THE REPUBLIC OF UGANDA

MINISTRY OF WORKS, HOUSING AND COMMUNICATIONS

ROAD DEVELOPMENT PROGRAM PHASE 2 PROJECT

CONSULTANCY SERVICES FOR THE PRODUCTION OF ENGINEERING MANUALS AND SPECIFICATIONS AS WELL AS PROVISION OF INSTITUTIONAL SUPPORT

Contract RDP/GN/S008

Road Safety Audit Manual

Client:
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Acknowledgements

This Manual draws extensively on the experience of road safety auditing in many countries. Key sources are listed below and the contribution made by the authors of these documents is acknowledged.

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FOREWORD

The Ministry of Works, Housing and Communications has a duty of care to all road users, and so has always been concerned with the safety of its roads. However, the significant increase in road crashes in recent years has prompted the Ministry to intensify its efforts to promote road safety. One small part of this effort are new procedures to ensure that the safety of all road schemes is checked by specialists before construction – this is called ***safety auditing.*** Experience elsewhere has shown that it is a simple and highly cost-effective way of reducing crashes on new roads. It will not bring a dramatic improvement in road safety, but every crash prevented means reduced economic loss and the avoidance of personal suffering. This Manual explