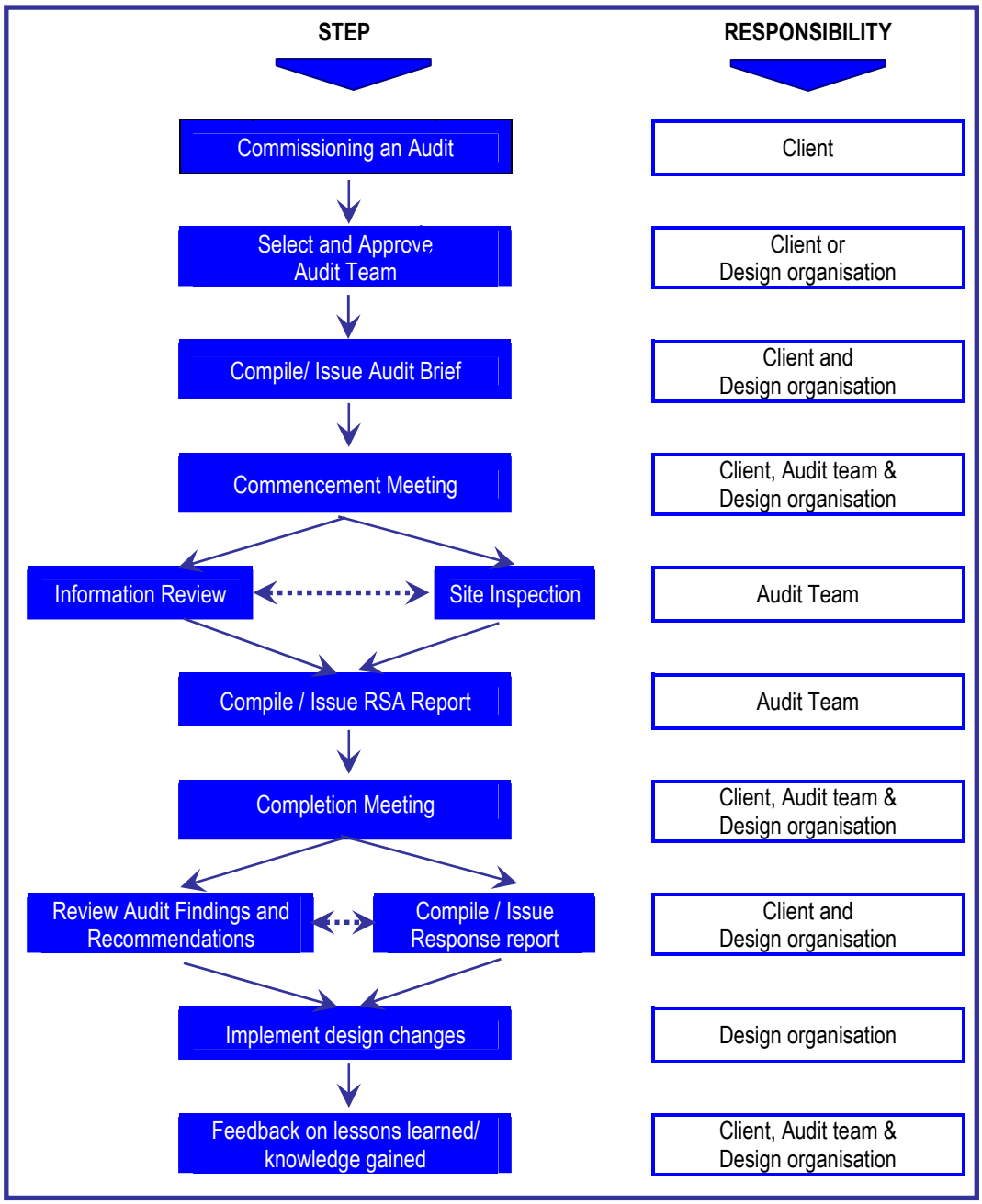


Figure 3.1: The steps in the road safety audit process
Source: AUSTROADS, 2009

The details in each step of the flow chart may differ from one type of project to another and should be adapted to suit the nature and scale of a particular project.

3.2 Commissioning an Audit

It is the responsibility of the Client, who is also responsible for the planning, design and construction of a project, to assess whether an audit is required, determine what stage audit should be done and then to commission the audit and manage the audit process.

Depending on the type of project, the client may also differ, for example:

- *For highway projects or projects on the primary route network, the client would be SANRAL;*
- *For certain Provincial roads, trunk roads and district roads, the client would be the Provincial road authority;*
- *For municipal projects, the client would be the municipality or local authority;*
- *For land-use developments the client may be the developer or the developer's representative, who may be the project manager or another consultant specifically appointed by the developer to oversee the development and safeguard the interests of the developer;*
- *For DBFO or D&B type contracts, the client would be the private operator or the main contractor/ consultant, depending on the detail of the agreement between the parties. In the case of a concession agreement between the road authority and the private operator, the oversight of road safety may have been retained by the road authority, which may then mean that the road authority remains one of the stakeholders, if not the client.*

3.3 Selecting the Road Safety Audit Team

Objective: *To select an audit team which is independent of the design team, with the proper skills, knowledge and expertise for that particular project;*

The success of a Road Safety Audit depends to a great extent on the successful selection of a Road Safety Audit Team. The Road Safety Audit Process is a process that adds expert road safety knowledge to a transportation project. The Road Safety Audit Team should therefore consist of accredited[19] Road Safety Auditors with at least one team member with expert knowledge and experience in road safety engineering.

3.3.1 Selection Process

The client representative may request the design organisation to propose an audit team to be considered by the client. If the client is satisfied with the independence, experience and expertise of the audit team, approval may be given for the appointment of the audit team to conduct the road safety audit/s as special services, specialist advice or as

[19] *Until a formal accreditation process for road safety auditors is in place in South Africa, clients should be convinced that the proposed road safety auditors have the proper experience of the auditing of projects similar to that for which auditors are being selected.*

additional services carried out on behalf of the client and subject to compliance with the Agreement for Consulting Engineering Services between the client and the design organisation. Alternatively, the client may call for quotations or tenders for the auditing subject to the procurement rules for the client. Irrespective of the appointment process, the audit team shall conduct the audit in accordance with the guidelines set in the Road Safety Audit Manual without interference or influence from the client or the design organisation.

3.3.2 Level of Skills of the Audit Team

The specialist skills and size of the Road Safety Audit Team depend upon:

- *the road safety audit project size;*
- *the stage of the road project (preliminary design, draft design, detail design, construction or pre-opening stage or existing roads).*

Audits at the different stages of design call for different skills[20]:

- ***Preliminary design stage (Feasibility):*** *The issues to be examined are often broader and much more subtle compared with later stages, and should only be conducted by very experienced road safety auditors. An experienced road design engineer who is familiar with road design standards and would be able to visualise the layout in three dimensions should be included. If the project include unusual aspects, the inclusion of a specialist in that field, either as audit team member or as specialist advisor to the audit team for that aspect should be considered;*
- ***Draft design stage:*** *Similar skills are required as for the preliminary design stage audit, but not all the members need be as experienced. Include team members with local knowledge of road user activities or relevant specialist experience, where possible;*
- ***Detail design stage:*** *In addition to the skills described for draft design, it would be beneficial to have audit team members familiar with the type of details included at detail design level, for example, traffic signal control, traffic signs and markings, street lighting, vehicle restraint systems or barriers, bicycle facilities or any other particular road user issue;*
- ***Pre-opening stage:*** *It is recommended that an experienced traffic officer with local knowledge of traffic patterns and road user activities, a representative of the maintenance agent and a representative from the community where the project is located are invited to attend and participate in a pre-opening audit. Care shall be taken that the audit team do not become unmanageably large. Alternatively, it may be beneficial for the audit team leader to conduct separate site visits with technical and non-technical members to ensure that the input of neither group would be stifled;*
- ***Temporary traffic management:*** *Include someone experienced in the management of construction work zones similar to the complexity of the project to be audited;*
- ***Specialist road user audits:*** *If the audit is aimed at a specific road user group, it is recommended that the audit team be strengthened by somebody from the same road user group as that for which the audit needs to be done. For*

[20] *Institute of Highways and Transportation, 1996*

example, if the facility is located in an area frequented by elderly pedestrians then an elderly person should be incorporated in the audit team to provide the audit team with the necessary insight on the experiences of that person during the audit.

3.3.3 Size of the Audit Team

The size of the audit team should be dictated by the size and the complexity of the project. An audit by one person can be effective on a small or uncomplicated project, provided that the auditor is well experienced. Using a one-person team just because of cost considerations should be avoided. In such a case it may be worthwhile to include a trained auditor with limited experience from within the client organisation as an additional member or observer. The need for such a member or observer to be independent from the actual design process or from the line management pertaining to that project must be emphasised.

3.3.4 Requirements for Audit Team members

Audit Team Leader

- *Attended at least 5 days formal crash investigation or road safety engineering training;*
- *Successfully completed a recognised road safety audit course of at least 4 days duration;*
- *Have at least five years experience in a relevant road design, construction or traffic engineering field; (team leaders for complicated projects should have more experience);*
- *Have at least three years experience of crash investigation or road safety engineering;*
- *Undertaken at least five road safety audits within a period of two years as an audit team leader or team member, including at least three at design stages;*
- *Demonstrate a minimum of two days CPD in the field of road safety audit, crash investigation or road safety engineering in the preceding twelve months;*

Audit Team Member

- *Attended at least 5 days formal crash investigation or road safety engineering training;*
- *Successfully completed a recognised road safety audit course of at least 4 days duration;*
- *Have at least three years experience in a relevant road design, construction or traffic engineering field;*
- *Have at least two years experience of crash investigation or road safety engineering*;
- *Undertaken at least three road safety audits within a period of two years as an audit team leader, team member or observer, including at least two at design stages;*

- *Demonstrate a minimum of two days CPD in the field of road safety audit, crash investigation or road safety engineering in the preceding twelve months.*

Observer:

- *Attended at least 5 days formal crash investigation or road safety engineering training;*
- *Successfully completed a recognised road safety audit course of at least 4 days duration;*
- *Have at least one year experience of crash investigation or road safety engineering*.

Notwithstanding these guidelines, it remains the prerogative of the client representative to accept the nomination of an audit team leader or member based on an overview of the nominee's experience and skills as provided in a *curriculum vitae* of three pages maximum.

The *curriculum vitae* should demonstrate that the previous experience of road safety audit, crash investigation or road safety engineering would be relevant to the project to be audited in terms of type and complexity. The CPD record should also focus on road safety audit, crash investigation and road safety engineering.

Specialist Advisor to the Audit Team:

If the project has unusual or specialist features, the client may consider the appointment of a specialist advisor to assist the audit team in that particular aspect. Such a specialist need not participate in any of the activities of the audit team that would not be related to the specialist input required from him/her.

Audit Team continuity:

It is preferable that the same audit team undertake all the audit stages of a particular project wherever possible. This is advantageous from a point of view of economy and consistency of approach. Any changes to the audit team or its individual members will be subject to approval by the client representative.

3.4 Audit Brief

Objective: *to provide the auditor with all the information that is necessary to conduct an adequate and effective Road Safety Audit of the project.*

The audit brief is central to the audit procedure. It defines the scope of the audit and contains all the background information to provide the audit team with a full understanding of the project.

The audit brief will be prepared by the design team on instruction from the client representative. A draft of the brief will be discussed with the audit team which would use this opportunity to clarify any aspects of the brief. The audit brief shall be issued by the client organization and instruct the audit team and/or specialist advisors on the scope of the audit and the role of the audit team and/or the specialist advisor.

All relevant information should be provided to the audit team. The design team/ client representative should provide the information in a format usable by the audit team. This step may need to be initiated well before the time to engage the audit team to avoid possible delays.

The Audit Brief shall contain the following**:**

- ***Scope of the Audit***
  - *An instruction to carry out the audit in terms of the road safety audit manual;*
  - *The stage audit to be conducted;*
  - *The project title;*
  - *A description of the section of roadway or junction/s to be audited;*
- ***Background Information***
  - *The purpose of the project;*
  - *The approach to achieving the purpose of the project;*
  - *Known concerns or deficiencies in the project that need to be considered during the Road Safety Audit;*
  - *A list of compromises that were made during the design process and reasons for the compromises;*
  - *Community input/ discussions*/ consultations/ correspondence *Known unresolved road safety issues;*
  - *A list of guidelines and standards that were utilised in the design;*
  - *Any known or approved departures from standards;*
  - *All previous road safety audit reports relating to the project;*
  - *All previous audit response reports (Exception reports);*
  - *Details of any notable events that have occurred or are related to existing features that in the opinion of the client representative will be required by an audit team with no prior knowledge of the project or of existing conditions.*
- ***Site Data***
  - *Traffic volumes for commercial and non-commercial uses and cyclists and pedestrians;*
  - *Environmental background such as adverse weather conditions (fog, mist, snow etc.), topography, historical monuments, vegetation and services that could influence the safety performance of the project;*
  - *Adjacent land-use and community characteristics.*

- ***Drawings and Project Documentation***
  - *Project drawings that are relevant to the particular stage of the project;*
  - *Drawings and plans covering the adjacent land-uses and road network that might affect the proposal or be affected by the proposal;*
  - *Appropriately sized plans of the project for the audit team to mark up and include in the road safety audit report; (preferably A3 sized sheets).*

3.5 Commencement meeting

Objective: *To ensure the design team understands the audit process; to provide the audit team with any additional information; identify key issues, constraints and potential issues requiring special consideration;*

A formal commencement meeting is the most effective way to acquaint the audit team with the background to the project and to share information that would not be readily available or discoverable during the short period that the road safety audit is conducted.

Purpose of the commencement meeting:

- *Hand over all relevant information, as set out in the audit brief, to the audit team;*
- *Review the scope and objectives of the road safety audit;*
- *Delegate responsibilities;*
- *Agree upon a schedule for the completion of the road safety audit;*
- *Set up lines of communication between the audit team leader, the client representative and the design team;*
- *Communicate matters of importance to the audit team; and*
- *Establish the format of the road safety audit report (whether the Client prefers the findings per category* or *for each road section/ project part per category).*

3.6 Information Review

Objective: *To review the designs and background information and identify potential safety problems and determine the safety status of the project.*

The design drawings are reviewed to gain insight in the interaction between the project and the road users and takes place in parallel with the site inspection/s.

The audit team shall review all information provided prior to the site inspection. The drawings are initially perused to record first impressions and list possible issues to be considered on-site. The audit team shall assess the drawings, traffic characteristics and, field notes and other information to identify any areas where potential safety problems may be found. The audit team may utilise the prompt lists during this review.

If the team had been provided with *crash data, t*he audit team leader may decide to initially disregard this information, because it is relevant to past safety issues. Alternatively he may allocate the assessment of such information to one of the members of the audit team. On completion of the site inspection such information could then be reviewed to complement the site findings.

The drawings and other relevant information shall again be reviewed after completion of the site inspection and earlier road safety observations be confirmed or revised.

Reviews of the information should be done individually and in a team-setting. Individual auditing allows an in-depth consideration of different aspects of the design while "brainstorming" in the team-setting can lead to the identification of new safety issues and better ways to mitigate or eliminate safety concerns.

3.7 Site inspection

Objective: *To identify how the proposal interacts with its surroundings and nearby roads; to visualise potential obstructions and conflicts for road users.*

Site inspections are essential for the success of a Road Safety Audit of any stage of a road project. A number of site inspections should be carried out to:

- *Familiarise the Road Safety Audit Team with conditions during the day and night-time and also during adverse weather conditions;*
- *Establish the interaction of the road project with the adjacent road network and land-uses;*
- *Identify potential safety problems such as conflicts between the movements of the different road users at a particular site;*
- *Review the site characteristics by using the prompt lists and the knowledge and expertise of the Road Safety Audit Team;*
- *Assess conditions on-site from perspective of all road users, identifying safety concerns relating to possible disruption of existing patterns and evaluating proposed new measures;*
- *Acquaint the Road Safety Audit Team with:*
    - *The adjacent road sections;*
    - *How the design of the road project handles the transition between the new road project (or existing location) and the adjacent road sections/ intersection (i.e. design consistency);*
    - *The extent to which the road user is being prepared for changes in design*.

ALL Road Safety Audit team members should be present at

ALL the site inspections.

It is recommended that photographs be taken during the site visit to be included in the Road Safety Audit Report. Apart from being illustrative, this also serves as a record for the Client. Videos are particularly useful for later reference and reconsideration when the Audit Response Report has been prepared or when an audit of a subsequent stage is being conducted. It serves as a record of the conditions on-site when the audit had been done.

3.8 Road Safety Audit Report

Objective: *To describe the background information provided for the Road Safety Audit; to report on the findings of the Road Safety Audit and to make recommendations regarding remedial measures to mitigate the identified safety deficiencies*.

At all road safety audit stages, including a possible Interim Stage Audit, the audit team shall prepare a written road safety audit report.

3.8.1 Layout and Contents of the Report

A road safety audit report shall include the following:

- *A brief description of the audited project;*
- *Identification of the audit stage and the team members as well as the names and affiliation of other contributors to the audit;*
- *Details of who was present at the site visit/s, when it was undertaken and what the conditions were on the day of the visit (weather, traffic, etc.)*
- *The specific road safety problems identified, supported with the background reasoning, stating:*
    - *The location of the problem;*
    - *The nature of the problem;*
    - *The type of crash that is likely to occur as a result of the problem;*
- *Recommendations for action to mitigate or remove the problems, taking cognisance that:*
    - *The recommended remedial measure shall be appropriate and viable for that particular stage of the audit;*
    - *Recommendations should be proportionate to the scale of the identified problem;*
    - *Recommendations worded as "to consider...", "to study....", "to monitor...", "to investigate possible treatments and implement the most appropriate...", etc. shall be avoided;*
    - *Recommendations shall not be motivated for implementation in a way that could be construed as the audit team trying to convince the client to take a specific action.*
- *An A3 or A4 location map, marked up and referenced to the problems and, where available, photographs of the problems identified;*

- *A statement, signed by the audit team leader in the recommended format;*
- *A list of the documents and drawings considered for the audit*.

The Road Safety Audit Report is focused solely on road safety aspects.

It refrains from commenting on any aspect that does not have demonstrable bearing on safety.

3.8.2 Style for Writing and Compiling the Report

It is important that:

- *The Road Safety Audit Report shall be written in an objective, professional and sympathetic manner, and shall not be judgmental. It should not create the impression that the professionalism or technical knowledge of the design team is being questioned or evaluated. Terms such as "unsafe", "sub-standard", "unacceptable" and "deficient" should be avoided where possible;*
- *Findings in the Road Safety Audit Report should be written from the perspective of describing a problem, rather than framing the problem in terms of the solution; For example: Where there is a high steep embankment carrying the road, the finding should rather be described as "The embankment at km... is too steep for an errant vehicle to traverse or regain control' than describing it as "The embankment at km ... has no guard rail." The latter description frames the problem in terms of a possible solution;*

Austroads provides the following guidance for framing of recommendations:

- Be constructive about how the safety problem may be resolved*;*
- Be realistic in providing feasible recommendations, considering the severity of the problem and the cost of solutions;
- Bear in mind that there may be high-cost/ low-cost and short-term/ long-term solutions;
- Avoid re-designing or specifying solutions in detail, but equally do not be so obscure or general that the client representative does not understand the point being made.

- *Road safety problems that had been raised in earlier Road Safety Audit Reports shall be revisited to determine if the proposed remedial measures have been implemented or alternative remedial measures approved by means of a response*

report. Where alternative solutions have been approved the audit team should recognise this and only raise the issue if it is considered remaining a safety problem. Where problems remain, it may be necessary to revise the recommended solutions taking into account the later stage in the audit process and the likelihood that the initial recommendation might not be feasible at this stage any more;

- *The Road Safety Audit Report should never be prescriptive;*
- *The Road Safety Audit Report shall separately address matters that may not fall within the audit brief, such as maintenance defects observed during site visits; such defects may be included in a separate section of the report, clearly identified as such or may be reported by letter to the client representative or the maintenance agent in order to be actioned as soon as possible.*
- *A road safety audit report should NOT include copies of any correspondence or copies of prompt lists that have been used in conducting the audit.*

3.8.3 Issuing the Report

The Audit Team shall send a draft report directly to the client representative

The Audit Team Leader shall discuss the draft report with the client representative prior to formal submission. The purpose of this discussion is solely to ensure that the findings and recommendations are within the scope of the audit, as defined in the audit brief. The client representative shall refrain from requesting amendments to the findings or the recommendations.

Once the Road Safety Audit Report is issued, it is a FINAL report – the report can not be amended and the Client may not request amendments or ask team members to omit certain details or findings.

The Audit Team:
Interprets the potential safety performance of a project
Provides independent road safety advice
Documents its findings and recommendations

3.9 Completion meeting

Objective: *To present the key findings and recommendations of the Road Safety Audit Report.*

The completion meeting is attended by the client representative and the Audit Team. The Client may determine if the Design Team Leader should also attend the completion meeting.

Whereas the Road Safety Audit Report often only shows the negative side of a project, the Completion Meeting can be used to share positive aspects of the project as well. Pictures or video footage may be shown to further illustrate key concerns of the audit team.

The completion meeting provides the opportunity to better understand the approach by the audit team in assessing the safety performance of the project. It is important that the completion meeting should NOT be viewed as an opportunity to disagree with the findings of the report.

3.10 Responding to the Audit Report

Objective: *To deal with the audit findings or recommendations in an effective manner; to determine whether the recommendations of the road safety audit should be implemented and, if decided otherwise, to record the reasons in writing for such a decision; and to put the audit recommendations into effect.*

3.10.1 Procedure to deal with audit findings

As the road safety audit process is a formal process it is also necessary that the close-out of the audit be properly and formally concluded by the preparation of a Road Safety Audit Response Report and the signing off by an officer from the client organisation with the necessary delegated authority.

After receiving the Road Safety Audit Report, the Client and Design team shall assess the report to decide how to respond to the findings and the recommendations. It is essential that the dealing with road safety audit reports should be well defined and documented as far as the following is concerned:

- *Who will respond to an audit report?*
- *Who will sign off on the audit response report?*
- *How will the agreed remedial measures be taken on board for action?*
- *Who will ensure that the agreed actions are followed through?*

Audit recommendations are not mandatory. Due to the potential for litigation subsequent to a crash at an audited site, it is necessary that the audit findings be given due consideration and the reasons for not accepting the recommendations forthwith or for

adopting another solution or delaying the implementation of the recommendations be well documented in the Response Report.

Each finding in the Road Safety Audit Report can be dealt with by either:

- *Accepting the problem and the proposed recommendation and initiating the remedial action;*
- *Accepting the problem in principle, but due to other constraints, implement changes that only go part of the way to resolve the safety problem, or implement a different solution than that recommended in the Audit Report;*
- *Not accepting the finding or recommendation at all*.

In SARSM, 1999, it was indicated that the client organisation provide formal feedback to the audit team. The scope of the audit brief does not provide for any further action by the audit team subsequent to the submission of the Road Safety Audit Report, making such a feedback unnecessary and superfluous. The non-response by the client may, however, have serious consequences.

It is important that the client organisation (road authority) specify a proper close-out procedure to the audit process.

It is **recommended** that the client regularly report to the political functionaries of that road authority on:

- Road safety audits that had been done;
- Responses to the road safety audits.

This ensures that the close-out process:

- Reaches the elected representatives of the community;
- Provides additional focus on the need to respond to a deteriorating situation that requires a turn-around strategy.

3.10.2 Risk assessment of safety concerns

On deciding upon the response to road safety audit findings, the client (with or without the design team) will have to bear in mind all of the competing objectives involved in the project, some of which may be seen as conflicting with safety. One of the concerns raised with regard to Road Safety Audits, is that the audits do not distinguish between major and minor safety problems or the likelihood that such a problem may lead to a harmful event.

It is therefore essential that the client needs to consider various options in managing the risk of rejecting a necessary action[21]. The client needs to consider the:

- *Likelihood that the identified problem will result in harm;*
- *Severity of that harm;*
- *Effectiveness of a remedy in reducing the harm;*
- *Designer's advice/ response to the audit finding;*
- *Cost of remedying the problem.*

This leads to a consideration of the risk that any identified problem may hold.

Risk assessment requires careful consideration at each step, which unfortunately, introduces a degree of uncertainty and inconsistency into the process. This may be reduced by regularly using the same group of officials to risk assess road safety audit findings and recommendations. If required in the Audit Brief, the audit team may be required to apply the same risk assessment process for all problems identified in a Road Safety Appraisal to provide guidance to the Client on the relative importance of the concerns voiced by the audit team for safety problems on existing roads.

Various risk assessment processes exist. They normally utilise conventional risk matrices assessing the severity and frequency of an occurrence. The combination of severity and frequency is qualitatively interpreted in bands of varying risk. The following four-step procedure outlines such a process[22] and may be useful to provide an indication of the level of risk and how to respond to it.

Step 1: Estimate the Possible Crash Frequency

FREQUENCY	DEFINITION
Frequent	One or more per month
Probable	One or more per year (but less than one per month)
Occasional	Once every one to three years
Remote	Less frequent than once in three years

Step 2: Estimate the Possible Crash Severity

SEVERITY of OUTCOME	EQUIVALENT CRASH OUTCOME	EXAMPLES
Catastrophic	Likely multiple deaths	High speed multi vehicle crash on freeway Car runs into crowded bus stop Bus and petrol tanker collide
Serious	Likely death or serious injury requiring hospitalization	High or medium speed vehicle/ vehicle crash High or medium speed collision with fixed roadside object Pedestrian or cyclist struck by car
Minor	Likely minor injury	Low speed vehicle crashes Cyclist falling from bicycle Left-turn rear end crash in a slip lane
Negligible	Likely trivial injury or property damage only	Some low speed vehicle crashes Pedestrian walks into object Car reverses into post

21 *Austroads, Guide to Road Safety: Part 6: Road Safety Audit, 2009*

22 Combined from: IHT, Road Safety Audit, 2008, RTA, *Road Safety Audit Manual for Dubai, 2008 & AUSTROADS, Guide to Road Safety Part 6: Road Safety Audit, 2009*

Step 3: Determine the Level of Risk

		FREQUENCY			
		Frequent	Probable	Occasional	Remote
SEVERITY	Catastrophic	**Intolerable**	**High**	**High**	**Medium**
	Serious	**High**	**High**	**Medium**	**Medium**
	Minor	**High**	**Medium**	**Medium**	**Low**
	Negligible	**Medium**	**Medium**	**Low**	**Low**

Step 4: Determine a Course of Action

RISK	SUGGESTED TREATMENT ACTION
Intolerable	The safety concern "must" be corrected, even if the cost is high
High	The safety concern "should" be corrected or the risk significantly reduced, even if the treatment cost is high
Medium	The safety concern "should" be corrected or the risk significantly reduced if the treatment cost is moderate, but not necessarily high
Low	The safety concern "should" be corrected or the risk reduced if the treatment cost is low

The suggested treatment action shown in Step 4 is indicative only. Road authorities should review the levels of risk that they would be prepared to take and develop a particular policy pertaining to the utilisation of Risk Assessment as part of road safety auditing and revise the suggested treatment actions to fit such a policy. This policy should then be implemented consistently.

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PART B: CONDUCTING ROAD SAFETY AUDITS

4 ROAD SAFETY AUDITS ON NEW PROJECTS

4.1 Pre-Construction Phase Audits

4.1.1 General

The greatest potential to improve infrastructure road safety is in the pre-construction phase of a project when the planning or design of a project can be positively influenced without the need to alter existing works. Pre-construction phase audits can be conducted on any proposal that is likely to influence the interactions between road users, or between road users and their physical environment.

This section discusses pre-construction phase road safety audits at the following stages:

- *Stage 1: Feasibility/ preliminary design stage*
- *Stage 2: Draft design stage*
- *Stage 3: Detail design stage*

4.1.2 Stage 1: Feasibility/ Preliminary Design Stage Audit

A Stage 1 Road Safety Audit has the following objectives:

- *To identify the potential safety problems that can influence the:*
  - *Project scope*
  - *Choice of route, layout and/or treatment*
  - *Design standard selection*
  - *Impact on the adjacent road network*
  - *Access Control: Provision of accesses/ intersections/ interchanges*
  - *Continuity of routes*[23]
- *To consider the design and operating speeds*[24]*;*
- *To assess the relative safety performance of various alternatives for the road project*.

[23] Ogden, 1996, Safer Roads: A Guide to Road Safety Engineering
[24] Transit New Zealand, 1993, Safety Audit Policy and Procedures

Austroads lists the following reasons for conducting a Stage 1 Road Safety Audit at Feasibility Stage:

- *To input safety engineering into the consideration of options;*
- *To influence safety when the there is the greatest scope for change;*
- *To avoid obvious safety problems that can be locked-in once designs commence or land is acquired;*
- *To ensure all likely road users groups have been considered in the design;*
- *To consider if the concept is compatible with the type of road and road user expectations;*
- *To test that the design standards are compatible with the type of road and the road user expectations;*
- *To look beyond the project and consider effects in transition areas and away from the project:*
    - *How does it fit into the environment?*
    - *Is it consistent?*
    - *Will staging involve compromises or be unsafe?*
    - *Is the scope of the project adequate, or are additional works needed elsewhere?*

In a Stage 1 Feasibility stage audit, the road safety audit team shall visit the site of the proposed project taking special cognisance of the following:

- *Locations that involve permanent changes to the existing road layout or features;*
- *Transition areas between existing roads and the proposed projects*.

A safety review of the design brief may identify possible problems like[25]:

- *Reference to standards that are out of date or no longer considered best practice from a safety perspective;*
- *Reference to standards that may not provide sufficient flexibility in designing for safety;*
- *A lack of appreciation how one specification can have an adverse safety impact on other elements of the project;*
- *The absence of design criteria for safe operation of trucks or vulnerable road users;*
- *The absence of basic road safety requirements*.

[25] *Austroads, Guide to Road Safety: Part 6: Road safety audit, January 2009*

The involvement of an experienced road safety engineer could be beneficial right from the start, during pre-design meetings when issues pertaining to new project identification are considered. The early, direct inclusion of road safety engineering is applicable on major road schemes, minor schemes and private developments. It provides the opportunity to involve the client in safety discussions, rather than only the designer. The client can often have a different or broader view and may have alternative ways of incorporating road safety comments.

4.1.3 Stage 2: Draft Design Stage Audit

The Draft Design Road Safety Audit is done after completion of a draft design. If alternative schemes have been developed for public consultation, each should be audited.

Stage 2 Road Safety Audit: Draft Design should be performed BEFORE any land acquisition takes place.

A Stage 2: Draft Design Stage Road Safety Audit has the following objectives:

- *To address the design standards utilised for the draft design;*
- *To consider, among others, the following:*
  - *Alignment (horizontal, vertical);*
  - *Sight distances;*
  - *Layout of intersections and configuration of interchanges;*
  - *Widths: Lanes and shoulders;*
  - *Cross-section and superelevation of pavement;*
  - *Location of accesses;*
  - *Provision for different road user groups: Pedestrians, Cyclists, Heavy vehicles, etc*
- *To evaluate whether any deviation from guidelines and design standards would impact safety negatively;*
- *To determine how possible staged implementation of the project could influence road safety; If staging is proposed then the safety of each stage should be considered as well as the transition from one stage to the next;*
- *To consider the issues listed in the Stage 1 Road Safety Audit if the Stage 2 Road Safety Audit is the first audit of the road project.*

Austroads lists the following reasons for conducting a Stage 2: Draft Design stage audit:

- *An audit may not have been done before;*
- *To identify anything might have been missed in an earlier audit and confirm the mitigating measures that may have been implemented since the Stage 1 audit;*
- *To avoid costly design time if only a detail design road safety audit is done;*
- *To evaluate the possible departures from standards and the effect thereof from a safety perspective;*
- *To evaluate that all road user groups have been considered, such as:*
  - *Can vehicles turn safely?*
  - *Can road users see each other?*
  - *Can road users see traffic control devices?*
  - *Is cross-section and alignment appropriate?*
  - *Is property access safely catered for?*
- *To evaluate intersection layouts for possible conflict points;*
- *To alert designers to areas where attention on road safety aspects will be needed during the detail design stage;*
- *To evaluate safety at the connections with existing roads, e.g.:*
  - *Consistency*
  - *Vulnerability of fixed objects, etc*

In a Stage 2 Draft Design stage audit, the road safety audit team shall visit the site of the proposed project taking special cognisance of the following:

- *Locations that involve permanent changes to the existing road layout or features;*
- *Transition areas between existing roads and the proposed projects.*

At this stage of the design process fundamental decisions regarding route choice, the overall design and layout of the project have already been decided.

The audit team may still suggest physical changes to horizontal or vertical alignment, provision of a median, lane and shoulder width, provision of cycle lanes or sidewalks or channelisation.

Accesses provided should be reviewed for upstream and downstream effects, possible conflicting movements, sight distance and the possible consolidation of access points.

Any such recommendations should be based on the consideration of safety issues only and should be supported by justifiable background reasoning, which need not necessarily be included in the road safety audit report.

The ability of the design to safely accommodate future widening, expansion or extension should also be taken into account. Specific attention needs to be given to assess the safety of different usage scenarios.

> Audits should not stifle safety innovations, simply because it is not a standard way of dealing with an issue.

4.1.4 Stage 3: Detail Design Stage Audit

The Detailed Design Road Safety Audit normally takes place after completion of the detailed design but before the contract documents are prepared. This stage is the last opportunity to influence the design before construction commences and is a review of those drawings that are put forward as those on which the project will be constructed.

This audit is very much focused on aspects of detail of the road layout, traffic arrangements and information transfer to the proposed road user groups. It is also important that any issues that have not been satisfactorily been resolved from earlier audits be reiterated in the Stage audit. It may well happen that the proposed remedial measures for such an outstanding issue be different in this stage than an earlier stage, because the flexibility to influence the design is less.

A Stage 3: Detailed Design Road Safety Audit has the following objectives:

- *To consider, among others, the following:*
  - *Any changes since the Stage 2 Audit;*
  - *Road traffic signs and markings;*
  - *Road lighting;*
  - *Intersection detail;*
  - *Roadside hazard management issues (clear zones, traffic barriers, fixed objects etc.)*
  - *Needs and requirements for Special Road Users (pedestrians, cyclists, individuals with disabilities, heavy vehicles, buses etc.)*
  - *Traffic management and control drawings for the proposed accommodation of traffic during construction*
  - *Drainage*
  - *Landscaping*
  - *Cross-section and side-slopes, etc.*
- *To review those findings of earlier stages and the implementation of mitigating measures;*
- *To consider the issues listed in the Stage 1 and Stage 2 Road Safety Audit if the Stage 3 Road Safety Audit is the first audit of the road project.*

Austroads lists the following reasons for conducting a Stage 3: Detail design audit:

- *Audits may not have been done at earlier stages;*
- *To identify anything missed in previous stages and confirm the mitigating measures that may have been implemented as a result of earlier findings;*
- *To utilise the last opportunity of influencing safety prior to the construction of the project;*
- *To evaluate the possible departures from standards and the effect thereof from a safety perspective;*
- *To review the safety of typical details to be used on the project.*
- *To evaluate the signage, markings and landscape plans;*
- *To evaluate that all road user groups have been considered, such as:*
    - *Can vehicles turn safely?*
    - *Can road users see each other?*
    - *Can road users see traffic control devices?*
    - *Is cross-section and alignment appropriate?*
    - *Are fixed hazards located within the relevant clear zone?*
- *To review the interaction of the detailed elements;*
- *To evaluate safety at the connections with existing roads, especially consistency*;

In a Stage 3: Detail design stage audit, the road safety audit team shall visit the site of the proposed project taking special cognisance of the following:

- *Locations that involve permanent changes to the existing road layout or features;*
- *Transition areas between existing roads and the proposed projects.*

At this stage the drawings should be completed to such a stage that they could be used in the preparation of contract documentation. If the audit team are concerned about a possible lack of sufficient details, the audit team may request such additional details from the client or project manager to allow the audit to be completed without possible conditional findings.

If the project will be implemented in separate stages, each stage should be considered as well as the transition between stages. This is specifically also applicable for the proposed traffic management for the accommodation of traffic during construction.

4.2 Construction Phase Audits

4.2.1 General

Three different road safety audit stages are possible during the construction phase of any project. Only two of these are included in the construction phase as formal staged road safety audits, namely:

- *Stage 4: Construction work zone traffic management, and*
- *Stage 5: Pre-opening Stage Audit.*

The third possible stage is the auditing of changes to the design during construction. Such audits should be handled as Interim road safety audits and are described in Chapter 6.

4.2.2 Stage 4: Work zone traffic management audit stage

A Stage 4: Construction work zone (CWZ) traffic management audit is undertaken during the construction phase of a road project. The Stage 4 audit shall review the traffic management proposed by the Contractor. It is necessary to recognise the different focus of a Stage 4 audit in comparison with the Stage 4 audit as contained in the first edition of the SARSM:

- *In the initial edition of SARSM a Stage 4: Construction stage road safety audit was conducted during construction, with the objective of comparing the traffic accommodation drawings with conditions on site, identifying any issue with safety hazard potential and specifically recommending mitigating measures;*
- *A Stage 4 CWZ traffic management audit (as described in this edition) only evaluates the traffic management proposals that the contractor proposed using, taking into account the changed conditions as experienced on the works when compared with the traffic management proposals that had been contained in the Detail Design. The CWZ traffic management audit therefore differs from the earlier Stage 4 Construction stage audit in the following respects:*
    - *It recognises that conditions change rapidly on a construction site;*
    - *It is practically impossible to conduct a representative road safety audit during construction;*
    - *It also recognises that the contractor has to develop a safety plan in terms of the safety regulations applicable to construction work zones and that this safety plan shall be monitored by the Engineer.*
- *Any ad-hoc safety inspections during the construction period may be conducted as Interim road safety audits, as described in Chapter 6.*

Austroads lists the following reasons for conducting a Stage 4: Construction work zone traffic management audit:

- *Road works sites typically involve a change in speed environment, additional conflicts and confined road space, which can increase the potential for crashes;*
- *Traffic arrangements during road works can change several times and can bear very little resemblance to permanent arrangements. Audits at design stage can give little indication of the safety of the temporary works;*
- *Construction contractors may not appreciate the finer points of traffic management, roadside safety and the operation of safety devices (especially from the viewpoint of the road user, rather than from that of the construction team);*
- *To evaluate that standard arrangements are applied, for consistency and for adequacy under those particular conditions;*
- *To avoid conflicting messages between permanent and temporary devices and between traffic signs, markings and other devices;*
- *To review the appropriate use of signs and guidance to the road user;*
- *To evaluate the safety of the access to the construction site from the "public" road network and locations where construction traffic is in conflict with the general travelling public.*

In a Stage 4 Work zone traffic management audit, the audit team shall recognise the guidance given to contractors in the SA Road Traffic Signs Manual, Volume 2, Chapter 13: Road Works Signing and pay particular attention to the following aspects:

- *Appropriateness of the proposed traffic management scheme, especially conditions in transition areas;*
- *Adequacy of advance warning;*
- *Proposed and actual speed limits;*
- *Conflicts between permanent and temporary features;*
- *Any aspects of the layout that could be misread by road users or aspects that violate driver expectancy;*
- *Likelihood of mud or dust obscuring devices;*
- *Appropriateness of vehicle restraint systems/ barriers and the correct installation and the safety of the terminals;*
- *Adequate provision for pedestrians and public transport vehicles like minibus taxis;*
- *Conflict points between site traffic and the general public;*
- *The effect of congestion during peak periods;*
- *The effect of an incident within the detor/ deviation areas.*

4.2.3 Stage 5: Pre-opening Stage Audit

The Pre-opening Road Safety Audit should be conducted before the opening of a road scheme to traffic but not before substantial completion of the project; enabling the audit team to review conditions as it would be experienced by different road user groups.

Pre-opening stage audits represent the last opportunity that the audit team has to identify potential road safety concerns before the road is opened to all road users. The team should have the opportunity to conduct a site visit of the whole project, especially intersections and tie-ins with the existing network.

It is particularly important to also conduct a night time site visit to review the site under conditions when the road user cannot be assisted by wider perception of the road environment to safely use the facility.

The potential for making significant changes to the road safety situation on-site during a Pre-opening stage audit is rather limited and the audit team may have to accept that the mitigating measures that may be recommended at this stage would similarly be limited in scope.

If it is not possible to audit the project before the road is opened to traffic, the Stage 5 audit may be conducted after the opening of the road, but within one month after such opening and with the approval of the client.

The Road Safety Audit Team will need to walk, drive and possibly cycle the project to assess:

- *Sufficient provision made for the different road users of the road project;*
- *Adequate protection of Roadside hazards;*
- *Influence on safety as result of variations between actual construction and Detail Design;*
- *Road signs and markings, lighting and other night-time related issues;*
- *To consider the issues listed in the Stages 1, 2 and 3 Road Safety Audits if the Stage 5 Road Safety Audit is the first audit of the road project.*

In the stage 5: Pre-opening stage audit it is also important that the audit team confirm that temporary signage, markings, construction equipment, barriers, fencing, materials and debris that may constitute a hazard, either as physical entity or as the causal factor for road user confusion, are removed from the newly constructed road facility.

The implementation of the mitigating factors agreed upon in a stage 3 audit, should also be assessed in a stage 5 audit. If these issues had not been resolved satisfactorily, they should be re-iterated in the road safety audit report.

Austroads lists the following reasons for conducting a Stage 5: Pre-opening stage audit:

- *Audits may not have been done at previous stages;*
- *To identify anything which may have been missed in earlier stages or might not have been considered as a possible hazard when assessed from the drawings;*
- *To check the interrelationship of elements*
    - *Vertical and horizontal alignment*
    - *Things that may look fine on plans but not on site (in 3D)*
- *To check that the project has been built as designed (from the viewpoint of the road user);*
- *Designs and "incidentals" can get changed on-site:*
    - *Spoil areas or services can get in the way*
    - *Landscaping gets added or expanded*
- *To evaluate night time conditions for visibility and possible confusion;*
- *Location of unplanned hazards;*
- *Signs getting lost against their backgrounds.*

5 ROAD SAFETY AUDITS ON EXISTING ROADS (Road Safety Appraisals)

5.1 General

In SARSM, 1999, provision had been made for a Stage 6 Audit, the Existing Facilities audit. These audits were intended to form part of road authorities' Road Safety management plans. The experience with such Stage 6 audits had not been very positive. It was found that the road authorities often conducted such audits, but that the means to implement these audit findings were not available, resulting in a degree of disappointment with the road safety audit concept.

During the year 2007/2008 a total 14 627 persons were killed on South African roads.

It is estimated that a further 7 500 people are permanently disabled and

60 000 persons seriously injured per year.

These statistics, nevertheless, emphasise the pressing need for remedial measures to be implemented on existing roads to reduce the carnage.

Reactive and proactive approaches to road safety improvement are described in Chapter 1 and the point made that both are required in a holistic approach towards improving road safety.

SARSM, 1999, in Volume 5 describes four different strategies for crash reduction on a reactive basis. These reactive crash reduction strategies are:

- *Treatment of Hazardous locations, i.e. the treatment of single high frequency crash locations;*
- *Mass-action plans where a common crash problem is treated by an appropriate remedial action across various locations;*
- *Route-action plans where a route with high crash rate is treated with an appropriate remedial measure;*
- *Area-wide plans where a number of remedial measures are implemented in an area e.g. traffic management and speed-reducing devices such as traffic calming.*

Volume 5 further confirms that crash data forms a crucial part in the identification and implementation of remedial measures. Besides giving guidance on site-specific crash problems, it also provides guidance to identify, develop and evaluate remedial measures.

The lack of credible crash information on the South African road network casts a shadow upon the use of this information and also any crash-based analyses. Performing rudimentary quality control on the available information often indicates that the quality and the reliability of the information would be questionable and not appropriate to be used as a basis for statistical analysis or recommendations for remedial measures.

SARSM, 1999, indicates that the Road Safety Engineering Assessment procedure described in Volumes 2 and 3 may be used as a screening methodology to identify routes or sites with promise to be treated. The methods described therein are not crash-based and create lists of possible sites that should be further investigated.

The road safety auditing process provides a mechanism whereby these "sites with promise" may be assessed without the need to have crash data available. Because of concerns that certain authorities worldwide have expressed on the use of the term "*Audit*" on existing roads, the term "Road Safety Appraisal" is recommended for use when road safety auditing is conducted on existing roads in South Africa.

A major constraint for road safety audits on existing roads in the past has been the fact that the recommendations were not implemented, the reason being that the road safety recommendations and other major rehabilitation on those roads were not coordinated.

For the recommendations from road safety audits on existing roads to be implemented, it is therefore necessary that the implementation be coordinated with the availability of resources on a particular section of road. In other words, that road safety auditing should be coordinated with resurfacing or upgrading projects, when contractors would be on-site to implement remedial works. This methodology would ensure that road safety audits are not being done for the sake of road safety auditing, but that the opportunity is taken to make a difference in the safety performance of such a road.

The fact that the appraisal process should be coordinated with the resurfacing / pavement rehabilitation process ensures the presence of the design team and the possibility to commission the audit as additional or specialist services through the Agreement for Consulting Engineering Services.

5.2 Road Safety Appraisal Process

5.2.1 Definition

Road Safety Appraisal: *A systematic examination of an existing road location, in which an independent and qualified team reviews on-site conditions and historical evidence to identify existing or potential road safety problems and suggest measures to mitigate those problems*

The definition of the road safety appraisal is very similar to that for the road safety audit, with the added review of historical evidence. This allows the introduction of road crash information and any other information that are relevant to the reactive approach to road safety improvement, to be combined with the pro-active approach of a road safety audit.

5.2.2 Objectives

The objectives of the Road Safety Audits on existing roads are as follows:

- *To ensure compatibility between the safety features of a road and the functional classification of the road;*
- *To identify any feature that can, with time, create a safety problem – for example vegetation blocking a sign;*
- *To identify all features in the road environment that pose a safety hazard to any of the road users.*

5.2.3 Process

The flow chart of activities as shown in figure 3.1 should still be followed, making appropriate adjustments for the site-specific conditions as required by the special case of an existing road.

- *The audit brief and the provision of background information shall be similar to the road safety audit process with certain additional requirements:*
    - *Analysing existing crash data to identify possible clusters of crashes and over-exposure of specific types of crashes and the comparison with control data, if possible. (The appraisal team leader may decide not to assess the crash data prior to a site inspection, to reduce possible bias towards existing crash locations);*
    - *Assessment of risks in terms of the risk assessment process described in section 3.10.2 pertaining to specific concerns, whereby the appraisal team would make a qualitative judgement of the importance of remedial measures for specific concerns;*
- *Site inspections would have as important a role in preparing possible remedial measures, if not more so than in the case of design projects because junction layout information would not be readily available, for example. In particular both day and night-time site visits shall be conducted. (It should be noted that Google Earth Street View™ photographs are not a substitute for a site inspection.);*
- *Identification of road safety concerns should be done for all issues, irrespective of the fact that the origin may be routine maintenance related; Routine maintenance related concerns should be combined and reported separately in the road safety appraisal report.*

5.2.4 Reporting

The road safety appraisal report shall have the same basic layout and content as that of a road safety audit report as described in Chapter 3. The road safety appraisal report shall include recommended remedial measures in a way similar to the road safety audit reports. *(Note that this deviates from the principle advanced in the SARSM, 1999)*

It may be feasible to group the results of the road safety appraisal in terms of concerns noted at specific sites, recurring concerns along the route or features that are located along the route, rather than site specific, road markings for example.

Specific attention shall be given to the analysis of crash data (provided the quality thereof is acceptable) and the subsequent identification of possible remedial measures based on the combination of the crash data and the site inspections.

Specific attention shall also be given to the recording of the level of risk and the constituent components thereof.

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6 OTHER ROAD SAFETY AUDITS

6.1 General

The principles underpinning the road safety audit concept allows this concept to be applied at all stages of the life cycle of a road or of a transport related project. Depending on the audit brief issued by the client organisation, it is also possible to conduct a road safety audit assessing only certain aspects. In this section the following possible audits are described:

- *Land-use development project audit*
- *Monitoring Stage Audit*
- *Interim road safety audit*
- *Specialist audits for specific user groups*

6.2 Land use development projects

Land-use development projects can be found in industrial, commercial or residential environments. They often have their own car parks, driveways or footpaths and therefore have traffic interactions in much the same way as roads and streets. Since these projects have a great potential to change the traffic volumes, traffic patterns, vehicle mix, road environment or user perception of the area, they fit into the type of project envisaged for road safety auditing as contemplated in the definition of a road safety audit.

The SARSM, 1999, did not identify the road safety audit of land-use projects as a specific road safety audit stage but included additional checklists for land-use projects and rezoning applications.

It is acknowledged that National Guidelines are being drafted for traffic impact assessments and that these guidelines would provide more emphasis on the safety impact assessment of the proposed development. The inclusion of road safety impact assessments in the guidelines thus being developed may go a long way in improving the understanding of the road safety impact of such a development and the identification of possible mitigating measures.

The inclusion of road safety engineers in pre-design issues meetings in the UK has been beneficial in the case of land-use developments[26]. Following initial reluctance by developers, this approach is welcomed because:

- *It saves the developer time and money, because arguments about poor safety are removed from decisions and planning inquiries or appeals;*
- *It avoids last minute re-designs;*
- *Developers can use safety as a positive selling feature.*

[26] *Institution of Highways and Transportation, Road Safety Audit, 2008*

Austroads recognises the value of road safety audits on land-use developments, especially on developments (or town planning applications) of a significant size or which interacts directly with at least an arterial road or a significant traffic route, or being close to destinations with significant numbers of pedestrians or cyclists.

Austroads lists the following reasons why road safety audits should be conducted on land-use development projects:

- *Most land-use developments need to accommodate road users like pedestrians, car parks, delivery vehicles, etc. Road safety is just as important as on public roads. Some large developments operate just like road systems, (for example large car parks);*
- *Safety problems can occur where a development connects with the public road system;*
- *A development (or several in combination) can result in safety problems on the public road network some distance away, due to changes in traffic patterns;*
- *Some developments become public roads;*
- *Designers of land-use developments typically do not have road safety engineering experience. Audits permit the input of that experience and expertise;*
- *If development costs are initially avoided through inadequate design, the cost may be transferred to later road users as crash costs and possibly to the community as remedial costs incurred by the road authority;*
- *Typical guidelines for the design of access roads and car parks do not provide adequately for road safety.*

Road authorities should therefore ensure that the typical information available to it subsequent to stage 1, stage 2 or stage 3 audits on normal projects should also be addressed and reported on in a Traffic Impact Assessment for a particular land-use development project, failing which the road authority may consider the option of instructing the developer to provide such information, in a manner acceptable to or to such detail as the road authority required and comparable with the requirements of the relevant stage in the road safety audit process.

6.3 Monitoring Stage Audit

A Monitoring Stage Audit is a mandatory audit in the UK road safety audit process. The monitoring stage audit is conducted after the implementation of road safety remedial measures and is intended to review the effects that road safety audits and the response report had on the project.

A monitoring stage audit differs from the process of a road safety audit in the sense that it is based on an in-depth study of personal injury crashes, rather than an assessment of roadway conditions.

When required by the relevant road authority, the Monitoring Stage Audit shall be conducted using 12 months or 36 months of crash data from the time that the project had been opened to traffic after the implementation of the remedial road safety measures.

The crash records shall be analysed in depth to identify:

- *Locations at which personal injury crashes have occurred;*
- *Possible personal injury crashes that appear to occur from crashes with similar causes or showing common causal factors.*

The monitoring stage audit shall comprise an analysis of the crash records as well as a site visit/s to the area.

The crash analysis should include the following:

- *Analysis of the crashes in terms of:*
    - *frequency and rates;*
    - *vehicle involvement;*
    - *severity;*
    - *location across the study area;*
    - *weather conditions;*
    - *road surface;*
    - *light conditions;*
    - *vehicle manoeuvres;*
    - *comparison with the crash record of the study area prior to the implementation of the project and road safety remedial measures.*

The report shall discuss the crash analysis as well as the following aspects:

- *Traffic conditions;*
- *Comparison with control data;*
- *Identification of possible problems and comparison with earlier road safety audit reports and response reports;*
- *Recommendations for possible mitigation, including a first order cost estimate and economic assessment*.

6.4 Interim road safety audit / road safety advice

It is a fundamental principle of road safety auditing that the audit team should be independent of the design team. In the development of a design a situation may, nevertheless occur where the early identification of possible road safety problems may lead to savings in design or project costs. This may be particularly beneficial in larger projects or projects running on accelerated schedules or Design-Build type of contracts.

The client organisation may approve the use of an *Interim* road safety audit. The audit team shall be appointed in the normal way and the design team may not contact the audit team without the authorisation of the client.

Requests for an Interim Audit shall clearly indicate the scope of the interim audit or the advisory information requested.

The Interim Audit shall be conducted in the normal process for an audit relevant to that stage of the design; the interim report shall be structured similar to a normal staged audit report and shall only address the issue submitted for interim auditing. Any communication between the audit and design teams shall be conducted via the client representative, who shall also chair any possible meetings between the two teams.

The use of an interim audit shall not negate the need to conduct the normal road safety audit for that stage.

One aspect that should also be referred for interim road safety auditing is a change to the design during the construction phase of a project. It is recognised that certain changes during construction may be of very limited influence on the road safety performance of the project. The opposite is unfortunately also true. Field changes may be done without the broader consideration of their effects to the safety of the project and may also be done by designers that are not as experienced as the original design team. This may result in unanticipated hazardous conditions being introduced to the project. The changes so submitted shall be assessed in terms of the requirements for a Stage 3 Detail design audit.

6.5 Specialist audits for road user groups

All road safety audits are being conducted in a way that addresses the needs of all road users. Conditions may occur where specialist audits need to be conducted to assess the exposure to risk for specific road user groups.

The audit process may be used on existing roads, streets, bicycle paths, etc. to identify potential safety problems for such a road user group or groups. The results may then be used as input into other road or traffic safety programs like *Safe Routes to Schools* or safety awareness programmes.

These specialist audits can include audits like the following:

- *Safety audit for passenger coaches on major highways;*
- *Audits of roads for cyclist or pedestrian safety;*
- *Pedestrian safety audits of shopping centres and car parks;*
- *Audits of safe access for people with limited mobility like the elderly, or people with disabilities.*

It is necessary that in an audit of this kind, the audit team uses the mode of travel in question, or include an elderly team member or a person with the disability being assessed.

PART C: LEGAL ENVIRONMENT

7 LEGAL IMPLICATIONS OF ROAD SAFETY AUDITS

Note:
The information provided here is not legal advice. It is intended to sensitise the reader to those aspects of the civil law that could assist a road authority or road safety auditor in minimising the risk of incurring liability.

Objective: *To provide a basic description of legal principles involved in possible litigation;*

To sensitise the road authority and the road safety auditor to the risks involved in the conduct or not of road safety audits.

Concern has been raised that conducting road safety audits might increase the risk of the road authority to be found liable in a civil suit if an audit identified safety deficiencies that could have contributed to a crash. The totally opposite viewpoint is also possible, namely that a road safety audit demonstrates a proactive approach to identify and mitigate possible road safety problems and could thus be used as a defence in liability litigation.

7.1 Criminal Law and Law of Delict

Road and local authorities are subject to the criminal law and can be prosecuted in a similar way that an individual can. A road or local authority also has certain statutory duties with respect to the planning, design, construction, operation, management, control, maintenance and rehabilitation of roads that expose them to a civil lawsuit. Such a lawsuit is possible if an injured road user can show that a road authority has done something that a reasonable road authority would not have done, or has failed to do something that a reasonable road authority would have done.

7.1.1 Criminal Law

Criminal Law is directed at offences against public interests. Punishable criminal conduct is referred to as a “crime” or “an offence” and is prosecuted by the state in a public trial. The offender is called “the accused” when on trial. A crime is the unlawful blameworthy conduct punishable by the state. Punishable criminal conduct could be a contravention of either a common law offence or a statutory offence or both. All crimes are defined by law which means that the elements of the specific crime are known and specified in the charge sheet (or other method of informing the accused about the charges against him.)

The Constitution and the law of criminal procedure demand that the accused shall be provided with sufficient information to be defended in a trial.

A crime (when committed) is investigated by the police. The complainant or the victim who has suffered harm or injury as a result of the commission of such crime cannot decide to proceed or withdraw the criminal charge. The National Prosecuting Authority decides to prosecute the crime and even if the complainant does not want to proceed with the criminal charge, the decision is not that of the complainant. The state bears the onus to prove *beyond reasonable doubt* that the accused is guilty of the alleged crime.

When an accused person or organization is convicted of a crime, the criminal sanction or punishment that follows may be imprisonment, a fine, correctional supervision or other forms of punishment provided for in the Criminal Procedure Act 51 of 1977 or other Acts.

7.1.2 Law of Delict

Delict is a concept of civil law in which a willful wrong or an act of negligence gives rise to a legal obligation between parties for which damages can be claimed as compensation for which redress is not dependent on a prior contractual undertaking to refrain from causing harm. A delict may be defined abstractly in terms of infringement of rights. The South African Legal System uses the law of delict as opposed to torts. The Law of Delict is recognised as comprising of five generic elements that all have to be satisfied before a claimant can be successful. These are:

- **Conduct** - which may consist of either a commission (positive action) or an omission (the failure to take required action);
- **Wrongfulness** - the conduct complained of must be legally reprehensible. This is usually assessed with reference to the legal convictions of the community;
- **Fault** - once the wrongfulness of the conduct is established, it is necessary to establish whether or not it is blameworthy. However, in certain instances it is possible to find liability without fault, such as in cases of vicarious liability;
- **Causation** - the conduct that the claimant complains of must have caused damage; in this regard both factual causation and legal causation are assessed. The purpose of legal causation is to limit the scope of factual causation. When considering the event that has happened, it is asked whether or not the damages sustained were foreseeable or too remotely connected to the incident to even consider. If the consequence of the action is too remote to have been foreseen by an objective, reasonable person the defendant will escape liability; as only reasonably foreseeable damage may be recovered by an action in negligence.
- **Damage** - finally the conduct must have resulted in some form of loss or harm to the claimant in order for him to have a claim. This damage can take the form of patrimonial loss (a reduction in a person's financial position, such as is the case where the claimant incurred medical expenses) or non-patrimonial damages (damages that cannot be related to a person's financial estate, but compensation for something like pain and suffering).

South African law follows a conservative approach to the extension of delictual liability and although organs of state and administrators have no delictual immunity, something more than a mere negligent statutory breach and consequent economic loss is required to hold them delictually liable for the improper performance of an administrative function.

In terms of the South African approach, breach of a statutory duty is regarded as being *per se* unlawful. To entitle a person to sue for breach of a statutory duty, it must be shown that:

- the statute was intended to give a right of action;
- that the claimant was one of the persons for whose benefit the duty was imposed;
- the damage was of the kind contemplated by the statute;
- the defendant's conduct constituted a breach of the duty; and
- the breach caused or materially contributed to the damage.

7.1.3 The Difference between a Crime and a Delict

The difference between a delict and a crime can be described as follows:

- Delict is a civil/private wrong whereas crime is a public wrong;
- Action of delict is brought by the person who suffered the harm; criminal actions are brought by the State;
- Delict must be proved on the balance of probabilities while the commission of a crime must be proved beyond reasonable doubt.
- Main aim of an action in delict is to compensate the victim; in crime to punish the guilty;

7.1.4 Negligence and Liability

In delict the conduct-requirement is defined as a voluntary human act or omission. A juristic person (such as a close corporation) may act through its members and may thus be delictually liable. The capacity to act also encapsulates understanding as to the consequences of one's actions. The South African law of delict is founded on the basic principle that harm caused by wrongful and blameworthy (or culpable) conduct can be recovered by delictual action. A wrongdoer who caused damage could be delictually liable only if there was fault on his part, which may be intentional or negligent.

Negligence arises where someone acts without taking proper care – they have not acted as a "reasonable person" would have acted. The test for negligence is:

- Would a reasonable person in the position of the defendant [wrongdoer] foresee the possibility of his or her conduct causing damage to another person;
- Would a reasonable person have taken steps to guard against the possibility of harm, and
- Did the defendant fail to take the steps that a reasonable person would have taken to guard against this possibility of harm?

For liability to attach, harm must be caused in a wrongful manner. Without wrongfulness a defendant cannot be held liable. Wrongfulness is a conclusion of law that the court draws (or does not draw) from the facts pleaded and proved by the claimant. One cannot "prove wrongfulness" though one can prove facts from which the court may be prepared to draw the conclusion that the defendant acted wrongfully. This can therefore relate to either a defendant's positive action or a defendant's omission to act. The general rule is that a person does not deliberately act unlawfully when he merely fails to prevent damage or bodily injury to another. Liability only follows if its failure was unlawful, and it would only be unlawful if, under the specific circumstances, there was a legal duty on the said person to act positively to prevent the damage, and he failed by acting in accordance with such a duty. Whether such a legal duty actually exists is answered by means of the legal conception of the public morals[27].

Usually, one person cannot be held liable for the actions of another, but an employer can be held liable for the actions of employees, arising out of the scope and course of their employment; this is referred to as vicarious liability.

The right not to suffer physical injury at the hands of another is constitutionally entrenched, and there is an injunction on our courts to develop the common law in accordance with the spirit, purport and object of the Constitution. That same right has always existed at common law. At common law where there is bodily harm, it gives rise to a specific civil claim where proof of fault in the form of negligence has always been necessary.

Other than expert evidence, an exception to proving negligence can be used by the claimant to show that the defendant deviated from standard practice. This allows the claimant to infer negligence of the alleged wrongdoer merely from the fact that the incident, which was under the exclusive control of the defendant, actually happened, that the incident would not have happened in the absence of negligence, and that the claimant did not contribute to the harm by his own negligence. The burden of proof then falls on the defendant to refute this *prima facie* inference of negligence that has been created.

7.1.5 Possible Defences in Delict Cases

If any of the generic elements of a delict can be shown to be missing, there is no case to answer. For example, the defendant may be able to prove the absence of negligence, or show that the act was actually committed by some other person altogether or that any one of the five base elements were not proved by the claimant.

The common law test for unlawfulness in case of omissions is that the court has to find that a failure to fulfil a legal duty existed and that such failure caused harm. The existence of a legal duty will be a value judgement on what is reasonable and will also include the court's assessment of the "common convictions of society".

[27] *The South African Lawkipedia, Encyclopaedia of South African law (Ed: Van der Merwe, S)*

Defences to negligence

The most straightforward defences are:

i.) that a reasonable person would not have:

a. foreseen the harm; or

b. taken the steps necessary to guard against the harm;

ii.) that one acted reasonably (i.e. if a reasonable person would not have done it then the defendant (accused) does not need to do it either).

iii.) A partial defence is to establish that someone else was also at fault (contributory negligence) so as to have one's damages reduced according to the degree of fault of the other person.

The State is not immune against claims based on invalid administrative action, but the negligent breach of a statutory duty that causes loss is not enough to establish liability. The existence and breach of a constitutional norm or fundamental right will always be relevant during an enquiry into delictual unlawfulness, but will not *per se* lead to a finding of unlawfulness, as all circumstances will be considered in an enquiry and normative policy factors will ultimately determine liability. Policy considerations of fairness and reasonableness have to be taken into account when imposing a legal duty (duty of care) and ultimately liability to make good the harm suffered by a claimant.

7.2 Statutory Duties of Road Authorities

7.2.1 Road Infrastructure and Traffic Acts

Road authorities in South Africa are subject to at least two pieces of legislation that govern their conduct as far as potential exposure to delictual liability is concerned. The primary legislation is the founding legislation for that particular authority, whether an agency like SANRAL or a provincial or local authority. In all these acts the responsibility to establish and maintain roads are given to such agencies or authorities.

Founding Legislation

Extracts from three pieces of legislation are shown hereafter, namely from the South African National Roads Agency Limited and National Roads Act, the KwaZuluNatal Provincial Roads Act as well as the proposed Western Cape Transport Infrastructure Bill. It is clear in these extracts how the legislator attempted to reduce the exposure of the road authority by ruling that the authority would not be liable for any claims unless they stem from wilful acts or omissions by officials or that the responsibility of the road authority would be subject to availability of financial resources.

In the Western Cape Transport Infrastructure Bill, the minimum qualification for a person to take responsibility for the planning and design of future infrastructure projects or of technical recommendations on such transport infrastructure are also clearly set out. This may be considered as a constraint in conducting road safety audits.

The South African National Roads Agency Limited and National Roads Act

25. (1) The Agency, within the framework of government policy, is responsible for, and is hereby given power to perform, all strategic planning with regard to the South African national roads system, as well as the planning, design, construction, operation, management, control, maintenance and rehabilitation of national roads for the Republic,

... ...

26. In addition to the Agency's main powers and functions under section 25, the Agency is competent—

(c) to appoint any private person, institution or body, in terms of a contract concluded for that purpose, in order to perform any work on behalf of the Agency with regard to the planning or design of a national road or proposed national road or the construction, operation, management, control, maintenance or rehabilitation of a national road, or in order to perform any work in the execution of a project or in connection therewith, and to monitor the execution and the work performance;

(e) to provide, establish, erect and maintain facilities on national roads for the convenience and safety of road users;

KwazuluNatal Provincial Roads Act Nr 4 of 2001

5. (1) The Minister must establish, control, implement, administer and manage the provincial road network, which must be planned, declared and administered within a structured framework to provide equitable road access to address developmental needs in all communities within the Province.

(3) The Minister is entitled to access to any public road in the Province to provide planning, development, construction and maintenance services.

(4) Legal responsibility and liability for work undertaken in connection with any road under subsection (3) is limited solely to provincial roads within the provincial roads network or roads on which the Minister has authorised construction or maintenance.

... ...

6. (1) The Minister must determine all standards and requirements for provincial roads and public roads and the standards and requirements must apply to any responsible authority, municipality, entity or person with respect to the provincial road network.

(2) Provincial standards and requirements relating to the provincial road network under subsection (1) must apply to-

(b) construction or maintenance of a provincial road;

... ...

9. (1) The Minister is, within available financial resources, responsible for construction and maintenance of provincial roads and any other work the Minister deems desirable for the maintenance of provincial roads.

(3) The Minister is not liable for any claim or damages arising from the existence, construction, use or maintenance of any provincial road, except where the loss or damage was caused by the wilful or negligent act or omission of an official.

Draft Western Cape Transport Infrastructure Bill, 2008

3. (1) The road or public transport infrastructure authority responsible for the planning, design, declaration, expropriation, construction, maintenance, control, management, regulation, upgrading and rehabilitation of roads, railway lines and other transport infrastructure is—

(a) the Minister in the case of trunk, main, district, minor, public transport roads, public pathways and railway lines declared in terms of the Ordinance or under section 18, whereby the Province is the road or public transport infrastructure authority for such road or railway line;

(b) the relevant municipality in the case of main, district, minor and public transport roads, public pathways and railway lines declared in terms of the Ordinance or under section 18, where the municipality is the road or public transport infrastructure authority for such road or railway line.

(2) The road or public transport infrastructure authority responsible for the planning, design, declaration, construction, expropriation, maintenance, control, management, regulation, upgrading and rehabilitation of ancillary road and public transport infrastructure is—

(a) the Minister in the case of ancillary road and public transport infrastructure declared in terms section 18, where the Province is the road or public transport infrastructure authority for such infrastructure;

(b) the relevant municipality in the case of ancillary road and public transport infrastructure declared under section 18, where the municipality is the road or transport authority for such infrastructure.

(3) The Minister or a municipality, as the case may be, shall be responsible for the activities mentioned in subsections (1) and (2) subject to available financial resources.

5. (1) The Minister or a municipality, as the case may be, must ensure that the functions preformed in terms of this Act are undertaken under the responsibility and due diligence of a suitably qualified professional person, subject to subsection (2).

(2) No person except a Professional Engineer or Professional Technologist registered by the Engineering Council of South Africa established under the Engineering Professions Act, 2000 (Act No. 46 of 2000) or a town planner or architect registered in terms of the relevant professional accreditation body may be responsible for the oversight and approval of technical strategies or plans related to research, technical analysis and recommendations for future transport infrastructure.

5. (3) No person except a Professional Engineer or Professional Technologist registered by the Engineering Council of South Africa established under the Engineering Professions Act, 2000 (Act No. 46 of 2000) may be responsible for the oversight and approval of technical strategies or plans related to the following activities, which may further be prescribed by regulation:

(a) Design of civil, structural, electrical and mechanical engineering components of transport infrastructure;

(b) Development of remedial and maintenance strategies of existing transport infrastructure;

(c) Management of the construction and maintenance of transport infrastructure distance indicators, signposts and warnings on declared roads

50. Subject to the National Road Traffic Act, every road authority must erect and maintain—

(a) direction signposts at the junction of every road of which it is the road authority, with any other road;

(b) on roads of which it is the road authority such distance indicators, signposts, directions and warnings as may be necessary or desirable for the safety or guidance of the public.

(2) Subject to the National Road Traffic Act, road or public transport authorities may provide and maintain such traffic signs, traffic control devices and markings as they may deem necessary for the guidance and safety of traffic on roads, and appropriate signals and signs on railway lines.

Whereas certain legislation specifically avoids the setting of a legal duty and rather empowers the authority to do certain tasks, the court ruled in cases that the community considered such a task as part of the duties of the road authority. Notwithstanding restrictive conditions in legislation the courts have considered claims where negligence had been based on the omission to comply with such tasks or functions.

National Road Traffic Act and Regulations

A second piece of legislation that governs the operations of any road authority is the National Road Traffic Act, 1966 and its National Road Traffic Regulations, 1999. The Act clearly specifies the responsibility for the display of road traffic signs on public roads. Whereas the Act provides for the display of those signs that the responsible authority may deem fit, the Regulations to the Act clearly indicate that any road traffic sign should be displayed in accordance with the SADC Road Traffic Signs Manual. This immediately establishes the Traffic Signs Manual as the reference document to determine if signs have been installed in the way that the reasonable professional would have done. It is therefore essential that the road authority and those that are advising the authority on signs for particular projects should take cognisance of the conditions which the signs should comply with and be aware of the potential risks involved if the signs are not being displayed as intended in the legislation.

National Road Traffic Act, 1996

57. Authority to display road traffic signs

1) The Minister, or any person authorised thereto by him or her, may in respect of any public road cause or permit to be displayed in the prescribed manner such road traffic signs as he or she may deem expedient.

1A) The chief executive officer, or any person authorised thereto by him or her, may in respect of any public road cause or permit to be displayed in the prescribed manner such road traffic signs as he or she may deem expedient.

2) The MEC concerned, or any person authorised thereto by him or her either generally or specifically, may in respect of any public road not situated within the area of jurisdiction of a local authority, cause or permit to be displayed in the prescribed manner any such road traffic signs as he or she may deem expedient.

3) a) A local authority, or any person in its employment authorised thereto by it either generally or specifically, may in respect of any public road within the area of jurisdiction of that local authority display or cause to be displayed in the prescribed manner any such road traffic signs as such authority or person may deem expedient.

National Road Traffic Regulations, 1999

287. Manner of display of road signs and road signals

1) Subject to the provisions of this Part, a road sign or a road signal shall –

a) be displayed on a public road where its significance is applicable, to face oncoming traffic;

b) be placed in a position and at a height which is the most advantageous with regard to the design, alignment and other features of the public road concerned; and

c) be displayed substantially in conformity with the Southern African Development Community Road Traffic Signs Manual.

Access to Information

An additional piece of legislation exists in the South African legal environment that may have an impact in the arguments surrounding possible litigation on perceived negligence. This legislation is the Promotion of Access to Information Act, 2002.

Although this legislation has nothing to do with negligence, *per se*, it does provide the opportunity for a claimant to discover reports available to the authority leading to an argument that the road authority had known about deficiencies in the road environment and should therefore have acted to remove such deficiencies or to have, at least, safeguarded the situation for the general travelling public.

Promotion of Access to Information Act, 2000 (Act 2 of 2000)

11. Right of access to records of public bodies

1) A requester must be given access to a record of a public body if--

a) that requester complies with all the procedural requirements in this Act relating to a request for access to that record; and

b) access to that record is not refused in terms of any ground for refusal contemplated in Chapter 4 of this Part.

2) A request contemplated in subsection (1) includes a request for access to a record containing personal information about the requester.

3) A requester's right of access contemplated in subsection (1) is, subject to this Act, not affected by--

a) any reasons the requester gives for requesting access; or

b) the information officer's belief as to what the requester's reasons are for requesting access

7.3 Implications for road safety auditing

7.3.1 Liability arising from the conduct of an audit

The main concern for the road safety auditor is that he or she fails to identify an issue that later leads to a crash, which leads to litigation. There may be a number of reasonable explanations for this:

- *The safety problem was identified and discussed in the audit team but not included in the safety audit report because it had been rejected in a previous Audit Response report;*
- *The safety problem affected part of the project that was considered to be outside the scope of the road safety audit brief;*
- *Road safety knowledge has changed since the road safety audit had been carried out. At the time of the audit it would have been unreasonable to foresee that type of problem;*
- *The safety problem was considered by the audit team, but not included in the road safety audit report because it was considered to be not a real problem at that time or one with a very small chance to cause a crash;*
- *The crash that took place may have resulted mainly from human error or from a vehicle fault*.

The road authority as client of the road safety audit may also have certain concerns after a crash occurred on a new or improved road project:

- *No road safety audit was undertaken, maybe despite procedures being in place recommending road safety audits, or common practice demonstrating that others would have conducted road safety audits under similar circumstances;*
- *The road safety audit identified the possibility of a similar type of crash and made recommendations for improvement. However, no evidence exists of any response to the audit and no changes were made to the design in response to the recommendations;*
- *The road safety audit identified the possibility of a similar type of crash but the road authority rejected the findings of the audit team or rejected the recommendation of the audit team without implementing reasonable alternative mitigating measures.*
- *The road safety audit was carried out by untrained road safety auditors, or auditors undertaking an audit beyond their level of competence or experience.*

7.3.2 Minimising the risk of litigation

In order to minimise not only the potential for successful litigation, but also to reduce the possibility of a claim being made in the first place, the following steps may be taken:

- *Road authorities should ensure that road safety audits are undertaken. If resources are constrained then road safety audits should be conducted on a prioritised basis, where the prioritisation should be done in accordance with a policy accepted by the authority;*
- *The draft policy in this regard should have been cleared by legal counsel for the road authority;*
- *The road safety audit process should be well documented and road safety auditors should be able to show that the audits have been done and that notes have been kept of deliberations and team discussions, especially of those "findings" that had not been included in a road safety audit report;*
- *Road safety auditors should ensure that safety concerns possibly raised as issues in earlier audits should be repeated in subsequent stages of a road safety audit if still relevant;*
- *Road safety auditors should be careful in their choice of language in a report. The words "must" and "shall" could be construed as an instruction implying that the road safety auditor assumed a line function responsibility for the project, rather than an advisory role;*
- *Clients should ensure that they commission road safety audits from competent road safety auditors who can demonstrate that they are suitably experienced to undertake the task;*
- *Authorities should decide how long to retain records of a road safety audit and to keep such records accessible in the case of a very late claim;*
- *Clients should ensure that they give due consideration to the findings and recommendations of a road safety audit report and the preparation of an audit response report. The court may take greater cognisance of what was said and done at the time of responding to an audit, rather than the justifications developed after a crash has taken place.*

Notwithstanding the possibility of litigation, road safety auditors should keep the objective of reducing the risk of crashes or the reduction of severity of crashes as their prime motivation. By padding road safety audit reports with risk averse or unreasonable findings merely to “cover your back” the road safety auditor just adds to the cost of road safety auditing and the cost of a project, without contributing in a reasonable way to the true objective of the road safety audit.

Four case studies related to claims as a result of possible negligence are described in Appendix B to this report. These cases clearly show the importance of pro-active or timeous action by road authorities and the risks that a road authority implicitly accepts when site specific information is under-estimated or ignored.

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APPENDICES

APPENDIX A: ILLUSTRATIVE EXAMPLES OF ROAD SAFETY ISSUES

The Concept of Design for Safety

Road safety engineers must understand the road features that contribute to crashes to be able to take appropriate remedial action. Not only is it the road safety engineer's task to understand WHY crashes occur, but also HOW to reduce the risk of them continuing by making changes to the road environment as far as road layout, road surface, traffic signing, etc. or a combination of various factors are concerned.

A safe road environment should:

- **Warn** road users of any unexpected features or those requiring special attention;
- **Inform** road users of changes in the approaching road environment and what is likely to be expected;
- **Guide** the road user through unusual sections;
- **Control** road users' passage through conflict points and road links;
- **Forgive** the driver for inappropriate behaviour.

An error in perception or judgement or a faulty action on the part of the driver can easily lead to a crash. Roads should be designed in such a manner that only one decision at a time is required from a driver, ensuring that he/she is never surprised by an unexpected situation, and that adequate time is provided to make the decision. Standardisation in road design features and traffic control devices plays an important role in reducing the number of required decisions, as the driver becomes aware of what to expect on a certain type of road.

Principles of Safe Design

Best safety practice in road design is usually achieved by constant reference to the basics of road safety. During the design of the road, the following questions should be asked:

- Can road users misunderstand the design?
- Does it cause confusion?
- Does it create ambiguity?
- Does it provide insufficient information?
- Does it provide too much information?
- Does it provide inadequate visibility or obstructions to vision?
- Does it contain obstacles or booby traps?

Drivers and other road users must perceive and process information, make decisions and react, all within specific time frames. Comfortable and safe driving and riding occurs when road users are operating well below a stressful processing and decision-making rate, and above the minimum level of arousal. The driver should not be over-stimulated, or lulled into boredom. These aspects are critical components in the development and maintenance of a safe road environment.

Similar situations should be treated in similar fashion. Things to be avoided are:

- Inadequate treatment (not treating a situation to an appropriate level)
- Inappropriate treatment (using the wrong treatment for the situation)
- Excessive treatment (using "more treatment for more safety", thereby masking other similar situations that have already been treated to the appropriate level).

Optimum values for design parameters should be used as often as possible, consistent with prevailing constraints, such as terrain. Advance information and warning should be used to strengthen the delineation of a road. Driver overload should be avoided, as it may cause some drivers to shed vital information. Overload can result from too many road signs, conflicting messages or a lack of delineation.

Therefore a safe road environment is one which provides:

- No surprises in road design or traffic control (expectancy factors)
- A controlled release of relevant information (not too much at once)
- Repeated information where pertinent to emphasise danger

The illustrative examples that are shown hereafter are intended to sensitise the road safety practitioner on issues that are commonly found during road safety audits. It is essential that the designer as well as the Resident Engineer and the Maintenance Supervisor pay particular attention to detail to identify similar issues and prevent the duplication of unsafe practices.

Reducing these conditions will contribute to the improvement of the safety performance of the road environment.

GENERAL

Landscaping / Vegetation

A Warning sign obscured by overgrown vegetation

Shade on the sign face reducing the legibility thereof

GENERAL

East West Orientation of Roads

Serious sunset effect on westbound traffic

Headlight Glare

Glare screens erected on concrete barriers to reduce possible headlight glare.

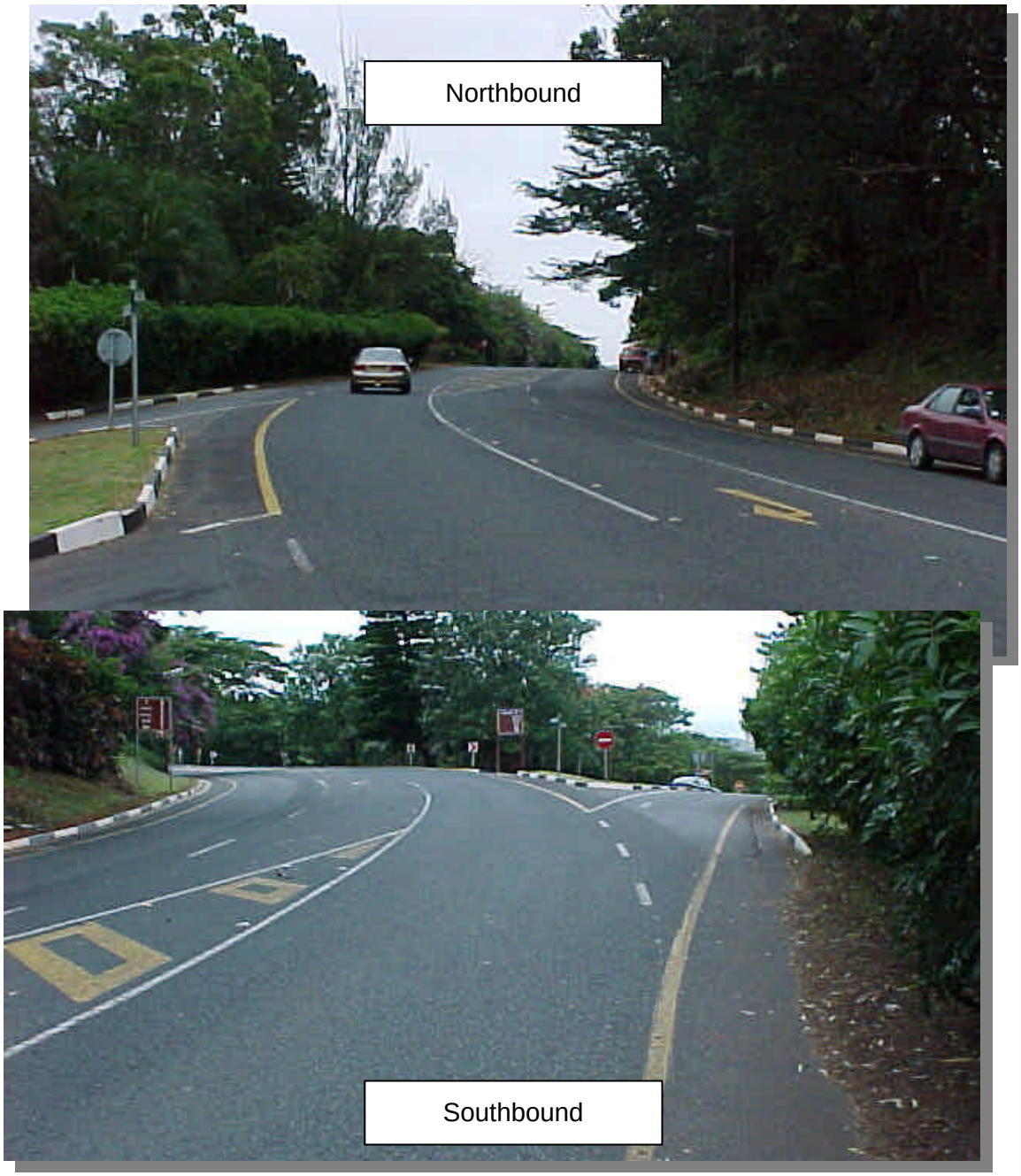
CROSS-SECTION AND ALIGNMENT

Visibility and Sight Distance

Poor forward visibility hampers driver expectancy:
As the driver approaches the crest there is no indication of the curve just behind the crest.

CROSS-SECTION AND ALIGNMENT

Readability by Drivers



Effective use of road markings to guide driver along the curve

CROSS SECTION AND ALIGNMENT

Design Speed and 85th Percentile operating speed

Conspicuous and prominent warning signs are provided as the operating speed is perceived to be too high for the horizontal and vertical alignment of the road

CROSS SECTION AND ALIGNMENT

Widths of traffic lanes, carriageways and bridges

Adequate lane and shoulder widths
Shoulders on bridge are wide enough to accommodate broken-down or emergency vehicles. Separate provision is also made for pedestrians.

Inadequate bridge cross section:
The bridge width does not provide continuation of the shoulders across the bridge. No provision for pedestrians

CROSS SECTION AND ALIGNMENT

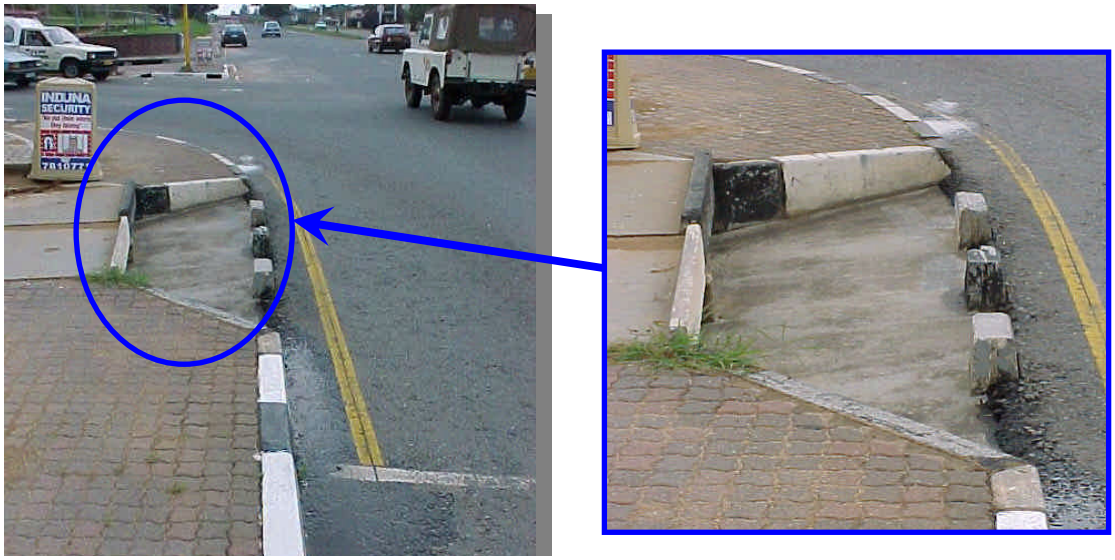
Shoulders

Functionality of shoulder:
The shoulders are not paved but may be used for broken down vehicles. The transition between the surfaced traffic lane and the shoulder, however, is hazardous.

Examples of highly dangerous edge drops between traffic lanes and shoulders

CROSS SECTION AND ALIGNMENT

Shoulders and Drainage inlets



Kerb inlet detail at intersection:
The vertical kerbing at the edge of the traffic lane may cause loss of control crashes

Uncovered and broken drainage inlets within the shoulder area may cause loss of control crashes

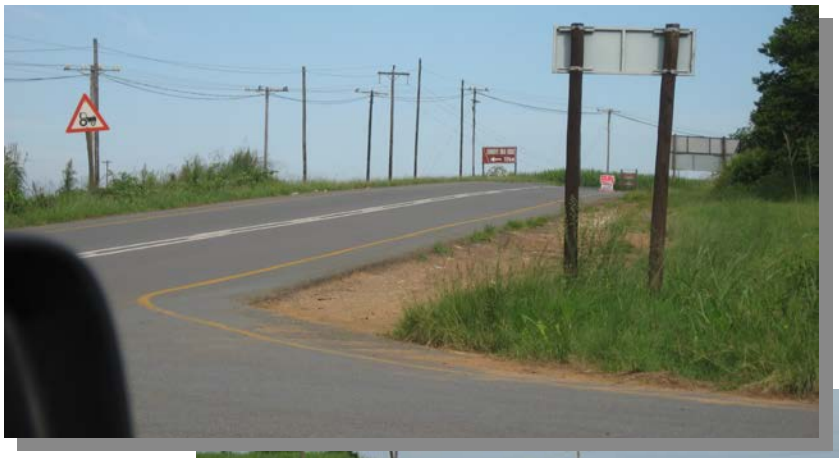
AUXILIARY AND EXCLUSIVE TURNING LANES

Visibility and adequate stopping sight distance &
Turning lane lengths

Approach to exclusive right turn lane with adequate length and visibility for the ruling operating speed

INTERSECTIONS

Located in Hazardous Positions



Intersections located close to crests or tight horizontal curves

Intersection located at an acute angle making it particularly difficult to safely assess potential entry opportunities.

INTERSECTIONS

Layout:
Alignment of traffic islands

This physical island is not properly offset from vehicle paths and may be replaced with a painted island and guide lines with better effect.

This physical island performs a clear function. It is properly offset from vehicle paths and well delineated to steer vehicles safely past the obstruction.

INTERSECTIONS

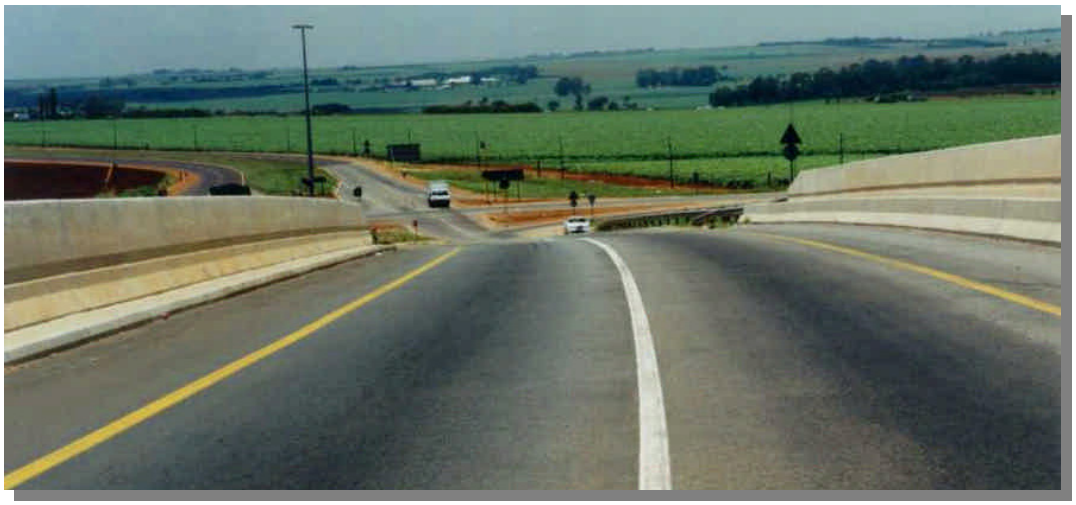
Layout:
Using traffic islands to reduce potential conflict

Physical islands have been used to reduce potential conflicting turning movements.

Liberal use of painted islands to clearly delineate dedicated turning movements from sheltered locations.

INTERSECTIONS

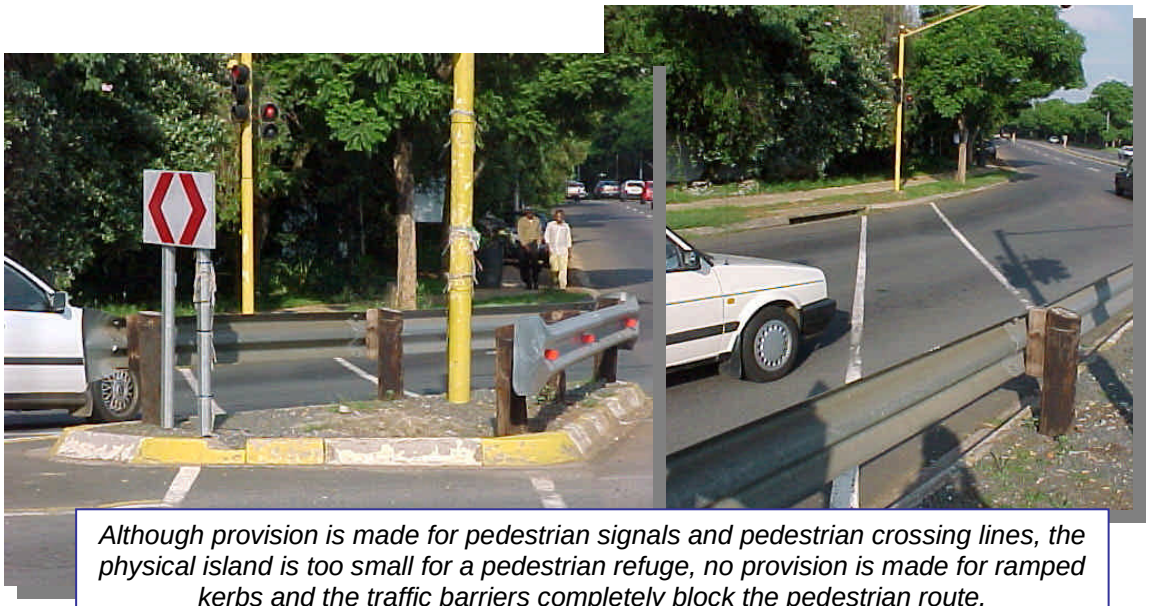
Layout:
Inadequate sight distance leading to insufficient driver guidance



Poor forward visibility hampers driver expectancy:
The upper photo clearly fails to prepare the driver for the imminent combination of S-curve, start of dual carriageway and the intersection.

SPECIAL ROAD USERS

Pedestrian routes and Crossing facilities

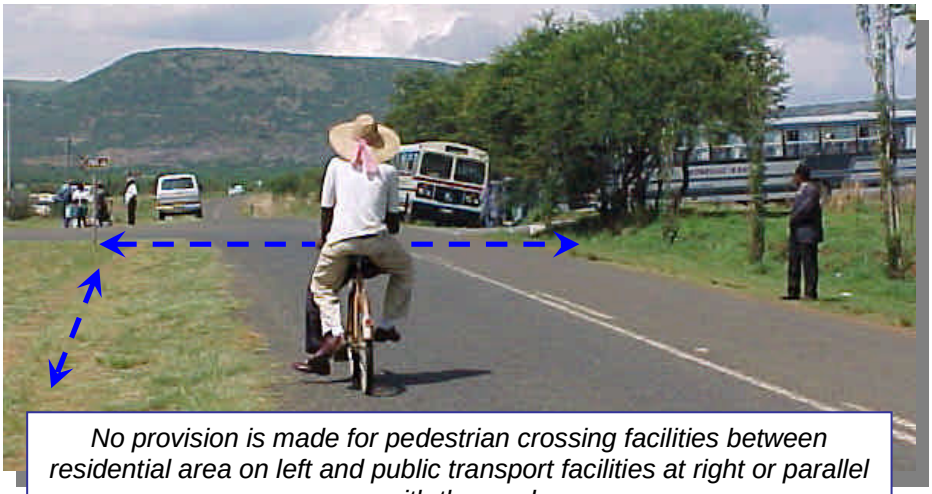


Although provision is made for pedestrian signals and pedestrian crossing lines, the physical island is too small for a pedestrian refuge, no provision is made for ramped kerbs and the traffic barriers completely block the pedestrian route.

Pedestrian crossing is not continued for the full width of the road and is being stopped short of a high speed slip road.

SPECIAL ROAD USERS

Pedestrian walkways



No provision is made for pedestrian crossing facilities between residential area on left and public transport facilities at right or parallel with the road

Obstructions in the walkway, whether overgrown vegetation or physical objects, impede the use of the walkway and force pedestrians closer to through traffic.

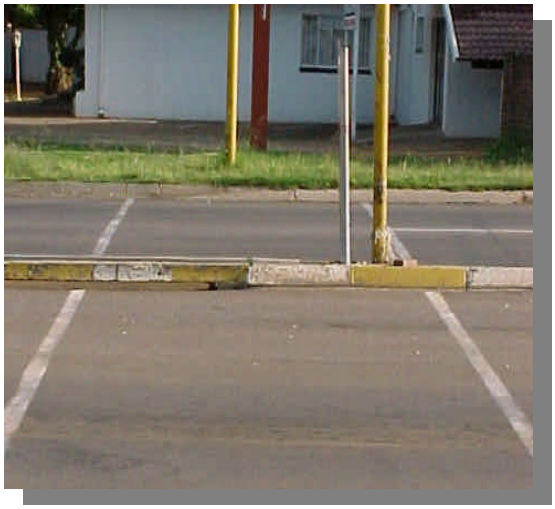
SPECIAL ROAD USERS

Pedestrians: Bridges and lighting

Contrasting situations: The photo at the top indicate the ample provision of protected pedestrian walkway and lighting along a bridge; the bottom photos show the total lack thereof and the exposure of pedestrians to through traffic. .

SPECIAL ROAD USERS

Pedestrians
Children, the elderly and the disabled

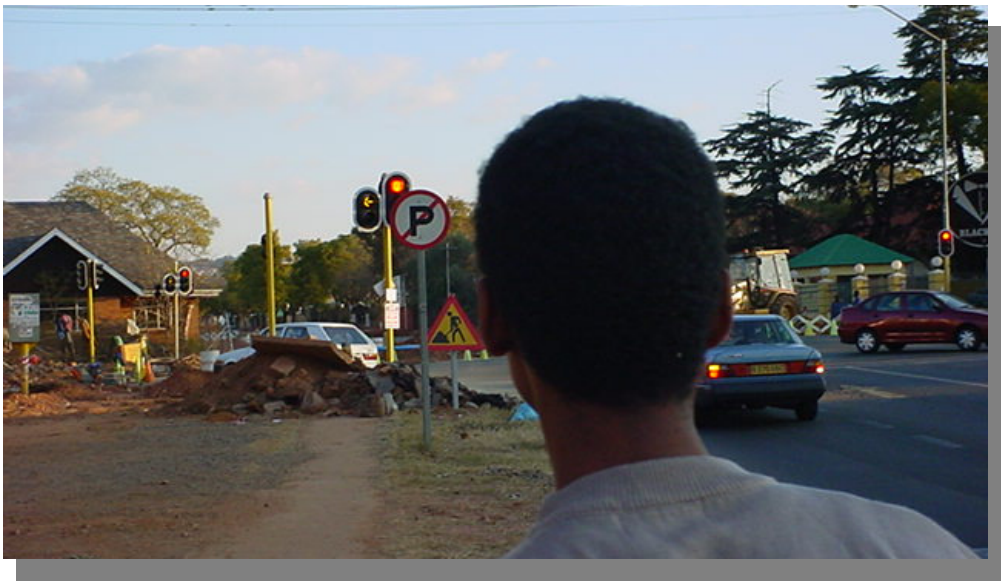


Vertical kerbing is a severe trip hazard for pedestrians and a major obstruction for disabled road users. The photo on the right shows a marked improvement with dropped kerbs and tactile blocks to assist visually impaired.

Particular care should be taken with pedestrian facilities on routes used by children going to school.

SPECIAL ROAD USERS

Planning for Pedestrians and Cyclists in Work Zone Traffic Management



Particular attention should be given to planning for the safe passing by pedestrians and cyclists through construction work zones, especially if normal routes will be interrupted

SPECIAL ROAD USERS

Public transport facilities

Two examples where the public transport facilities have been well located outside the through traffic.

Queuing area for bus passengers is located very close to the through traffic.

SPECIAL ROAD USERS

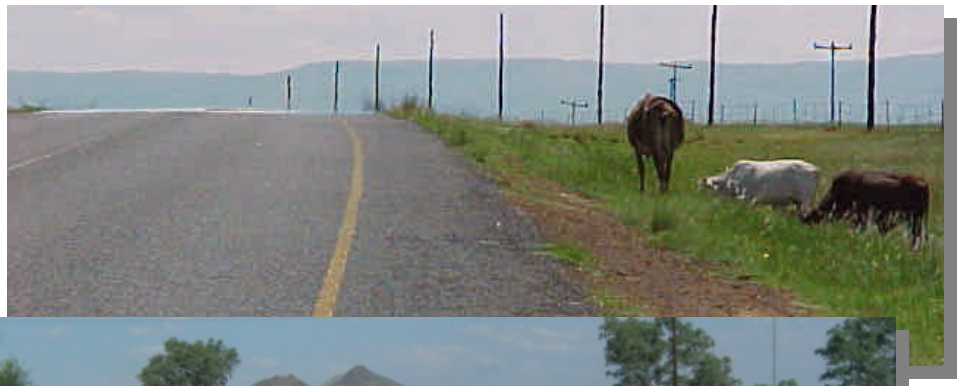
Heavy Vehicles

The risk of tragedy is very high because the alignment of this main road through a regional town did not anticipate the growth in heavy vehicles on this route.

Truck arrestor beds need to be marked in a standardized way and should be kept clear of refuse and properly maintained to offer best functionality.

SPECIAL ROAD USERS

Livestock



Vehicles using the roadway at speed are put in grave danger by livestock grazing uncontrolled in the road reserve or by stock being herded along or across roads. It is essential to give attention to the condition of fences or the provision of cattle underpasses.

ROAD SIGNS, MARKINGS AND LIGHTING

Visibility of signs

Despite poor visibility conditions, warning of this curve is achieved by proper signing.

Road signs obscuring each other:
The fact that the signs are not in compliance with the SADC RTSM is not in itself a safety issue unless the meaning of the old signs could be considered as potentially confusing.

ROAD SIGNS, MARKINGS AND LIGHTING

Road Signs

Care should be taken when unconventional conditions need to be communicated with road users.

Worn and damaged road signs that provide little warning or guidance to motorists.

ROAD SIGNS, MARKINGS AND LIGHTING

Road Signs

Comparison how daytime and nighttime appearance of signs (under dipped beams) differ when they reach the end of serviceable life; Daytime inspection only would provide a false sense of security pertaining to information transfer to the motorist

ROAD SIGNS, MARKINGS AND LIGHTING

Road Markings

Good visibility of road markings providing forward guidance to motorists despite poor visibility conditions.

Confusing road markings:
It is left to the motorist to guess how the approaching three lanes reduce to two or one lane within a tight right turn with light posts located immediately behind the kerbs on the outside of the curve.

Road lighting

This lighting pole is located within the clear zone. Although it seems to be protected by guard rail there is no deflection distance available and could result in pocketing when impacted.

Unprotected lighting poles can pose a serious hazard to road users – as shown above.

TRAFFIC SIGNALS

These signals had been damaged during a crash. Approaching motorists now simultaneously face RED and GREEN signals.

The efficient use of backboards to ensure contrast against a variable background

ROADSIDE HAZARD MANAGEMENT

Unprotected Roadside Hazards

Trees

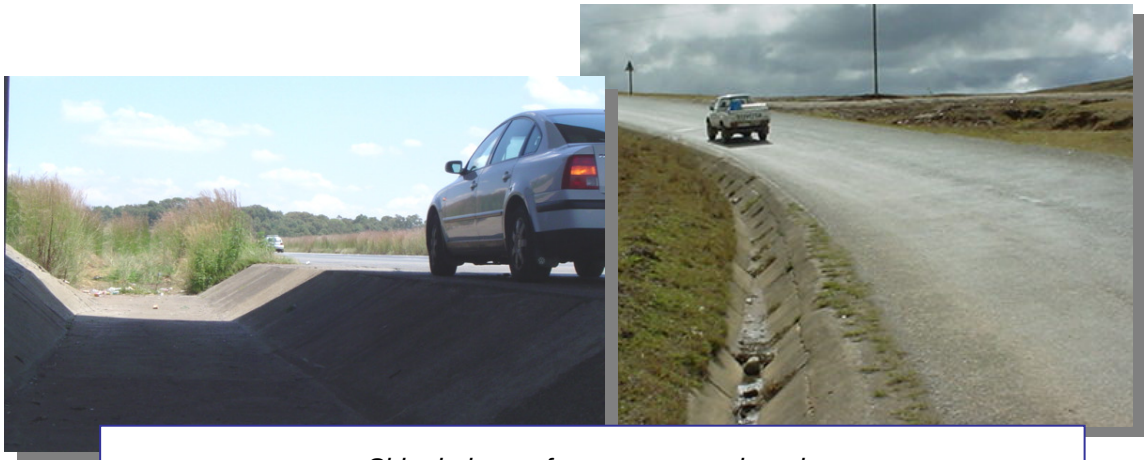
Lighting Posts

Kerb Inlets

Bridge Piers

Back Slope
Non -Traversable

Side drains



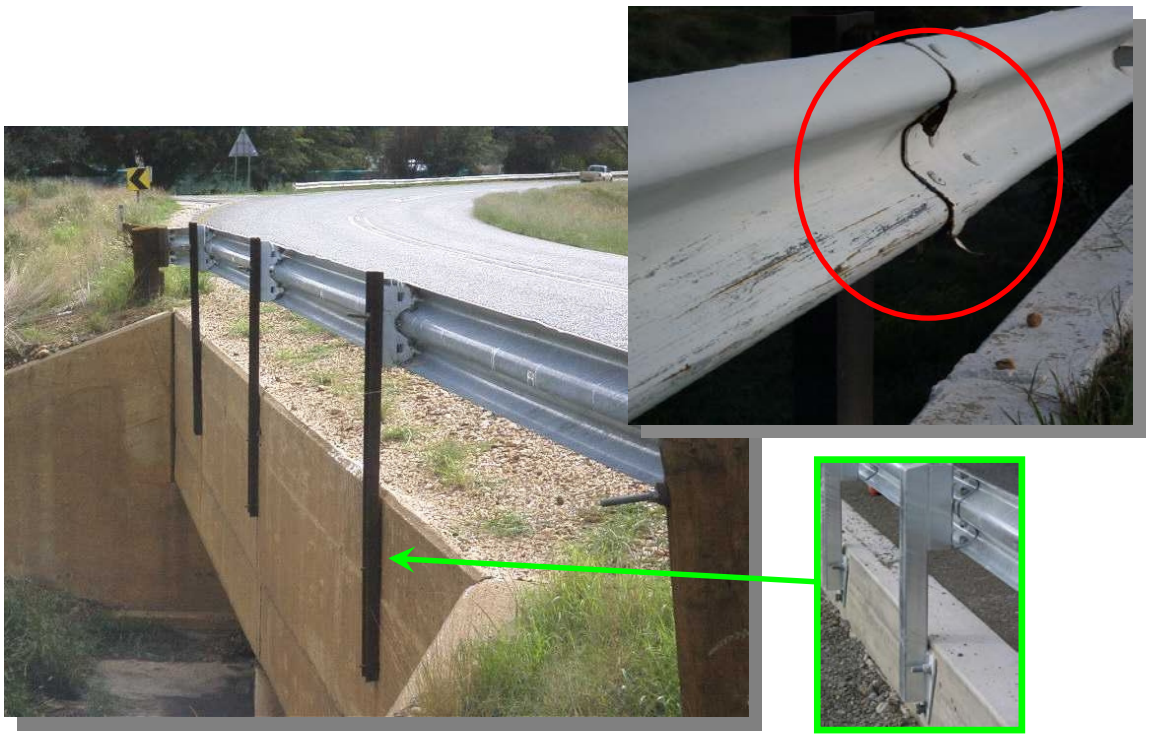
Side drains on freeways or rural roads

Non-recoverable drainage ditches

ROADSIDE HAZARD MANAGEMENT

W-Beam Semi - Flexible Guard Rail

Inappropriate protection of a bridge pier and inadequate attention to the transition between guard rail and concrete bridge railing



Inappropriate guard rail installation and overlap detail:

ROADSIDE HAZARD MANAGEMENT

Traffic barriers

Short lengths of guardrail are hazardous because there is insufficient length to develop tension to counter the forces of a crash

The lack of end-treatment on W-beam guardrail may lead to penetration into a vehicle on impact.

Traffic Barriers with no or inappropriate end treatment;
The end-treatment is supposed to provide gradual energy dissipation in case of a crash.

ROADSIDE HAZARD MANAGEMENT

Traffic barriers

Two views of the same culvert to show the high risk situation when appropriate traffic barriers are not installed

Although a short section of guard rail has been installed adjacent to the road, no protection is given for an errant vehicle using the gravel intersection on the left

DRIVER PERCEPTION

The warning signs create awareness with the driver for the conditions that will be following

Care should be taken when the road conditions seem different than the information given on signs in an advance location;
in this case contrasting directions

PAVEMENT

Loose Material

Potholes

PAVEMENT

Skid Resistance

Ponding

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OTHER

Access Management

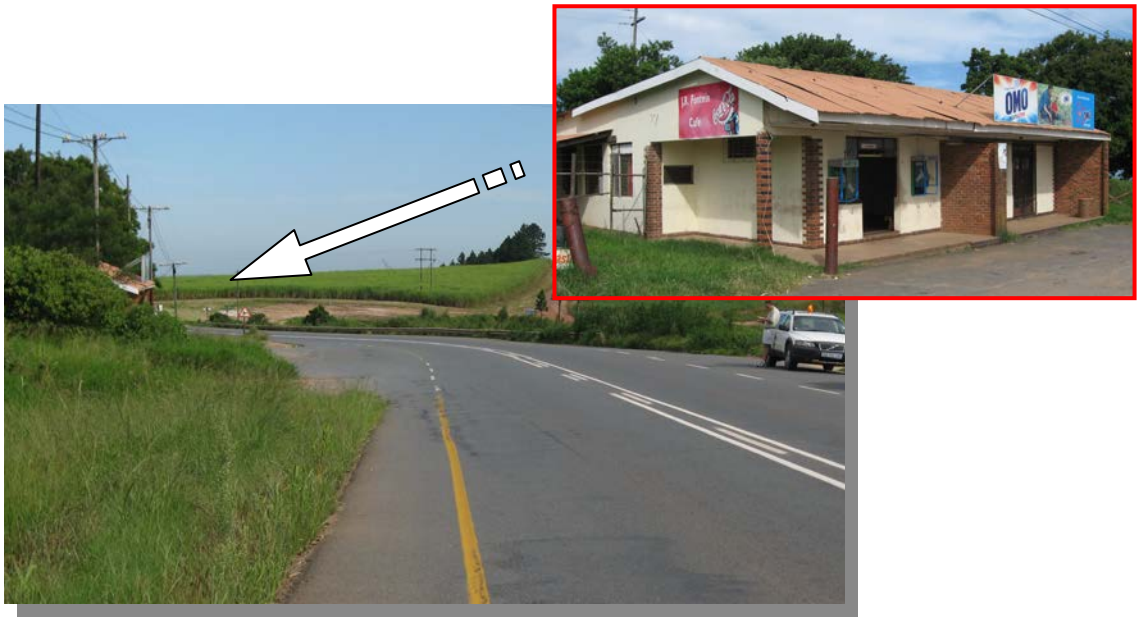
In this example, a median opening is provided within the functional area of the intersection. The land-uses are indicated in the photographs below.
The Road Safety Audit Team will typically state in their report that this opening is a safety hazard at the site. This statement is made whether information is available on the reasons for the opening or not. As long as it is a safety problem, for whatever reason, it should be included in the Road Safety Audit Report.

Fast Food Outlet

Filling Station

OTHER

Access Management



Hidden entrance to roadside store, located on a curve with restricted sight distance from both directions

Uncontrolled and random access to Provincial Main Road

OTHER

Traffic Calming

This roundabout has been installed on entry into a rural town to act as a gateway treatment in the transition from Provincial Main Road (100km/h) into the street section (dual carriageway; 60km/h). No provision has been made for the splitter island to deflect the motorist into the circulatory movement.

Special Events

The road safety auditor needs to be particularly careful to identify possible special events that may influence the safety performance of a road. Special events are not reserved for urban areas. This photo was taken on pension pay-out day in a rural area when a market is held to help pensioners spend their money.

APPENDIX B: LITIGATION SCENARIO AND CASE LAW

There are a number of landmark cases in the South African judicial system that clearly addresses the principles of delictual liability where the statutory duties of the road authorities have been questioned when the safety of the road users had been compromised. The inclusion of these case studies is intended to sensitise the road authority and the road safety auditor on the potential implications of not acting upon available information.

Road safety audits *per se* did not feature in any of these cases, but information available to the road authorities had not been appropriately acted upon; resulting in findings of negligent conduct.

Case studies addressing some of the aspects criticised in the court provide invaluable lessons.

Case 1: Pedestrian Safety: *Cape Town Municipality v Bakkerud, 1997*[28]

An aged pedestrian (the claimant) used a sidewalk near her home where it was known that two holes existed in the tarred surface of the pavement. The claimant stepped into one, stumbled and fell and sustained some injuries and loss. Evidence led in the case described that a pole was located near the holes. A wire cable ran from the pole and was attached to the pavement near to the holes. This had the effect of shepherding passers-by in the direction of the holes. The pavement was narrow and the holes existed for at least six months. The holes were repaired two days after the incident. The relevant applicable legislation empowered, but did not oblige the local authority to construct and maintain and repair streets and pavements within its area of jurisdiction. The lower court found the local authority liable and the claimant contributory negligent to a 50% extent.

In the Supreme Court of Appeal the local authority argued that the legislation did not establish legal duty upon the local authority to repair a street or pavement. This premise had been so entrenched that it had been seen as a "general immunity" or a high degree of immunity for municipalities in relation to accidents caused by potholes and the like in the surface of streets."

The court reviewed this principle at length and concluded that the doctrine of "general immunity" was not as rigid as earlier and that the court, in applying the test of what the legal convictions of the community demand to reach a particular conclusion, should make value judgements on an *ad hoc* basis.

In hindsight it is easy to identify aspects that assisted the court in ruling against the Municipality. All of the aspects that played a role in this unfortunate incident could have been foreseen in a road safety inspection of the location.

[28] *Cape Town Municipality v Bakkerud* 1997 (4) SA 356 (C)

Case 2: Cycle Safety: *McIntosh v Premier, KwaZulu-Natal, 2008*[29]

The claimant and a group of friends went cycling in the Kamberg area near Pietermaritzburg. They cycled in a group up a fairly steep incline. This section of the road rises to the top of a hill in the course of which there are a number of bends in both directions. The centre of the road is marked with a barrier line comprising two solid white lines with a broken white line between them. Shortly after reaching the crest of the rise the claimant and two of his companions decided to ride back in the direction from which they had come. They set off from the crest of the hill, one after the other, with a short interval between the departures of each. The speed limit on the road is 100km/h. The claimant attained a speed of about 55km/h as he descended down the hill and travelled about a metre from the centre line. As he entered a bend in the road to his right he began to converge on the barrier line in order to negotiate the bend more easily. The road beyond the bend curved to his left so as to afford him a clear view of oncoming traffic. He observed an approaching vehicle but it was still a long way off. Suddenly he observed a large pothole ahead of him on the broken line between the two solid white lines. In an effort to avoid the pothole he attempted to swerve to his left by shifting his weight to a more upright position. In the process he lost control of the bicycle and the next thing he remembered was lying on the grass on the other side of the guardrail with people helping him.

The court was told that the pothole had been at least one year old and had been classified as very serious. Weekly inspections took place on that section of the road and a routine maintenance team started repairing potholes on that section shortly before the cyclist fell. The respondents denied negligence and advanced lack of funds for the earlier maintenance of that section of road as defence, combined with an argument that the location of the pothole between the solid line markings of the barrier line reduced the priority of repairing that particular pothole. Lack of funds was particularly advanced because Section 3(2) of the KwaZuluNatal Provincial Roads Act determines that the responsibility for construction and maintenance are "within the Province's available resources". The foreman of the pothole repair team explained to the court the process that he was following in determining the priority of which potholes to be repaired first.

In determining negligence the court considered whether the harm coming from the omission to repair the pothole had been foreseeable and whether the reasonable man would have taken steps to safeguard the situation. The court heard that there had been no signs warning of potholes at the time of the crash, but that such signs had been installed after the crash. The court could find no rational reason why the pothole had been left unrepaired for so long, notwithstanding the regular weekly inspections.

The court found that the road authority had indeed been negligent, but that the cyclist was also contributory negligent. The court ruled that negligence/ liability was estimated to be 60%/ 40% and ordered the respondents to pay 60% of the costs incurred by the claimant.

In this case experts on pavement management and pavement engineering testified for both sides and both referred to manuals pertaining to the visual assessment of roads as a means to classify the extent of the pothole problem. The court had been critical of the fact that the road authority failed to do maintenance to stop the development of the pothole at an earlier stage, stating: "*No rational reason presents itself as to why the pothole was left unrepaired for so long; nor was one advanced.*"

[29] *McIntosh v Premier, KwaZulu-Natal (632/07) [2008] ZASCA 62 (29 May 2008)*

Vehicular Safety

Two important cases are presented hereafter to indicate the importance of timeous and appropriate response to well known deficiencies that may influence the safety of road users.

Case 3[30]: Graham v Cape Town Metropolitan Municipality, 1999

The facts before the court were summarized as follows:

The claimant claimed payment of damages allegedly suffered by him in consequence of serious injuries and permanent disablement sustained when the vehicle in which he was driving was struck by a mudslide on Chapman's Peak Drive between Hout Bay and Noordhoek in the Cape Peninsula. Chapman's Peak Drive was a naturally dangerous road in all weather conditions. Because of its excavated situation and geological environment it was subject to natural hazards such as rockfalls and, especially in rainy weather, slope failures in the form of rock and earthslides from high adjacent cliffs and mountain slopes onto the road, which made it particularly dangerous to road users. There was an alternate and quite safe road available from Noordhoek and Hout Bay via Constantia, but it was about twice the distance. Commuters living at Noordhoek would naturally only use the longer route when Chapman's Peak Drive was closed or regarded as unusually dangerous for particular reasons. The rainfall in the month prior to the accident had been much higher than normal, for which reason, at the time of the claimant's accident, the ordinary danger to road users had been considerably heightened.

The only danger signs on Chapman's Peak Drive were the W22 'Falling Rocks' warning signs at both entrances to the road. The W22 sign, which was commonly seen in mountain passes in the Western Cape, was to warn motorists of the likelihood of falling rocks. The sign was taken by the average driver as meaning no more than that he should keep a good look-out for rocks on the road ahead.

The defendant was a local government body entrusted with the responsibility for the maintenance and control of Chapman's Peak Drive, the functions of which included clearing of fallen rocks from the road and the provision and maintenance of stormwater drainage in its immediate vicinity. It was not in dispute that the defendant was under a duty to exercise such due care and to take such reasonable precautions as circumstances, particularly weather conditions, might require in order to avoid or minimise the risk of injury to road users. The defendant not only maintained and managed the road but exercised *de facto* and exclusive physical control over it. The defendant was entitled to close the road at any time and to make use of special warning signs. The defendant had not monitored weather reports and forecasts with a view to the assessment of the risk of rock and landslides on Chapman's Peak Drive. Furthermore, no official had been charged with any general or specific inspection duties at the time of the claimant's accident.

30 *Graham v Cape Metropolitan Council 1999 (3) SA 356 (C)*

The Court found as follows:

- that wrongfulness in terms of the sense of justice and legal convictions of the community applied to omissions by a public authority.
- that a duty of care towards road users had to apply to the controlling public authority unless there was a valid basis for its exclusion. Such a duty only arose, however, when the injury could have been avoided by reasonably practical means. Put differently, the norm to be applied in cases such as this was whether the sense of justice of the community would view the failure of the local authority to take positive action as wrongful, subject to the qualification that the local authority was not required to do more than might be reasonably expected.
- that a local authority which was in control of a dangerous road such as this was under a duty to warn intending road users specifically of the nature of the hazard and the risk involved, by special and appropriate road signs or other means;
- that the controlling authority's duty was to close the road under hazardous conditions, unless closure would not be reasonably practical, in which case the most effective alternative means to avoid injury or decrease the risk thereof had to be employed;
- that as the risk of injury to road users from the hazards increased considerably in rainy weather conditions, the controlling road authority was under a duty to monitor the condition of the road and its stormwater drainage, as well as reports and forecasts of local weather on a regular, daily basis, inclusive of holidays and weekends;
- that there had to be special and effective warning signs at both entrances of the road, apart from the commonplace and familiar W22 'Falling Rocks' signs, informing drivers of the existence of the unusual and serious danger of rockfalls and earthslides in the rainy season and warning drivers that they would use the road at their own risk during or after rainy weather. A telephone number also had to be given for enquiries;
- that as soon as an unusually high risk of slope failures was reasonably foreseeable in consequence of higher than average rainfall, the road had to be closed to traffic;
- that the defendant's failure, prior to the claimant's accident, to place special and effective warning signs at both entrances to Chapman's Peak Drive to warn road users of the high risk of rock and earthslides because of rainfall was an unlawful omission, as was the defendant's failure to close the road to traffic before the accident. Both those omissions constituted negligence;
- that as the existing W22 roadsigns at the entrance to Chapman's Peak Drive could not serve as a warning of the risk posed by conditions on the road during heavy rainy weather, it could not be said that the claimant had accepted any risk or that there had been any contributory negligence on his part;
- that the defendant was liable for payment of all such damages as the claimant might be found to have suffered in consequence of the accident.

It is clear from the judgment that the court was of the opinion that the road authority:

- knew about the conditions on the road;
- knew that these conditions deteriorated extensively during rainy periods;
- closed the road under severe conditions before but had failed to do so in time on this occasion;
- failed to have a system in place to monitor the deterioration of conditions during high rainfall periods;
- failed to warn motorists about the increased risks of using the road during such conditions.

Case 4[31]: Esterhuizen v Free State MEC for Public Works, Roads and Transport [2005]

The court found that the accident occurred under the following circumstances:

The accident occurred at night with limited visibility. Driving from west to east the driver had, after observing a small buck in front of him, taken evasive action by veering to the left thereby bringing the two wheels on the left side of the vehicle off the tar onto the gravel shoulder on the northern side of the road while the two wheels on the vehicle's right side, i.e., the southern side remained on the tar. As the driver attempted to regain the tar he felt a jerking action on his steering wheel and then lost control of the vehicle. The vehicle swerved to the right across the road, struck an embankment on the southern side of the road, rolled over and came to rest on its wheels in a field.

The court found as a fact that the point at which the driver had attempted to bring the two left wheels back on to the tar, had a dangerous difference in height between the gravel and the tar. This, it concluded, was the cause of the jerking action of the steering wheel which resulted in the driver's loss of control of the vehicle.

In court it was indicated that the road authority had been advised of the edge drop between surfacing and the shoulder some ten years earlier as part of the visual assessment of the road for pavement management purposes, but that nothing had been done since to rectify the condition.

The road authority was held fully liable because it had failed to properly maintain the road.

Notwithstanding the fact that a visual assessment report of the road in the vicinity of the crash location ten years prior to the crash identified an edge drop between the surfaced road and the shoulder no action had been taken by the road authority to restore this condition. Evidence by the road authority on the lack of budgetary allocation for construction and maintenance of Provincial roads was noted by the court as informative but no defence against the evidence that the road or parts thereof had not been properly maintained.

The omission by the road authority to act in a reasonable manner, notwithstanding the availability of relevant information, contributed to the decision by the court to rule against the road authority when a crash did occur.

This case confirms the need that any road authority:

- should take due cognisance of information being made available to it;
- review such information;
- decide how to act upon it;
- plan and implement such action.

31 *Esterhuizen e.a. v Die Lid van die Uitvoerende Raad vir Openbare Werke, Paaie en Vervoer van die Vrystaat Provinsie; Case 1673/2004; Unreported Case; 23 June 2005; G van Coppenhagen J*

APPENDIX C: AUDIT PROCESS TEMPLATES

APPENDIX C-1: RSA Team Application
APPENDIX C-2: Audit Brief Checklist
APPENDIX C-3: RSA Report Layout
APPENDIX C-4: Model Audit Team Statement
APPENDIX C-5: Appraisal Report Example
APPENDIX C-6: Audit Response Report Template

APPENDIX C-1: RSA Team Application

(Client organisation and logo)

APPLICATION FOR APPROVAL OF ROAD SAFETY AUDIT TEAM[32]

Road Number: .....
Description of project: .....
.....
Project Reference Number: .....
Brief description of extent of works:
.....
.....
.....
Consulting Engineer: .....
Address: .....
.....
.....
Contact: Name: .....
Phone/ e-mail .....

RSA Stage: # ..... Description: .....

Proposed RSA Team members:
(Propose at least two members and attach CV's not exceeding 3 pages each showing training and relevant experience)

Name	Proposed position			Training (Compliant with requirements? Y/N)			Experience	
	Leader	Member	Observer	Road Safety Engineering	Road Safety Audit course	CPD	Accident Investigation/ Safety engineering (Years)	# of Road Safety Audits (1 year/ 2 years)

The abovementioned individuals are hereby proposed for conducting a road safety audit on this project as a special service in accordance with the General Conditions as required by the Client. It is confirmed that none of the proposed audit team members have been involved in the design of the works.

Consulting Engineer: ..... Date:.....

[32] *Adapted from National Roads Authority, Ireland, July 2004, Road Safety Audit Guidelines, Advice note NRA HA 42/04*

APPENDIX C-2: Audit Brief Checklist

(Client organisation and logo)

CHECKLIST: ROAD SAFETY AUDIT BRIEF[33]

Road Number: .....

Description of project: .....

Project Reference Number: .....

Brief description of purpose and scope of project: .....

.....

Audit Stage required: 1 ( ) 2 ( ) 1/2 ( ) 3 ( ) 4A ( ) 4B ( ) 5 ( ) 6 ( )

Client organisation .....

Director .....

Project Manager/ Liaison Engineer .....

Design organisation

Design Team Contact

Documents provided for Audit (tick where applicable)

Y / N	Site Location Drawing	Y / N	Signs and Markings Drawings
Y / N	Horizontal alignment drawings	Y / N	Traffic signal layout details
Y / N	Vertical alignment drawings	Y / N	Traffic signal timing plans
Y / N	Typical cross sections	Y / N	Crash data/ Plots
Y / N	Typical details (Standard drawings)	Y / N	Traffic counts
Y / N	Previous Safety Audit Reports	Y / N	Speed survey
Y / N	Previous Safety Audit Response Reports	Y / N	Landscaping drawings
Y / N	Departures from standards	Y / N	As-Built drawings

Other background information:

.....

.....

.....

The approved road safety audit team is hereby instructed to conduct a Road Safety Audit in terms of the SA Road Safety Audit Manual on the project as indicated above. The appended information is considered to provide necessary background information to the proposed audit. Additional information may be provided in a commencement meeting or as requested by the road safety audit team.

Name:	
Position:	
Organisation:	
Address:	*Signed:*
	Date:

[33] *Adapted from Municipality of Abu Dhabi City, 2009, Road Safety Audit Procedures for Abu Dhabi City Internal Roads*

APPENDIX C-3: RSA Report Layout

Proposed Layout of the Road Safety Audit Report

Chapter 1: Introduction

Project Title
Commissioning Authority
Terms of Reference
Main Parties to the Audit

Chapter 2: Background Information

Project description
Purpose of the Road Safety Audit
Reviewed Information
Risk Assessment

Chapter 3: Findings and Recommendations

The specific road safety problems identified, supported with the background reasoning, stating:

- *The location of the problem;*
- *The nature of the problem;*
- *The type of crash that is likely to occur as a result of the problem;*
- *Recommendations for action to mitigate or remove the problems*

(This chapter should be structured in a way that would suit the specific audit or as prescribed or approved by the client and may be prepared in a narrative way or in a tabular layout)

Chapter 4: Concluding Statement.

Appendices

An A3 or A4 location map, marked up and referenced to the problems

Photographs of problem conditions, where possible

APPENDIX C-4: Model Audit Team Statement

Concluding Statement for a Road Safety Audit[34]:

We hereby certify that this Road Safety Audit has been conducted in accordance with the South African Road Safety Audit Manual, 2012.

We have examined the plans and documents listed in Appendix ..... to this report. We have inspected the site. The audit has been carried out for the sole purpose of identifying any features of the design which could be altered or removed to improve the safety of the proposed project. The identified issues have been noted in this report. The accompanying findings and recommendations are put forward for consideration by the Client for implementation.

AUDIT TEAM LEADER:

Name: ..... Signed: .....

Position: ..... Date: .....

Organisation and address: .....

.....

AUDIT TEAM MEMBERS:

Name: ..... Signed: .....

Position: ..... Date: .....

Organisation and address: .....

.....

Concluding Statement for a Road Safety Appraisal:

We hereby certify that this Road Safety Appraisal has been conducted in accordance with the requirements of the South African Road Safety Audit Manual, 2012. The site has been inspected under day time and night time conditions.

AUDIT TEAM LEADER:

Name: …… Signed: ……..

Position: …… Date: ……..

Organisation and address: ……..

……..

AUDIT TEAM MEMBERS:

Name:

Position:

Organisation and Address

[34] *Austroads, Guide to Road Safety – Part 6: Road Safety Audit, 2008*

APPENDIX C-5: Appraisal Report Example

This example report is intended as guidance on the layout and level of argumentation that may be included in a road safety appraisal (Road safety audit on an existing road.)

Illustrative Report:

Road Safety Appraisal: Rxxx/ Ryy Intersection

1. Introduction

This report describes a Road Safety Appraisal carried out on the intersection of routes Rxxx and Ryy in the vicinity of Rural Town, Free State.

The appraisal was carried out on-site on 16 and 17 February 20xx with a follow-up visit to the site on 28 March 20xx.

The appraisal team members were: ....., Appraisal Team Leader, and .....

The appraisal comprised an on-site examination of the conditions at the intersection and in its immediate environment. The on-site examination entailed both nighttime and daytime inspections.

The scope of the appraisal is described more fully in the SA Road Safety Audit Manual (Draft 2010). The Client requested the audit team to conduct retroreflectivity measurements on the road markings on the approach to the intersection and also to report on a risk assessment in terms of the Manual.

The team has examined and only reports on the road safety implications of the intersection and its approaches and has not examined or verified the compliance of the design to any other criteria.

The audit team received crash information for consideration, but found that the information was incorrectly and inconsistently referenced and incomplete. Individual crashes included non-compatible elements. The crash information was therefore not analysed in this appraisal.

The intersection is a T-junction located in a horizontal curve and in a sag vertical curve on route Rxxx and immediately south of a bridge crossing a minor stream. All three legs of this intersection follow a downgrade alignment towards the intersection. The Ryy alignment from Regional Town follows a straight alignment and intersects route Rxxx on the outside of the horizontal curve.

2. ITEMS RESULTING FROM THIS APPRAISAL

2.1 PROBLEM

Location: *Rxxx Northbound towards intersection.*

Summary: *Risk of head-on crashes*

Risk Assessment: *Medium Risk (Severity: Serious; Frequency: Occasional)*

The intersection is located in a horizontal curve. A separate slip road accommodates traffic from Ryy wishing to turn southbound on to Rxxx.

Provision has been made for northbound traffic on Rxxx to turn right on to Ryy from a dedicated right turn lane. This dedicated lane develops in the horizontal curve in such a way that the slip road could be mistaken as an Y-junction by northbound traffic, which could cause possible wrong way entry into the slip road.

This perception is aggravated by the location of the right turn arrow markings in the dedicated turning lane and bifurcation arrow marking very close to the beginning of the dedicated turning lane together with the

front boundary line of the painted island lining up with the edge line in the slip road. The visual effect of superelevation may also play a role with the slip road being somewhat "behind" the crest of the superelevation on the main road.

Daytime: Rxxx Northbound

Nighttime: Rxxx Northbound

Recommendation

The possible perception of a free flow right turn movement towards Ryy should be removed.

This may be achieved by relocating the WM3 advance right turning arrow marking away from the throat of the slip road, the removal of the bifurcation arrow and the re-marking of the no-overtaking line marking along the dedicated turn lane as a no-crossing line (three line pattern) and the installation of new R3 (no-entry) signs facing possible wrong-way entrants into the slip road on both sides of the "*wrong way entrance*" into the slip road.

2.2 PROBLEM

Location: *Ryy Westbound towards intersection*
Rxxx Southbound towards intersection
Rxxx Northbound towards intersection

Summary: *Risk of nighttime crashes*

Risk Assessment: *High Risk (Severity: Serious; Frequency: Probable)*

Drivers approaching the intersection from all directions will find it very difficult to read the signs at night, although the legibility of the signs under daylight conditions is still good. The SADC Road Traffic Signs Manual governs the display of road traffic signs on public roads. Advance direction (GD1) signs have been erected on all three approaches to the intersection to provide the advance warning of an imminent direction change ahead. These are supplemented with direction (GD2) signs at the intersection itself. Furthermore, warning signs on high visibility backgrounds additional to the normal sequence of signs have been erected on the Ryy approach to the T-junction. The R1- STOP sign at the intersection with Rxxx was also placed on a high visibility background, reducing the value of shape recognition of the octagon shape.

During the nighttime inspection it was evident that all the warning signs and advance direction and direction signs have lost their retroreflective properties. This results in all these signs being inconspicuous and ineffective at night. Only one direction sign was dated in accordance with typical Provincial road authority practice. This sign is dated 199x which renders it 13 years old. The text style used on this sign (DIN B style) is in accordance with the 3rd edition of the SA Road Traffic Signs Manual. On another sign the text used is still the earlier type of text (Modified E) which predates 199x. The other guidance signs on the intersection perform similarly at night when compared with the dated sign.

The retroreflective sheeting used on these signs is class I material (engineering grade) which has a 7 year warranty for the retention of retro reflective properties. The lack of timeous replacement of the signs resulted in the loss of retro reflectivity of these signs to such an extent that they are rendered useless in nighttime conditions. These signs are therefore seriously overdue for replacement.

Comparison of nighttime and daytime legibility of traffic signs

Recommendation

The level of information given to the motorist under nighttime conditions should be improved significantly.

This may be achieved by the replacement of all warning signs and advance direction (GD1) and direction (GD2) signs at this intersection and utilising materials with a higher conspicuity performance.

It is also recommended that the R1 STOP sign be replaced with a larger sized sign without the high visibility background.

....

....

....

2.x PROBLEM

Location: *Approaches towards intersection.*

Summary: *Risk of possible crashes with fixed objects*

Risk Assessment: *High Risk (Severity: Serious; Frequency: Probable)*

The existing intersection is flanked with W-beam guard rails, bridge railings strengthened with W-beam guard rail and concrete edge blocks on the bridge deck. Although all of these measures could be considered as protective, the detail of their use constitutes potential risk of improper utilisation and increased risk in case of crashes:

The bridge railing on the eastern side of the bridge is bolted to the side of the deck and would not withstand the impact during a crash. The railing has been strengthened by continuous W-beam guardrail across the bridge but the stanchions (railing columns) have not been strengthened.

The bridge railing on the western side of the bridge has been replaced with concrete edge blocks. These edge blocks do not provide a continuous rub surface to redirect vehicles in the case of crashes, risking possible snagging of the vehicle on the intermittent near ends of these blocks. Furthermore the front face of the W-beam guardrail on the approaches to these concrete edge blocks line up with the rear of the blocks, which means that any vehicle impacting the guard rail will be guided directly into the end of the concrete blocks.

These concrete edge blocks have been erected within the existing shoulder reducing the shoulder width without any warning. The yellow edge line parallel to Rxxx deteriorated to such an extent that vehicles travelling along Rxxx, especially northbound (i.e. on the inside of the horizontal curve), would not realise how far they were encroaching into the shoulder, thus increasing the risk of crashing into the blocks.

The W-beam guard rail parallel to Rxxx (western side) is supposed to safeguard vehicles from the high embankment. This guard rail has been damaged by vehicles impacting at right angles from the westbound approach of route Ryy (leg of the T-junction). The lack of proper repair of the guardrail after such impacts has left the guardrail too low and not properly posted.

The end sections of the guard rail and the concrete edge blocks have not been marked with hazard marker road traffic signs. The W-beam guardrails are not marked with the D1 delineators as recommended in the SADC Road Traffic Signs Manual. Vegetation in front of the guardrails also obscures the small guard rail delineators that have been installed.

View along Route Rxxx Southbound
(Note: Road was closed at intersection for maintenance at time of daytime inspection)

Recommendation

The vehicle safeguarding measures in the form of bridge railings and W-beam on the approaches to the bridge railings should be replaced or upgraded in accordance with general accepted safe practice. This would include the installation of hazard marker signs on all the terminal positions of the guard rail.

The intermittent concrete edge blocks should either be replaced with continuous concrete balustrade or with continuous W-beam guardrail on sturdy and crashworthy steel stanchions.

Road markings should be upgraded and road studs installed on all the line markings to improve the nighttime readability of the intersection to approaching drivers.

3. CONCLUDING STATEMENT

I hereby certify that this Road Safety Appraisal has been conducted in accordance with the South African Road Safety Audit Manual, 2012.

APPRAISAL TEAM LEADER

Name:…… Signed:……..

Position: Date:

Organisation and address:

APPRAISAL TEAM MEMBERS:

Name:

Position:

Organisation and Address

APPENDIX C-6: Audit Response Report Template

(Client organisation and logo)

ROAD SAFETY AUDIT RESPONSE REPORT

Road Number:		
Description of project:		
Project Reference Number:		
Road Safety Audit Report:	Stage No.	#
Stage description:		
Date Completed:		
Client's instruction to respond:	Reference:	Date:

This response to the Stage xx Road Safety Report has been prepared in accordance with SARSAM, 2010 and represent the considered opinion of *(the design organisation)* having taken due consideration of the problem identification and recommendations for remedial measures made by the road safety audit team.

Problem No. in Audit Report	Problem accepted (Yes/No)	Recommended measure accepted (Yes/No)	Comments or Alternative Remedial Measure (Describe)

Design Team Leader's Statement:

I certify that I have considered the items raised in the Stage xx road safety audit report referenced above. I am content to accept all of its recommendations except for those items listed above. I have stated my reasons for not accepting the recommendations advanced by the road safety audit report and/ or submitted alternative remedial measures as indicated above. It is recommended that these alternative measures are approved by the *(Client Organisation).*

.... *Date:* ....

Design Team Leader *Consultant:* ....

Project Manager's Decision:

I certify that I have reviewed the road safety audit report (Stage No. .....; Dated: ....) and the response report prepared by the Design Organisation (....................................) and submitted hereby. I *agree/ disagree/ agree subject to the following conditions* [delete which is not applicable] and submit this report to you for approval of the remedial measures

....

....

....

.... Date: ....

Project Manager Name: ....

Client Organisation:

The recommendation is accepted/ rejected/ accepted with the following changes: ....

....

For Client: ,, Date: ....

APPENDIX D: AUDIT PROMPT LISTS

APPENDIX D-1: Stage 1 Road Safety Audit: Preliminary Design Stage
APPENDIX D-2: Stage 2 Road Safety Audit: Draft Design Stage
APPENDIX D-3: Stage 3 Road Safety Audit: Detail Design Stage
APPENDIX D-4: Stage 4 Work Zone Traffic Management Audit
APPENDIX D-5: Stage 5 Road Safety Audit: Pre-Opening Stage
APPENDIX D-6: Road Safety Audits on Existing Roads (Road Safety Appraisals)

APPENDIX D-1: Stage 1 Road Safety Audit: Preliminary Design

ITEM	POSSIBLE ISSUE
GENERAL TOPICS	
Project scope, function and mix of traffic	What is the function of the scheme? Is the design consistent with the function of the road? Does the project make adequate provision for: ▪ Pedestrians ▪ Passenger vehicles ▪ Heavy vehicles ▪ Buses ▪ Other road users that will make use of the facility? Does the project make adequate provision for the expected traffic mix? Is the proposed project consistent with adjacent roads, land forms and traffic management?
Type and degree of access to property and developments	Is the degree of access control consistent with the function of the road and with other sections of the road? Will sight distances be satisfactory at intersections and property accesses? Is the design speed (or the anticipated vehicle speeds) compatible with the number and type of intersections or property accesses? Does the width of the road satisfy access needs?
Major traffic generators	Are all major traffic generators far enough away from the project or from intersections to avoid unsafe influences on the form of the design? Have existing or alternative accesses been arranged to ensure that existing subareas are not cut off by the project? Will the proposed scheme be consistent with adjacent roads, land forms and traffic management?
Staging requirements	Will this design be implemented in one stage only? If the design is to be implemented in more than one stage, has safety been given a high priority: ▪ in transitions between stages? ▪ in transitions to existing roads? Will the work avoid problems with safety standards elsewhere during construction?
Future works	Will the route be free of compromises in safety if there is to be: ▪ future widening? ▪ the addition of a complete second carriageway? ▪ after realignments? ▪ major geometric changes at intersections? ▪ linear extensions of the scheme?
Wider network effects	Have all harmful safety effects of this scheme upon the surrounding road network been identified? Have they been adequately dealt with?

ITEM	POSSIBLE ISSUE
DESIGN	
Route choice	Are all aspects regarding the location of the route and the alignment thereof safe? Does the project safely tie in with the existing road network? If the route is new, is the alignment safe? Could it be safer? Does the project safely fit in with the physical constraints of the landscape? Does the project design safely take account of the existing road network?
Consistency/ continuity with the existing road section/ network	Does the project pose any safety problems where it ties in with the adjacent road network/ sections?
General design standards	Were the appropriate design standards used with specific reference to: ▪ The project scope? ▪ Road users that will utilise/ be influenced by the project? ▪ The traffic mix utilising the project? Does the geometric plan and profile meet design guidelines? Does the design meet the needs of the appropriate design vehicles? Does the proposed cross-section allow for providing a forgiving road side at the design speed?
Design speed ·	Is the appropriate design speed appropriate for: Vertical and horizontal alignment Sight distances and visibility ▪ Merging ▪ Weaving ▪ Deceleration/ acceleration of traffic at controlled intersections/ accesses Are there any changes in the design speed/ posted speed limit? Are the design speed and speed limit appropriate? Is the sight distance safe enough at: ▪ Intersections? ▪ Interchange on and off ramps? ▪ Accesses to properties? ▪ Accesses for emergency vehicles? Is the design speed and posted speed limit reconcilable with each other?
Design traffic characteristics ·	Is the design appropriate for the: ▪ Design volume ▪ Design traffic characteristics (e.g. vulnerable road users and heavy vehicles) Does the design provide for the safe accommodation of · ▪ An increase in traffic volume if expected? ▪ Changes in traffic characteristics?

ITEM	POSSIBLE ISSUE
INTERSECTIONS	
Type and number	Are all aspects of the intersections (e.g. spacing, type, layout, etc.)appropriate with respect to: ▪ The broad concept of the project ▪ The function of the road and intersecting roads ▪ The traffic mix on the roads and intersecting roads ▪ Road users to use the project ▪ Land-use adjacent to the project ▪ Consistent with adjacent sections. Is the frequency of intersections appropriate: ▪ For safe access? ▪ To avoid impacts on the surrounding network? ▪ For emergency vehicle access? Have all physical, visibility or traffic management constraints which would influence the choice and spacing of intersections been considered? Has the vertical and horizontal alignment of the intersecting road sections been taken into account in the design, layout and spacing of intersections? Are all the intersections essential or necessary Can the number of intersections be reduced to improve safety? Can access safety be improved by changes on the surrounding road network? Is the angle of the intersecting road sections and sight lines safe for all road users? Is there adequate provision for the movement of vulnerable road users? Is there adequate provision for the movement of heavy vehicles?
ENVIRONMENTAL ISSUES	
Physical characteristics of the terrain	Is the surrounding terrain free from physical or vegetation characteristics which could affect the safety of the project? (for example deep cuttings, steep or rocky bluffs, heavy planting or forestry that constrain the design) Do the gradients, curves and general design approaches fit in with the likely weather or environmental aspects of the terrain? (for example fog-prone areas) Are there any vegetation-related aspects that will reduce the safety of the project? Does the project deal safely with possible animal conflicts? (e.g. stray cattle & game) Has safety been considered in the location of environmental features like noise fences? Are visual distractions like scenic vistas safely dealt with? Has the issue of unstable countryside been considered? (e.g. mining subsidence)
Day-night time aspects	Has the effect of the angles of the sun at sunrise and sunset been considered? Will the safety of the project be satisfactory at night-time, when it is wet or there is fog?

ITEM	POSSIBLE ISSUE
OTHER	
Pedestrians	Are there any pedestrian desire lines crossing the project? Has provision been made for pedestrian movement along these lines?
	Will the project cause the division of existing communities or cause separation of communities from basic commodities like water, firewood or retail facilities?
Driver perception	Can the proposed project be properly signed to allow the driver sufficient reaction and manoeuvre time to respond without information overload?
	Has possible constraints on information transfer to the driver been considered that may limit his safe and timeous response for the driving tasks?
	Will the driver ever be exposed to sudden darkness?
Miscellaneous	Has the possibility of flooding been dealt with?
	Have all railway level crossings been identified and treated adequately?
	Have other possible distractions like advertising or low-flying aircraft been identified and adequately dealt with?
	Has the need for facilities such as laybys, parking or rest areas or safe facilities for informal trading been considered and provided where required?
	Have all unusual or hazardous conditions associated with special events been considered?
	Has the risk implications of the transport of hazardous materials been considered?
	Has any safety or crash problems on the existing network been considered to ensure that they will not be transferred to the new facility?
	Has the need for providing lighting on the design been considered?
	Has the absence electricity that will limit the use of lighting, warning signs or flashing signals been considered?
	Has the need for drivers to stop been considered? (e.g. rest areas, truck parking, overload control, enforcement, etc.)

APPENDIX D-2: Stage 2 Road Safety Audit: Draft Design

ITEM	POSSIBLE ISSUE
GENERAL	
Changes since previous audit	Do the conditions for which the original planning had been done, still apply? (e.g. no changes to the surrounding network, area activities or traffic mix)
	Has the general form of the project design remained unchanged since the previous audit, (if any)?
Drainage	Will the project drain adequately?
	Has the probability of surface flooding or overflowing of drainage from adjacent drainage features from adjacent roads, intersecting drains or water courses considered?
	Are there any environmental/ vegetation/ other effects that will hamper the functioning of drainage inlets (e.g. sugar cane blocking inlets)?
Climate	Has consideration been given to weather records or local experience that may indicate problems related to adverse weather conditions such as snow, fog, etc. typical in the area?
Landscaping	If landscaping proposals are available, how will they affect the safety of the project? (e.g. inter-visibility of drivers and pedestrians, sight lines, shade/ sun interplay on the road and hazards in the clear zones)
Services	Does the design adequately deal with buried and overhead services, especially overhead clearances on roads in superelevation, etc.?
	Has the location of fixed objects or furniture associated with services been checked, including the location of specific poles.
	Do any of the services intrude in the right of way of other road users? (e.g. poles located on the sidewalks, etc.)
Access to property and developments	Can all accesses be used safely?
	Is the design free from any downstream or upstream effects from points of access, particularly near intersections?
	Have truck parking and rest area accesses been checked for adequate sight distance, etc.?
Adjacent land-use	Will the project accommodate the traffic generated by adjacent developments and the adjacent road network safely?
	Is the design reconcilable with driver expectancy from the lighting and traffic signals provided on the adjacent road section/ intersection/network?
	Does the design make provision for special road users that are generated by adjacent land-uses and the existing road network?
	d) Are there any land-use issues that will have an effect on the safety of the project?
Emergency vehicles and access	Has provision been made for safe access and movement by emergency vehicles? (e.g. fire brigade trucks)
	Does the design and position of medians and vehicle barriers allow emergency vehicles to stop and turn without unnecessarily disrupting traffic or being exposed to danger?

ITEM	POSSIBLE ISSUE
Future Planning	If widening is planned: ▪ Are drivers adequately guided by the design? ▪ Are drivers adequately informed by signage? Is the possible transition between a single and dual carriageway (both directions) being handled safely?
Project Phasing	If the project is to be constructed/implemented in different phases: ▪ Are the phasing details adequate to ensure safety? ▪ Is the phasing programming safe? ▪ Are there measures to accommodate temporary traffic management between the different phases? If the construction is to be split into different contracts, are they arranged safely?
Maintenance	Can routine maintenance vehicles be safely located?
DESIGN	
Design Standards (General)	Is the design speed and proposed posted speed limits appropriate for the terrain and function of the road? Are they appropriate for the design vehicles and the road users? Is the design speed reconcilable with the expected operational speed? Has the appropriate design vehicle/s been used? (specifically also for possible constraining turning movements)
Typical cross-sections	Are the cross-section features such as widths of lanes and shoulders, medians, etc. adequate for the function of the project? Do the cross-section features conform to the requirements set for design for safety? Are lane and shoulder widths appropriate for: ▪ The alignment? ▪ Road users? ▪ The vehicles that will utilise the project? ▪ The operating speeds? ▪ The combinations of speed and volume? Are overtaking/ climbing/ crawler lanes provided if needed? ▪ Have adequate clear zones been provided?
Variations in cross-sections	Are there any variations in cross-section that will influence safety negatively? Are the cross-falls safe? (particularly where sections of existing roadways are used or accesses accommodated) Are there any unsafe compromises such as sudden narrowing at existing bridges
Layout of roadway	Do the traffic management features: ▪ Create unsafe conditions? ▪ Provide adequate warning or guidance? Do the road signs and markings provide adequate warning and guidance at locations where the alignment is substandard or changing? (also under night-time or low visibility conditions)

ITEM	POSSIBLE ISSUE
Shoulders and edge treatment	Are the following safety aspects of shoulder provision satisfactory: ▪ Provision of surfaced or unsurfaced shoulders? ▪ Width and treatment on embankments? ▪ Crossfalls of shoulders? Are the shoulders likely to be safe when used by slow moving vehicles or cyclists? Are any rest areas or truck parking areas designed safely?
Cut-and-fill	Are there any geological characteristics of the cut-and fill of the project that will endanger road users?
Deviations from and changes to standard design guidelines and standards	Do any of the deviations from accepted design guidelines or standards reduce the safety performance of the project?
ALIGNMENT	
Vertical and horizontal alignment	Does the horizontal and vertical alignment fit together appropriately? Does the vertical and horizontal alignment guide a driver accurately - is it free of visual clues that would cause the driver to misread the road characteristics? Is the vertical and horizontal alignment conducive to consistent operating speed?
Visibility and sight distance	Does the vertical and horizontal alignment provide the required sight distance and visibility? Are there any of the following objects or structures present that will obstruct sight lines or reduce sight distance that will have an adverse effect on safety: ▪ Fencing? ▪ Traffic barriers? ▪ Street furniture (including trash bins)? ▪ Services? ▪ Parking facilities? ▪ Signs? ▪ Landscaping/ vegetation? ▪ Bridge abutments? Are all hazards such as bridge abutments noticeable? Is there any local feature that will obstruct sight lines? Are railway crossings, bridges, intersections and other hazards clearly visible under daytime and nighttime driving?
Transition between project and existing adjacent road section/ intersection/ network	Does the transition from existing to new (and opposite) occur well away from any hazardous condition like the following: ▪ Speed differences? ▪ Differences in access provision? ▪ Geometry (e.g. is it on a curve or a crest where the visibility is poor / where the driver is likely to be distracted?) ▪ Differences in design standards? ▪ Differences in the physical features of the environment? (e.g. for example from lit to unlit, rural to urban)

ITEM	POSSIBLE ISSUE
	▪ Differences in the posted speed limit? Is adequate advance warning provided where required?
Other:	
Parking	Is on-site parking planned to minimise on-street parking? Can on-street parking be provided safely? If not, are measures provided to prevent it?
INTERSECTIONS	
Visibility of intersection	Do the horizontal and vertical alignments at the intersection or on the approach to the intersection allow safe forward visibility to the intersection and inter-visibility between the main road and the intersecting road/s? Will drivers be aware of the presence of the intersection and the control thereof? (Especially approaching on the minor road) and will they be able to react safely to it? Are there any of the following temporary features present that will obstruct sight lines: ▪ Parked vehicles? ▪ Public transport facilities/ lay-bys? ▪ Queuing vehicles? ▪ Heavy vehicle loading zones?
Layout and traffic control	Are the following appropriate for the function of the two intersecting roads: ▪ Layout? (e.g. crossroad, T-junction, roundabout, interchange) ▪ Traffic control type? (e.g. signalisation, Stop or Yield control) Will the layout or traffic control have a negative safety impact on special road users such as: ▪ Pedestrians? ▪ Vulnerable road users? ▪ Cyclists? ▪ Heavy vehicles? Does the layout make provision for all design vehicles that will utilise the intersection? (e.g. turning radii, swept paths of vehicles, lane widths, etc) Where a roundabout is proposed: ▪ Have cyclist movements been considered? ▪ Have pedestrian movements been considered? ▪ Are the details pertaining to the circulating roadway sufficient? Will the layout or traffic control affect the safety of public transport facilities (if planned)? ▪ Is the design free from any upstream or downstream geometric features that could affect safety? (e.g. lane merges) Are the approach speeds on the intersecting road sections safe?

ITEM	POSSIBLE ISSUE
Readability by drivers	Will the general type, function and broad features be perceived correctly by the drivers?
	Are the approach speeds and likely positions of vehicles as they track through the intersection safe?
	Do successive intersections violate driver expectancy because of inconsistencies?
	Does the driver get sufficient time to perceive the upcoming situation, decide upon a course of action, prepare for and execute the necessary actions safely?
	Does the design provide for erroneous decisions?
	Is the design free from possible sunrise and sunset problems that may create a hazard?
	Will the driver experience glare from oncoming vehicles or from road lighting?
	Is the driver ever exposed to sudden darkness?
SPECIAL ROAD USERS	
Pedestrians	Is the design safe for pedestrians?
	Is there a need for the provision of pedestrian crossings?
	Are pedestrian crossings provided along desire lines?
	Is there a need for paved footpaths? If not planned, where will the pedestrians walk and will it be safe enough?
	Is the carriageway widened to provide for pedestrian movement and can pedestrians utilise this safely?
	Is there a need for pedestrian refuge islands and are they wide enough to ensure safety?
	Is the expected operational speed appropriate for the pedestrian facilities that are provided?
	Is there a need for the special provision of facilities for vulnerable road users such as children and the elderly?
Cyclists and motorcyclists	Is consideration being given to the needs of cyclists and motorcyclists?
	Are bicycle lanes needed or can shared pedestrian-cycle facilities be implemented?
	Is the roadside forgiving in areas more prone to run off the road crashes by motorcyclists?
Animals	Is there a need to make provision for stock or equestrians?
Heavy vehicles	Does the design make provision for the limitations of heavy vehicles? (e.g. longer stopping distance, etc.)
	Does the design consider safe gradients for heavy vehicles?
	If in mountainous terrain, are any arrestor bed facilities required for the design? Are they provided or can a modification of the design eliminate the need?
	Should rest areas be provided? If planned, can they be used safely?
	Are safe heavy vehicle loading facilities provided where required?
	Is provision made for the safe manoeuvring of heavy vehicles where necessary?

ITEM	POSSIBLE ISSUE
Public Transport	Is safe provision made for public transport facilities where needed?
	Is provision made for the safe movement of pedestrians to, at and from the public transport facilities? (e.g. Are sufficient space available for passengers alighting from buses?)
Maintenance vehicles and crews	Can maintenance vehicles and crews be safely accommodated after implementation of the project?
ROAD TRAFFIC SIGNS AND LIGHTING	
Road signs	Can the project be provided with direction signs in an unambiguous manner?
	Are the road signs adequate to provide for driver needs (guidance, control and warning)
	Will the road signs be visible and readable? (review special needs for appropriate night-time reflectivity)
	Is the amount of reflectivity adequate/ excessive, i.e. blinding the driver?
	Will any of the road signing limit the visibility or sight lines at accesses or intersections?
	Will any of the road signing pose a safety hazard to errant vehicles? Was provision made to reduce the severity of such crashes?
	Were road signs placed with due cognisance of road safety?
Road markings	Are the planned road markings adequate in terms of safety?
	Are there any road elements that will require the provision of road studs for visibility at night-time? (e.g. raised median islands etc)
	Is the transition of road markings between the project and the existing adjacent road section/ intersection/ network safe?
Road lighting	Should road lighting be provided for this project?
	If lit, will safety still be maintained in the case of a break in power supply?
	Are there any special needs created by ambient lighting and will safety be maintained if such special features are not provided?
	Was due cognisance taken of features such as trees, over-bridges, etc. that will affect the installation of road lighting?
	Does the road lighting pose a roadside hazard?
	Is the road user adequately protected from colliding with lighting poles?
	If traffic barriers are used for this purpose, are they properly located or installed to ensure improved safety and will they function as intended?
TRAFFIC OPERATIONS AND CONSTRUCTION	
Traffic flow	Will the traffic flow of the project have a negative influence on the safety of adjacent road network/ developments?
	Was adequate consideration given to parking control features?
	Can exclusive turning lanes and deceleration lanes be used safely?
	Will the project cause or contribute to the movement of traffic at high speeds through residential areas (*rat-running*)?

ITEM	POSSIBLE ISSUE
Access management	Was adequate consideration given to the possible provision of accesses of future developments in or adjacent to the project?
	Are the existing and proposed accesses in the road project safe to use?
	Will any up-or downstream effects reduce the safety of an access, particularly those located close to intersections?
Merging and Overtaking	Are adequate shoulder widths provided during and after lane merges?
	Is adequate overtaking sight distance and stopping distance provided?
	Is advance warning provided for lane merging?
	Is proper sight distance provided for lane merging?
Rest areas and stopping facilities	Are sufficient stopping and rest areas provided?
	Are safe access provided to rest areas and stopping facilities?
	Is the sight distance and access design for accesses to rest areas safe?
Construction	If the project is to be constructed "under traffic", can this be done safely as far as the construction is concerned as well as the extent to which the general travelling public will be affected?
	Are there any elements of the project that will hamper the safe construction of the project? (e.g. construction vehicle routes and interaction with general public traffic)
	Can safe access be provided for construction vehicles?
	Are there any features of the project that will require special traffic management during construction, phasing or any period before implementation?
OTHER ISSUES	
Roadside hazard management	Are there any roadside hazards that can be: ▪ Redesigned ▪ Relocated ▪ Protected by traffic barriers? ▪ Made breakaway?
	Are traffic barriers adequate for the design vehicles of the project?
	Are safe end-treatments provided?
	Can traffic barriers be safely maintained?
	Will they function as was intended?
	Is adequate deflection distance provided for guardrail and cable systems?
Incident management	Can traffic be safely accommodated during an incident?
	Is safe access possible for emergency vehicles?
	In the case of fixed medians, does the project provide for the safe stopping and turning of emergency vehicles?
Tourism/ recreation	Are there any safety requirements for the accommodation of tourism or recreation facilities?
	Have all unusual or potentially hazardous conditions associated with special events been considered? If required, can the road be closed in a safe manner?

APPENDIX D-3: Stage 3 Road Safety Audit: Detail Design

ITEM	POSSIBLE ISSUE
GENERAL	
Changes since previous audit	Do the conditions for which the draft design had been done, still apply? (e.g. no changes to the surrounding network, area activities or traffic mix)
	Has the general form of the project design remained unchanged since the previous audit, (if any)?
Drainage	Will the project drain adequately?
	Has the probability of surface flooding or overflowing of drainage from adjacent drainage features from adjacent roads, intersecting drains or water courses been considered?
	Are there any environmental/ vegetation/ other effects that will hamper the functioning of drainage inlets (e.g. sugar cane blocking inlets)?
Climate	Has consideration been given to weather records or local experience that may indicate problems related to adverse weather conditions such as snow, fog, etc. typical in the area?
Landscaping	If landscaping proposals are available, how will they affect the safety of the project? (e.g. inter-visibility of drivers and pedestrians, sight lines, shade/ sun interplay on the road and hazards in the clear zones)
	Will the landscaping proposals introduce roadside hazards when the vegetation matures?
Services	Does the design adequately deal with buried and overhead services, especially overhead clearances on roads in superelevation, etc.?
	Has the location of fixed objects or furniture associated with services been checked, including the location of specific poles.
	Do any of the services intrude in the right of way of other road users? (e.g. poles located on the sidewalks, etc.)
Access to property and developments	Can all accesses be used safely?
	Is the design free from any downstream or upstream effects from points of access, particularly near intersections?
	Have truck parking and rest area accesses been checked for adequate sight distance, etc.?
Adjacent land-use	Will the project accommodate the traffic generated by adjacent developments and the adjacent road network safely?
	Is the design reconcilable with driver expectancy from the lighting and traffic signals provided on the adjacent road section/ intersection/network?
	Does the design make provision for special road users that are generated by adjacent land-uses and the existing road network?
	Are there any land-use issues that will have an effect on the safety of the project?

ITEM	POSSIBLE ISSUE
Emergency vehicles and access	Has provision been made for safe access and movement by emergency vehicles? (e.g. fire brigade trucks) Does the design and position of medians and vehicle barriers allow emergency vehicles to stop and turn without unnecessarily disrupting traffic or being exposed to danger? Will broken-down vehicles or stopped emergency vehicles safe from passing traffic? Have median breaks been safely provided on dual carriageway roads? (e.g. frequency, visibility, usage constraints, signage)
Future Planning	If widening is planned: ▪ Are drivers adequately guided by the design? ▪ Are drivers adequately informed by signage? Is the possible transition between a single and dual carriageway (both directions) being handled safely?
Project Phasing	If the project is to be constructed/implemented in different phases: ▪ Are the phasing details adequate to ensure safety? ▪ Is the phasing programming safe? ▪ Are there measures to accommodate temporary traffic management between the different phases? If the construction is to be split into different contracts, are they arranged safely? Do the construction plans and program for staged construction include specific safety measures for temporary arrangements?
Maintenance	Can routine maintenance vehicles be safely located?
Skid resistance	Has the need for anti-skid surfacing been considered and provided for in areas where improved braking or road adhesion is essential?
DESIGN	
Design Standards (General)	Is the design speed and proposed posted speed limits appropriate for the terrain and function of the road? Are they appropriate for the design vehicles and the road users? Is the design speed reconcilable with the expected operational speed? Has the appropriate design vehicle/s been used? (specifically also for possible constraining turning movements)
Drainage	Does the cross section provide for safe drainage parallel and perpendicular to the road? (e.g. Are the side slopes of concrete drains such that errant vehicles can recover after entering?) If concrete side drains pose a risk of trapping vehicles, has provision been made for guard rails? Are concrete head walls perpendicular to the main road sloped to reduce the impact upon an errant vehicle? Is the design of grid inlets such that it does not pose a danger to cyclists? Are kerb inlets set back from the face of guard rails?

ITEM	POSSIBLE ISSUE
Typical cross-sections	Are the cross-section features such as widths of lanes and shoulders, medians, etc. adequate for the function of the project? Do the cross-section features conform to the requirements set for design for safety? Are lane and shoulder widths appropriate for: ▪ The alignment? ▪ Road users? ▪ The vehicles that will utilise the project? ▪ The operating speeds? ▪ The combinations of speed and volume? Have adequate clear zones been provided? Are the batter slopes safe for errant vehicles to recover? Does the median width allow street furniture to be located safely? Does the verge design allow the safe installation of ground-mounted or overhead structures? Has provision been made for sidewalks and the safe handling of pedestrians and cyclists? (including full width dropped kerbs at pedestrian crossings)
Superelevation	Is the superelevation consistent with the design speed and the type of road? Will changes in superelevation at operating speeds result in the possible shifting of freight on heavy vehicles? Are there any curves with adverse cross-fall?
Variations in cross-sections	Are there any variations in cross-section that will influence safety negatively? Are the cross-falls safe? (particularly where sections of existing roadways are used or accesses accommodated) Are there any unsafe compromises such as sudden narrowing at existing bridges?
Layout of roadway	Do the traffic management features: ▪ Create unsafe conditions? ▪ Provide adequate warning or guidance? Do the road signs and markings provide adequate warning and guidance at locations where the alignment is substandard or changing? (also under night-time or low visibility conditions) Are overtaking/ climbing/ crawler lanes provided if needed? Are they properly signed and marked at the start and the end of these lanes?
Shoulders and edge treatment	Are the following safety aspects of shoulder provision satisfactory: ▪ Provision of surfaced or unsurfaced shoulders? ▪ Width and treatment on embankments? ▪ Crossfall of shoulders? (to allow safe use of shoulder as recovery area) Are the shoulders likely to be safe when used by slow moving vehicles or cyclists? Are shoulder widths sufficient for stationary vehicles? Are any rest areas or truck parking areas designed safely?

ITEM	POSSIBLE ISSUE
Cut-and-fill	Are there any geological characteristics of the cut-and fill of the project that will endanger road users? Is the stability of slopes safe to ensure that debris or loose material does not collect on the road or that an embankment remains stable?
Deviations from and changes to standard design guidelines and standards	Do the typical details used on the project reflect road safety best practices and have they been reviewed for applicability to this particular project? Do any of the deviations from accepted design guidelines or standards reduce the safety performance of the project?
ALIGNMENT	
Vertical and horizontal alignment	Does the horizontal and vertical alignment fit together appropriately? Does the vertical and horizontal alignment guide a driver accurately - is it free of visual clues that would cause the driver to misread the road characteristics? Is the vertical and horizontal alignment conducive to consistent operating speed? Is the design free from any misleading visual clues?
Visibility and sight distance	Does the vertical and horizontal alignment provide the required sight distance and visibility? Are there any of the following objects or structures present that will obstruct sight lines or reduce sight distance that will have an adverse effect on safety: ▪ Fencing? ▪ Traffic barriers/ guard rails? ▪ Street furniture (including trash bins)? ▪ Services? ▪ Parking facilities? ▪ Signs? ▪ Landscaping/ vegetation? ▪ Bridge abutments? Are all hazards such as bridge abutments noticeable? Are there any local features that will obstruct sight lines? Are railway crossings, bridges, intersections and other hazards clearly visible under daytime and nighttime driving? Is the design free from overhead obstructions that may restrict sight distance in sag curves or forward sight distance towards overhead mounted road traffic signs? Has minimum sight triangles been provided at: ▪ Entry and exit ramps? ▪ Gore Areas? ▪ Intersections? ▪ Roundabouts? ▪ Other possible conflict points?

ITEM	POSSIBLE ISSUE
Transition between project and existing adjacent road section/ intersection/ network	Does the transition from existing to new (and opposite) occur well away from any hazardous condition like the following: ▪ Speed differences? ▪ Differences in access provision? ▪ Geometry (e.g. is it on a curve or a crest where the visibility is poor / where the driver is likely to be distracted?) ▪ Differences in design standards? ▪ Differences in the physical features of the environment? (e.g. for example from lit to unlit, rural to urban) ▪ Differences in the posted speed limit? Is adequate advance warning provided where required?
Other:	
Parking	Is on-site parking planned to minimise on-street parking? Can on-street parking be provided safely? If not, are measures provided to prevent it?
Public Transport	Has the need for public transport facilities considered and implemented in a manner that would allow safe ingress and egress to possible bus stops?
INTERSECTIONS	
Readability by drivers	Will the general type, function and broad features be perceived correctly by drivers? Are the approach speeds and likely positions of vehicles as they track through the intersection safe? Do successive intersections violate driver expectancy because of inconsistencies? Does the driver get sufficient time to perceive the upcoming situation, decide upon a course of action, prepare for and execute the necessary actions safely? Does the design provide for erroneous decisions? Is the design free from possible sunrise and sunset problems that may create a hazard? Will the driver experience glare from oncoming vehicles or from road lighting? Is the driver ever exposed to sudden darkness?
Visibility of intersection	Do the horizontal and vertical alignments at the intersection or on the approach to the intersection allow safe forward visibility to the intersection and inter-visibility between the main road and the intersecting road/s? Will drivers be aware of the presence of the intersection and the control thereof? (Especially approaching on the minor road) and will they be able to react safely to it? Are there any of the following temporary features present that will obstruct sight lines: ▪ Parked vehicles? ▪ Public transport facilities/ lay-bys? ▪ Queuing vehicles? ▪ Heavy vehicle loading zones?

ITEM	POSSIBLE ISSUE
Layout and traffic control	Are the following appropriate for the function of the two intersecting roads: ▪ Layout? (e.g. crossroad, T-junction, roundabout, interchange) ▪ Traffic control type? (e.g. signalisation, Stop or Yield control) Will the layout or traffic control have a negative safety impact on special road users such as: ▪ Pedestrians? ▪ Vulnerable road users? ▪ Cyclists? ▪ Heavy vehicles? Does the layout make provision for all design vehicles that will utilise the intersection? (e.g. turning radii, swept paths of vehicles, lane widths, etc) Is the design free from any upstream or downstream geometric features that could affect safety? (e.g. lane merges) Is there a need for traffic barriers? Will their use result in the reduction of the severity of injuries? Have islands been provided to clarify specific movements and to provide refuge for pedestrians? Are the approach speeds on the intersecting road sections safe? Are sufficient queue lengths/ storage for turning movements available? (also in the centre of a staggered intersection) Will the layout or traffic control affect the safety of public transport facilities (if planned)?
Roundabouts	Where a roundabout is proposed: ▪ Have cyclist movements been considered? ▪ Have pedestrian movements been considered? ▪ Are the details pertaining to the circulating roadway sufficient? Is adequate deflection provided to reduce approach speeds? If splitter islands are required, are they adequate for sight distance, length, pedestrian storage, etc.? Is the central island prominent and does it limit see-through? Can pedestrians be seen early enough by drivers? Can pedestrians determine if vehicles would be turning in conflicting movements? Are direction markings provided in approach lanes where needed? Is the lighting at the roundabouts adequate and columns in safe locations?
Geometric design details	Can the layout safely handle unusual traffic mixes or circumstances? Does any median or island safely provide for: ▪ Vehicle alignments and paths? ▪ Future traffic signals? ▪ Pedestrian storage and surface? ▪ Turning path clearance? ▪ Stopping sight distance to the nose? ▪ Mountability by errant vehicles?

ITEM	POSSIBLE ISSUE
SPECIAL ROAD USERS	
Pedestrians	Is the design safe for pedestrians?
	Is there a need for the provision of pedestrian crossings?
	Are pedestrian crossings provided along desire lines?
	Is each pedestrian crossing satisfactory for: ▪ Visibility (in each direction)? ▪ Use by the disabled? ▪ Use by the elderly? ▪ Use by children/ schools?
	Is there a need for paved footpaths? If not planned, where will the pedestrians walk and will it be safe enough? Are pedestrians safely provided for at bridges and culverts?
	Is the carriageway widened to provide for pedestrian movement and can pedestrians utilise this safely?
	Is there a need for pedestrian refuge islands and are they wide enough to ensure safety?
	Is the expected operational speed appropriate for the pedestrian facilities that are provided?
	Has pedestrian fencing been provided on medians or complex intersection layouts to reduce jay-walking?
	Is the surfacing of pedestrian walkways appropriate?
	Has tactile edging been provided at pedestrian crossings to assist the disabled?
Cyclists and motorcyclists	Is consideration being given to the needs of cyclists and motorcyclists?
	Are bicycle lanes needed or can shared pedestrian-cycle facilities be implemented?
	Has the location of devices or objects that could destabilise a motorcyclist avoided on the road surface?
	Is the roadside clear of obstructions where the motorcyclist may lean into curves?
	Is the roadside forgiving in areas more prone to run off the road crashes by motorcyclists?
	Are drainage grids, culverts and bridge expansion joints traversable by motorcycle?
Heavy vehicles	Does the design make provision for the limitations of heavy vehicles? (e.g. longer stopping distance, etc.)
	Does the design consider safe gradients for heavy vehicles?
	If in mountainous terrain, are any arrestor bed facilities required for the design? Are they provided or can a modification of the design eliminate the need?
	If there are height restrictions, have alternative routes been provided and properly signed for use by such vehicles?
	Should rest areas be provided? If planned, can they be used safely?
	Are safe heavy vehicle loading facilities provided where required?
	Is provision made for the safe manoeuvring of heavy vehicles where necessary?

ITEM	POSSIBLE ISSUE
Public Transport	Is safe provision made for public transport facilities where needed?
	Is provision made for the safe movement of pedestrians to, at and from the public transport facilities? (e.g. Are sufficient space available for passengers alighting from buses?)
Maintenance vehicles and crews	Can maintenance vehicles and crews be safely accommodated after implementation of the project?
Animals	Is there a need to make provision for stock or equestrians? (e.g. animal underpasses)
ROAD TRAFFIC SIGNS, SIGNALS AND LIGHTING	
Road signs	Can the project be provided with direction signs in an unambiguous manner?
	Do the signs comply with the standards prescribed in the Act and National Road Traffic Regulations?
	Are the road signs adequate to provide for driver needs (guidance, control and warning)? Have the necessary advance warning signs been provided, including advisory speeds for hazardous conditions as well as hazard marker plates?
	Does the design overly rely on signs to be effective? (in lieu of appropriate geometric design)
	Are all physical obstructions properly signed to identify them as hazardous?
	Will the road signs be visible and readable with sufficient time for the driver to read, consider options, prepare to manoeuvre and act on the information in a timely and safe manner? (review special needs for appropriate night-time reflectivity)
	Is the amount of reflectivity adequate/ excessive, i.e. blinding the driver?
	Will any of the road signing limit the visibility or sight lines at accesses or intersections?
	Will any of the road signing pose a safety hazard to errant vehicles? Was provision made to reduce the severity of such crashes?
	Were road signs placed with due cognisance of road safety?
	Are the signs on the project consistent with those on the adjacent sections of the road?
Road markings	Are the planned road markings adequate in terms of safety?
	Do the markings comply with the standards prescribed in the Act and National Road Traffic Regulations?
	Have no-overtaking line markings been provided where required?
	Have guideline markings and painted islands been provided to clarify movements in complex layouts?
	Has attention been given to the improvement of wet weather visibility of markings in critical locations?
	Has the need for profiled markings been considered and implemented in the design?
	Are there any road elements that will require the provision of road studs for visibility at night-time? (e.g. raised median islands etc)
	Is the transition of road markings between the project and the existing adjacent road section/ intersection/ network safe?

ITEM	POSSIBLE ISSUE
Traffic Signals	Has the most appropriate signal phasing system been selected for the project? Is the system consistent with that on the adjoining sections of road? Are the traffic signal heads visible, i.e. are there any features such as trees, lighting, signage etc. that may prevent drivers approaching the intersection from seeing the signals? Are there any signal aspects visible near or within the intersection that may confuse drivers? Will the intersection be affected by sunrise/ sunset problems? Is provision made for this in the form of backboards, louvres or high intensity signals? Does the vertical alignment on the approaches allow for sufficient stopping distances? Is the signal phasing clear to the driver? Does the phasing conform to the safety requirements set for the amber and all-red periods? Are pedestrians considered in the planned signal phasing? If islands are located in the path of the pedestrian, is the size of these sufficient to act as a refuge island? Will drivers be able to see pedestrians crossing? Is the signal phasing appropriate for: ▪ The expected traffic movements? ▪ The accommodation of all design vehicles? ▪ The geometry of the intersection? ▪ The geometry of the approaches?
Road lighting	Should road lighting be provided for this project? If lit, will safety still be maintained in the case of a break in power supply? Are all gore areas and lane merge conditions adequately lit? Are there any special needs created by ambient lighting and will safety be maintained if such special features are not provided? Was due cognisance taken of features such as trees, over-bridges, etc. that will affect the installation of road lighting? Does the road lighting pose a roadside hazard? Is the road user adequately protected from colliding with lighting poles? If traffic barriers are used for this purpose, are they properly located or installed to ensure improved safety and will they function as intended? Has lighting been provided at locations with known crash history?
ROADSIDE HAZARD MANAGEMENT	
Roadside hazards	Are there any fixed objects within the clear zone that should be relocated, redesigned, protected by traffic barriers or be made breakaway?
Traffic barriers/ crash barriers	Are traffic barriers provided where necessary and properly detailed for use at structures, embankments, trees, poles/ posts, drainage channels, bridge piers and gore areas of off-ramps?

ITEM	POSSIBLE ISSUE
Traffic barriers/ crash barriers (including wire rope systems)	Are proper deflection distances provided between the traffic barrier and the roadside hazard if flexible traffic barrier systems are used? Are all end treatments safe if hit by a vehicle? Will the traffic barrier pose a danger to any of the road users (also pedestrians and motorcyclists)? Was the movement of pedestrians considered in the location and placement detail of the traffic barrier systems? If guardrail barrier systems are provided, are the design and details safe in terms of: ▪ End-treatment? ▪ Anchorage? ▪ Post spacing? ▪ Block outs? ▪ Post depth? ▪ Soil stability? ▪ Rail overlap? Is all traffic barriers necessary? (e.g. is what it shield a greater hazard than the barrier?)
Bridges and drainage structures	Are bridges and culvert end walls visible and easily recognised? Is Horizontal clearance to moving traffic adequate? Are sight lines through bridge railing sufficient for safety purposes? Are end treatments safe? Are Road traffic signs and markings installed to warn of possible hazards? Are the transitions between different traffic barrier system types safe? (approach traffic barrier to bridge parapet) Are there differences in the shoulder widths of the approaches and on the bridge? Is provision made for the movement of non-vehicular traffic such as pedestrians, horses/ stock over the bridge? Does the bridge railing conform to the requirements set for safe traffic barriers in terms of rail height, containment and the fixing detail to the bridge? Do traffic barriers adequately protect dangerous culvert structures? Are there any headwalls present within the clear zone? Are they adequately protected or can the culverts be extended to place the end walls outside the clear zone? Is adequate warning signage and sight distance provided at floodways/ causeways?
Median barriers	Was the need for median barriers considered and adequately provided for? Is the design and median barrier type adequate for the particular application? (e.g. design vehicle, median width, maintenance requirements etc.) Are the details for the location and installation of traffic barriers correct? Are the end-treatments safe?

ITEM	POSSIBLE ISSUE
TRAFFIC OPERATIONS	
Traffic flow	Will the traffic flow of the project have a negative influence on the safety of adjacent road network/ developments?
	Was adequate consideration given to parking control features?
	Can exclusive turning lanes and deceleration lanes be used safely?
	Will the project cause or contribute to the movement of traffic at high speeds through residential areas (*rat-running*)?
Access management	Was adequate consideration given to the possible provision of accesses of future developments in or adjacent to the project?
	Are the existing and proposed accesses in the road project safe to use?
	Will any up-or downstream effects reduce the safety of an access, particularly those located close to intersections?
Merging and Overtaking	Are adequate shoulder widths provided during and after lane merges?
	Is adequate overtaking sight distance and stopping distance provided?
	Is advance warning provided for lane merging?
	Is proper sight distance provided for lane merging?
Rest areas and stopping facilities	Are sufficient stopping and rest areas provided?
	Are safe access provided to rest areas and stopping facilities?
	Is the sight distance and access design for accesses to rest areas safe?
ACCOMMODATION OF TRAFFIC	
Construction	If the project is to be constructed "under traffic", can this be done safely as far as the construction is concerned as well as the extent to which the general travelling public will be affected?
	Have innovative or accelerated construction techniques been considered to reduce the exposure of the public to restrictive construction conditions?
	Have different phasing options been considered? Are there any features of the project that will require special traffic management during construction phases or any period before implementation?
	Are there any elements of the project that will hamper the safe construction of the project? (e.g. construction vehicle routes and interaction with general public traffic)
Construction program	Have all applicable work zone types been adequately considered to establish the safest construction program? ▪ Work outside of roadway ▪ Full roadway closure ▪ Permanent lane/shoulder/ramp closures ▪ Crossovers/contra-flow ▪ Detour ▪ Intermittent road closures (*i.e.* 15-minutes, weekend) ▪ Reduced lane widths ▪ Reduced shoulder widths ▪ Lane shifts ▪ Daily lane/shoulder closures

ITEM	POSSIBLE ISSUE
Construction program	▪ Use of shoulder or median ▪ One-lane, two-way operation or Reversible lanes ▪ Use of temporary structures ▪ Use of temporary pavement ▪ Widening ▪ Nightwork ▪ Weekend work
Temporary traffic management planning	Are bypasses or temporary widening needed? Does pedestrian/bicycle traffic access need to be maintained? Are minimum allowable lane widths achievable? Is the reduced work zone speed limit realistic and appropriate? Should certain types of vehicles be prohibited from entering the work zone (over-height, weight restrictions)? Will oversized load permits be affected? Will the work zone be adequate in terms of: ▪ Traffic control devices? ▪ Rail crossings and controls? ▪ Geometrics (turning radii, ramp merge/diverge areas, etc.)? ▪ Bridge restrictions and other structures?
Project timing	Can the contractor restrict the roadway during: ▪ Peak hours? ▪ One direction? ▪ Both directions? ▪ Overnight? ▪ Holidays or weekends? ▪ Sporting or other special events? ▪ Other projects in the immediate area?
Protective devices	Are temporary barriers and impact attenuators required? Has extra protection be provided for: ▪ Pedestrians/Bicyclists? ▪ School areas and crossings? ▪ Playgrounds and parks? Have areas been designated for the contractor to safely store (where necessary): ▪ Equipment? ▪ Construction materials? ▪ Waste materials?

ITEM	POSSIBLE ISSUE
Detours or deviations	Does the detour planning show that the detours are adequate in terms of ▪ Weight restrictions? ▪ Height-width constraints and accommodation of abnormal vehicles? ▪ Capacity? ▪ Adequate traffic control devices? ▪ Railway crossing and controls (if needed)? ▪ Geometrics (turning radii, etc.)? ▪ Bridge restrictions and other structures? Is there other construction along the detour that might influence traffic? Will all fronting businesses have acceptable ingress and egress? Are alternate routes available to local motorists? Is a public information meeting required?
Work Zone Analysis	Has the work zone traffic analysis been conducted to identify work zone and ramp capacities? Have required number of maintained lanes and allowable lane closure hours been identified? Does the project comply with the guidelines set in the SADC Road Traffic Signs Manual and SARTSM Volume 2 Chapter 13?
Mobility impacts	Has the work zone traffic analysis identified impacts on any of the following and are measures included to minimise such impact? ▪ Ability to maintain all accesses (business, community, etc.) ▪ Pedestrian, and bicycle facilities ▪ Public safety (workers and travelling public) ▪ Emergency vehicle access ▪ Construction equipment access & movement through the work zone ▪ Specific user groups (businesses, communities) ▪ Over-height, over-weight vehicles ▪ Public Transport services and bus stops ▪ Traffic operations in and around the work zone (freeway queues, network operations, effect on local roads and detour routes) ▪ Ramp capacity ▪ Intersection traffic control (signal timing, adequate signage, etc.) ▪ Existing special traffic operations (HOV lanes, etc.) ▪ User Costs (delay)
Temporary traffic control	Are the temporary traffic control signs and markings shown on the drawings or referenced to typical details? Will sign message modifications be required on permanent signs? Have the modifications been shown? Are temporary signals required or will existing signals need to be kept operational? Will the removal of markings be required and has the work zone been set up to minimize removal? Will Portable Changeable Message Signs be required?

ITEM	POSSIBLE ISSUE
Work zone safety management strategies	Have the following work zone safety management strategies been considered? ▪ Speed limit reduction/variable speed limits with portable changeable message signs displaying speed? ▪ Temporary traffic barrier and movable traffic barrier systems? ▪ Temporary transverse rumble strips? ▪ Warning lights? ▪ Temporary roadway lighting? ▪ etc.
Incident management	Is provision made for Standby towing service, Emergency lay-byes and Planned detour routes in case of an incident? Have Work Zone ITS strategies like CCTV monitoring been considered for traffic monitoring/ management?
OTHER ISSUES	
Tourism/ recreation	Are there any safety requirements for the accommodation of tourism or recreation facilities? Have all unusual or potentially hazardous conditions associated with special events been considered? If required, can the road be closed in a safe manner?

APPENDIX D-4: Stage 4 Work Zone Traffic Management Audit

A Stage 4 CWZ traffic management audit only evaluates the traffic management proposals that the contractor proposed using, taking into account the changed conditions as experienced on the works when compared with the traffic management proposals that had been contained in the Detail Design.

It recognises that the contractor has to develop a safety plan in terms of the safety regulations applicable to construction work zones and that this safety plan shall be monitored by the Engineer outside of the road safety audit process.

ITEM	POSSIBLE ISSUE
TRAFFIC MANAGEMENT DURING CONSTRUCTION	
Construction	If the project is to be constructed "under traffic", can this be done safely as far as the construction is concerned as well as the extent to which the general travelling public will be affected? Have innovative or accelerated construction techniques been considered to reduce the exposure of the public to restrictive construction conditions? Have different phasing options been considered? Are there any features of the project that will require special traffic management during the construction phases? Are there any elements of the project that will hamper the safe construction of the project? (e.g. construction vehicle routes and interaction with general public traffic)
Construction program	Have all applicable work zone types been adequately considered to establish the safest construction program? ▪ Work outside of roadway ▪ Full roadway closure ▪ Permanent lane/shoulder/ramp closures ▪ Crossovers/contra-flow ▪ Detour ▪ Intermittent road closures (*i.e*. 15-minutes, weekend) ▪ Reduced lane widths ▪ Reduced shoulder widths ▪ Lane shifts ▪ Daily lane/shoulder closures ▪ Use of shoulder or median ▪ One-lane, two-way operation or Reversible lanes ▪ Use of temporary structures ▪ Use of temporary pavement ▪ Widening ▪ Nightwork ▪ Weekend work

ITEM	POSSIBLE ISSUE
Temporary traffic management planning	Are bypasses or temporary widening needed? Does pedestrian/bicycle traffic access need to be maintained? Are minimum allowable lane widths achieved? Is the reduced work zone speed limit realistic and appropriate? Should certain types of vehicles be prohibited from entering the work zone (over-height, weight restrictions)? Will oversized load permits be affected? Will the work zone be adequate in terms of: ▪ Traffic control devices? ▪ Rail crossings and controls? ▪ Geometrics (turning radii, ramp merge/diverge areas, etc.)? ▪ Bridge restrictions and other structures?
Project timing	Does the proposed traffic management restrict the roadway during: ▪ Peak hours? ▪ One direction? ▪ Both directions? ▪ Overnight? ▪ Holidays or weekends? ▪ Sporting or other special events? ▪ Other projects in the immediate area? Will such restrictions reduce the road safety performance of the construction site?
Protective devices	Are temporary barriers and impact attenuators required? Has extra protection be provided for: ▪ Pedestrians/Bicyclists? ▪ School areas and crossings? ▪ Playgrounds and parks? Have areas been designated for the contractor to safely store (where necessary): ▪ Equipment? ▪ Construction materials? ▪ Waste materials?
Work Zone Analysis	Does the proposed traffic management plan meet the capacity analyses done during detail design? Is the required number of lanes maintained within the set time constraints? Will all fronting businesses have acceptable ingress and egress? Does the project comply with the guidelines set in the SADC Road Traffic Signs Manual and SARTSM Volume 2 Chapter 13?
Mobility impacts	Has the work zone traffic analysis identified impacts on any of the following and are measures included to minimise such impact? ▪ Ability to maintain all accesses (business, community, etc.) ▪ Pedestrian, and bicycle facilities

ITEM	POSSIBLE ISSUE
Mobility impacts	▪ Public safety (workers and travelling public) ▪ Emergency vehicle access ▪ Construction equipment access & movement through the work zone ▪ Specific user groups (businesses, communities) ▪ Over-height, over-weight vehicles ▪ Public Transport services and bus stops ▪ Traffic operations in and around the work zone (freeway queues, network operations, effect on local roads and detour routes) ▪ Ramp capacity ▪ Intersection traffic control (signal timing, adequate signage, etc.) ▪ Existing special traffic operations (HOV lanes, etc.) ▪ User Costs (delay)
Temporary traffic control	Are the temporary traffic control signs and markings shown on the drawings or referenced to typical details? Will sign message modifications be required on permanent signs? Have the modifications been shown? Are temporary signals required or will existing signals need to be kept operational? Will the removal of markings be required and has the work zone been set up to minimize removal? Will Portable Changeable Message Signs be required?
Work zone safety management strategies	Have the following work zone safety management strategies been considered? ▪ Speed limit reduction/variable speed limits with portable changeable message signs displaying speed? ▪ Temporary traffic barrier and movable traffic barrier systems? ▪ Temporary transverse rumble strips? ▪ Warning lights? ▪ Temporary roadway lighting? ▪ etc.
Incident management and community liaison	Is provision made for Standby towing service, Emergency lay-byes and Planned detour routes in case of an incident? Have Work Zone ITS strategies like CCTV monitoring been considered for traffic monitoring/ management? Has the agreement of the road traffic police been received for the proposed traffic management and possible law enforcement within the work zone? Has relevant radio stations been advised of the construction in order for road users to be advised of the need to consider alternative routes? Is a public information meeting required?

APPENDIX D-5: Stage 5 Pre-Opening Road Safety Audit

ITEM	POSSIBLE ISSUE
GENERAL TOPICS	
Changes since Stage 3: Detailed Design Road Safety Audit	Were there any changes since the Stage 3 Audit? Was the translation of the design into the project satisfactory in terms of safety?
Adjacent land use	Was the effect/ influence of adjacent land uses catered for? Are all accesses safe and adequate as far as design, location and visibility are concerned?
Drainage	Is the drainage of the road and the surrounds adequate?
Climatic conditions	Is adequate provision made for adverse weather conditions?
Environmental features	Are there any environmental features such as a rock, bank or trees that will pose a danger to traffic in terms of its visibility and presence?
Landscaping	Is the actual landscaping on site appropriate from a safety point of view? Is the roadside hazard of the landscaping limited? Is the visibility through or along the vegetation satisfactory, especially for pedestrians? Will this remain when the vegetation matures?
Services	Do traffic barriers protect all services that are not located in safe locations and is the protection adequate?
Shoulders and road edges	Can the constructed shoulders and road edges act as a safe recovery area?
Surfaces and skid resistance	Are there any of the following features that will cause low skid resistance: ▪ Joints in surfacing that are bleeding excessively ▪ Loose material (e.g. gravel etc) on any of the trafficked areas
Treatment of batters	Will the treatment of batters prevent debris from falling on the roadway
ALIGNMENT	
Visibility and sight distance	Are the sight lines provided sufficient and free of obstructions? Is the visibility of the elements of the project adequate?
Readability by drivers	Is the form and function of the road and its traffic management easily recognised under likely operating conditions? (e.g. heavy traffic, minimal traffic, poor visibility or adverse weather conditions)
Transition between project and existing adjacent road section/ intersection/ network	Is there a need for additional signage or markings to ensure safe transition?
Bridges and culverts	Are all the signage and markings adequate and visible?
INTERSECTIONS	
Visibility to and at the intersections	Are the drivers aware of the existence of the intersections and the control type? Is visibility satisfactory at the intersection?

ITEM	POSSIBLE ISSUE
Readability by drivers	Is the function of the intersections clear to drivers? Is the stop line for all the approaches (if necessary) clear to an approaching driver? (This should prevent a vehicle from protruding into the conflicting traffic.)
Traffic signals	Is the alignment of the traffic signal heads and the general installation thereof correct? Are all the respective aspects visible from an appropriate distance on each approach? Is the signal phasing (for both vehicles and pedestrians) as programmed safe and functioning as intended? Are all the road signs, markings, lighting and signals combining effectively to guide/ warn road users?
Roundabouts and approach islands	Are the roundabout and islands fully visible and recognisable from all approaches? Are all signs, markings and lighting correctly in place?
DRIVER PERCEPTION	
	Has the design been implemented in such a manner that it takes due cognisance of the following limitations of a driver as a human being ▪ Adequate input for the driving tasks: navigation, guidance and vehicle control ▪ Overloading of the driver by the design features and elements ▪ Provision for erroneous decisions ▪ Driver expectancy of dangerous elements or changes in design standards ▪ Adequate reaction time ▪ The visual field of the driver – for example, if a driver should see something outside of the visual field of the driver, is there a cue for him to seek the object? (for example: a driver travelling at 100 km/h has a 40 degree visual field) · ▪ Is the driver ever exposed to sudden darkness? ▪ Will the driver experience glare from oncoming vehicles or from road lighting? Is the approach speed to the project safe? Does the driver easily perceive the function of the project and the traffic management? (also check for poor visibility or heavy traffic conditions) Is the transition between the new project and the existing road constructed in such a way that it ensures that there can be no uncertainty or ambiguity for the driver?
SPECIAL ROAD USERS	
Adjacent land use	Are the measures to prevent pedestrians and animals from crossing a freeway or rural road (e.g. fencing) effective?

ITEM	POSSIBLE ISSUE
Pedestrians	Are the following key features satisfactory at all pedestrian crossings and facilities? ▪ · Visibility – Can pedestrians see and be seen? ▪ Road signs ▪ Surfacing ▪ Lighting and other hardware ▪ Disabled pedestrians
Cyclists	Are the following key features satisfactory for the cycling facilities? ▪ Visibility – Can cyclists see and be seen? ▪ Road signs? ▪ Surfacing? Lighting and other hardware?
Animals	Are the following key features satisfactory for stock and equestrians? ▪ Visibility? ▪ Road signs? ▪ Other special features?

ROAD SIGNS, MARKINGS AND LIGHTING

General	Is the transition between the road signs and markings of the project and the adjacent road network safe? Does the existing signage on the adjoining road network tie in with those on the project? Are guide posts or any other delineation devices correctly installed? Are retroreflective crash barrier delineators properly installed, as far as colour , spacing and alignment are concerned?
Road signs	Are all the road traffic signs and markings provided as designed? Do the road traffic signs and markings clearly convey the intended message to drivers? Are the road traffic signs and markings visible as intended – for night-time and adverse weather conditions? Was all old and construction signage removed that may cause confusion? Are the following safe – both at day and nighttime conditions: ▪ Visibility? ▪ Message? ▪ Legibility? ▪ Location? ▪ Reflectivity/ illumination? ▪ Frequency (Is there a need for fewer or additional signage?) Are there any road signs that can easily be overgrown by close-by vegetation? Can it be moved without loss of effectiveness? Is any variable message signage operating satisfactorily?

ITEM	POSSIBLE ISSUE
Road markings	Are all road markings: ▪ Located correctly? ▪ Marked correctly (size, colour etc)? ▪ Visible to the road users as intended (also during night-time and adverse weather conditions)? Is the transition between the road markings of the existing adjoining road and the new project safe, continuous and appropriate? Are the road markings clear from any debris? Have road studs been installed in accordance with the correct colour convention and at all locations where hazardous conditions may exist?
Road lighting	Is the lighting safe in terms of operation and efficiency? Where located in a clear zone, is the lighting adequately protected by means of traffic barriers?
ROADSIDE HAZARD MANAGEMENT	
Fixed objects/ roadside hazards	Are all poles and breakaway poles installed correctly? Are all poles and supports appropriately located? Are there any roadside hazards within the clear zone that are not: ▪ Properly marked ▪ Properly signed ▪ Protected by a traffic barrier system
Traffic barriers	Do all the traffic barrier systems conform to the standards and guidelines to ensure safe operation? Especially in terms of: ▪ Location (do they create a hazard in themselves?) ▪ Lengths ▪ End-treatments ▪ Installation detail ▪ Anchorage ▪ Post spacing ▪ Proper deflection distance ▪ Soil stability ▪ Height of installation ▪ Intended function – design vehicle
Median barriers	Are all the median barriers installed to the exact specified details and is the installation safe and properly delineated where required? Are all median barriers located in such a way that they: ▪ Do not limit visibility or ▪ Constitute a hazard?

ITEM	POSSIBLE ISSUE
TRAFFIC MANAGEMENT AND OPERATION	
Operation	Are all operating features installed correctly and easily accessible?
Traffic management	Are all traffic management devices functioning satisfactorily (e.g. clarity of messages, readability from moving vehicles etc.)?
Access management	Are the design, location and visibility at the accesses safe for the intended purpose?
Speed management	Is the speed limit appropriate?
Emergency vehicles	Can emergency vehicles access the project safely and stop safely?
Temporary traffic management	Are all temporary construction signage, markings etc. removed from the project?
OTHER	
	Are there any other safety issues that were identified during the site visits?
	Did the site visits cover day-time conditions, sunrise and sunset and nighttime

APPENDIX D-6: Road Safety Audits on Existing Roads (Road Safety Appraisals)

ITEM	POSSIBLE ISSUE
GENERAL TOPICS	
Landscaping and natural vegetation	Does the existing landscaping have any negative safety effects (e.g. clearances, sight distance)? Will the clearances and sight distances be reduced by further plant growth?
Headlight glare	Is there a problem with headlight glare?
Parking	Are the parking provisions safe in terms of operation and sight lines?
Temporary works	Is there any construction or maintenance equipment, material or signage although no construction or maintenance is being done?
CROSS-SECTION AND ALIGNMENT	
Visibility and sight distances	Is the sight distance adequate for the 85th percentile operating speed? Is the sight distance for pedestrian crossings adequate?
Design speed and 85th percentile operating speed	Is the horizontal and vertical alignment appropriate for the 85th percentile operating speed? If not: ▪ Are adequate warning signs provided? ▪ Are advisory speed signs provided? Is the posted speed limit or advisory speed limits (if provided) appropriate for the curves?
Overtaking	Are adequate and safe overtaking facilities provided?
Readability by drivers	Can any of the road sections cause confusion in terms of: ▪ Roadway alignment not clearly defined? ▪ Disused pavement that was not removed or treated? ▪ Old pavement markings that were not removed properly? ▪ The alignment of lighting and/ or trees not conforming to the road alignment? Are there any curves (vertical or horizontal) or combinations of curves that: ▪ Can be misleading in guiding the driver to the approaching alignment of the road? ▪ Provide no guidance to the driver on the approaching alignment of the road?
Widths	Are the widths of the following adequate? ▪ Traffic lanes ▪ Shoulders ▪ Carriageways ▪ Bridges
Shoulders	Are shoulder widths appropriate? (e.g. for emergency vehicles, broken-down vehicles or as a recovery area for errant vehicles) Are all shoulders traversable by vehicles?

ITEM	POSSIBLE ISSUE
	Does the crossfall of the shoulders ensure proper drainage?
	Is the transition between the traffic lane and the shoulders safe?
Batter slopes	Are the batter slopes and table drains a safe recovery area for run-off-the-road vehicles?
Drainage	Are all drainage structures within the clear zone safe for vehicles to traverse?
AUXILIARY LANES AND EXCLUSIVE TURNING LANES	
Visibility and sight distance	Is adequate stopping sight distance provided up to the end of the queue of turning vehicles?
	Is adequate stopping sight distance provided for entering and leaving vehicles?
Tapers	Is the start and finish tapers located and aligned correctly?
	Is the sight distance to the end of the auxiliary lane sufficient?
Shoulders	Are the shoulder widths appropriate at merges?
Signs	Are the signage and road markings adequate to guide, control and warn drivers of the auxiliary and exclusive turning lanes?
Exclusive turning lanes	Is advance warning provided for the approaching exclusive right turning lane?
INTERSECTIONS	
Visibility and sight distance	Are the sight distances provided adequate for all road users?
Location	Are all intersections located safely in terms of the horizontal and vertical alignment?
Layout	Is the alignment of the medians, kerbing and
	traffic islands safe?
	Is the function and layout of the intersection clear to all road users?
	Are the tapers and turning radii appropriate?
	Does the layout address all potential conflict points between turning vehicles in a safe way?
	Are there any capacity problems that may influence safety negatively?
Traffic control	Is the traffic control provided by the road signs and markings satisfactory?
Warning	Are there adequate warning on the approaches of intersections that have high approach speeds (e.g. at approaches to towns)
SPECIAL ROAD USERS	
Pedestrians	Is the speed limit appropriate for the pedestrian activities in the area? Note particularly pedestrian-sensitive areas.
	Is adequate signage and delineation provided in pedestrian sensitive areas?
	Are crossing facilities provided at safe locations and at the pedestrian desire lines?
	Are paved footways provided? Note particularly where a discontinuation takes place or where the sidewalk is not “walkable”.
	Is provision made for the movement of pedestrians on bridges? (i.e. in terms of adequate width and protection)

ITEM	POSSIBLE ISSUE
	Is sufficient lighting provided along pedestrian walkways and at pedestrian crossings?
	Is adequate pedestrian facilities provided at and on the approach to public transport facilities?
	Is adequate provision made for the elderly, disabled and baby carriages (e.g. ramps, kerbs and median crossings)
	Is the distance between the stopping line and the pedestrian crossing of signalised intersections enough to ensure the visibility of pedestrians (for example for a driver of a heavy vehicle)
	Is the signal length sufficient in terms of: ▪ Cycle length ▪ Pedestrian clearance times
	Are all pedestrian buttons working?
	Are there any particular areas where traffic barriers are necessary to separate vehicular traffic and pedestrians?
Cyclists	Has appropriate consideration been given to the needs of cyclists? Also note whether bicycle paths are continuous
Public transport	Is adequate provision made for safe public transport facilities? (e.g. sight distance, stopping areas, pedestrian facilities, etc.)
	Are the public transport facilities adequately signed and marked?
ROAD SIGNS, MARKINGS, DELINEATION AND LIGHTING	
Road signs	Are all signage: directional, warning and regulatory, visible and adequately located?
	Are all the sign sizes and letter sizes adequate?
	s there any signage that is obscuring one another?
	Is there any need for the adding or the removal of signage?
	Is there any signage that can be confusing to drivers?
	Is all signage properly installed in terms of lateral clearance and height?
	Is the signage provided adequate for the intended message?
	Are there any signs that restrict sight distance (e.g. for turning vehicles, blocking the view to pedestrians)?
	Is all signage clearly visible during all likely conditions (e.g. adverse weather conditions, sunrise, sunset, night-time, poor lighting)?
	Does any of the signage supports present a danger to a run-off-the-road vehicle?
Road markings and delineation	Are all road markings clearly visible and reflective during all likely conditions?
	Is there a need for roadstuds? If provided, is their condition satisfactory?
	Are all line markings (edge, centre and traversable) clearly visible and effective during all likely conditions (e.g. adverse weather conditions, sunrise, sunset, night-time, poor lighting, oncoming headlights)?
	Is adequate delineation provided along curves? Are the chevron posts visible, adequately spaced and continuous?

ITEM	POSSIBLE ISSUE
	Are all reflective areas appropriate for the driver eye height (also check for heavy vehicle drivers)?
	Are guidelines provided for vehicular paths through intersections where necessary?
	Is there a need for additional road markings e.g. advisory lane directional arrows at the exiting approach of an intersection, to improve guidance to drivers?
	Warning signs and advisory speed limits: ▪ Are curve warning signs and advisory speed limits provided and located appropriately? ▪ Are the advisory speed limits along the route consistent?
	Does the placing of the warning signs and advisory speed limits provide for adequate reaction time?
Road lighting	Is appropriate lighting installed at intersections, pedestrian crossings and refuges?
	Is all lighting operating satisfactorily?
	Are all lighting posts that are located within the clear zone protected by traffic barriers?
	Is any of the lighting causing visual conflict with traffic signals and signage?
	Is appropriate lighting provided for overhead signage where necessary?
TRAFFIC SIGNALS	
Visibility	Are all traffic signals clearly visible to approaching drivers?
	Is adequate stopping sight distance provided to the end of queuing vehicles?
	Will the intersection be affected by sunrise/ sunset problems? Is provision made for this in the form of backboards or high intensity signals?
	Are the signal displays shielded so as to ensure that they are only visible to the motorists for whom they are intended?
	Is adequate warning provided where signals are not visible from an adequate distance?
	Are there any features in the environment, such as trees, signs, lighting etc, that obscure signal heads?
Operation	Are all traffic signals operating satisfactorily and correctly?
	Are the location and number of signal displays adequate?
	Where necessary, is provision made for the elderly and disabled pedestrians? (e.g. extended green phase)
	Is the controller located at a safe position?
	Are there any signal aspects visible near or within the intersection that may confuse drivers?
	Is the signal phasing clear to the driver?
	Does the phasing conform to the safety requirements set for the amber and all-red periods?
	Pedestrians: ▪ Are pedestrians considered in the signal phasing?

ITEM	POSSIBLE ISSUE
	▪ If islands are located in the path of the pedestrian, is the size thereof sufficient to act as a refuge island? ▪ Can drivers see the pedestrian crossing(s) and the pedestrians that are crossing? Is the signal phasing appropriate for: ▪ The traffic movements ▪ The accommodation of all vehicles utilising the intersection ▪ The geometry of the intersection ▪ The geometry of the approaches
ROADSIDE HAZARD MANAGEMENT	
Clear zone and roadside hazards	Is a clear zone provided? Are all roadside hazards within the clear zone appropriately protected?
Traffic barriers	Are traffic barriers installed at hazardous locations? Are the traffic barrier systems suitable for the purpose? Do all the traffic barrier systems conform to the standards and guidelines to ensure safe operation? Especially in terms of location (do they create a hazard in themselves?), lengths, end-treatments, anchorage, post spacing, proper deflection distance, soil stability, height of installation, rail overlap and installation detail. Does the traffic barrier system meet its intended function for the design vehicle on the road?
DRIVER PERCEPTION	
	Does the road environment take due cognisance of the following limitations of a driver as a human being: ▪ Adequate input for the driving tasks navigation, guidance and vehicle control ▪ Overloading of the driver by the design features and elements ▪ Provision for erroneous decisions ▪ Driver expectancy of dangerous elements or changes in design standards ▪ Adequate reaction time ▪ The visual field of the driver ▪ The rate at which the eye can gather information from the environment Is there any exposure of the driver to sudden darkness? Will the driver experience glare from oncoming vehicles or from road lighting? Can the driver easily perceive the function of the road and the traffic management? (also check for poor visibility or heavy traffic conditions)
PAVEMENT	
Loose gravel	Are there any loose screenings that can cause vehicles to lose control/ not brake properly?
Pavement defects	Are there any pavement defects that can cause safety problems like loss of control? (e.g. Excessive roughness, Rutting, Potholes, etc.)

ITEM	POSSIBLE ISSUE
Skid resistance	Is adequate skid resistance provided on curves, steep grades and intersection approaches?
Ponding	Are there any areas where ponding or sheet flow of water occur that can result in safety problems?

APPENDIX E: BIBLIOGRAPHY

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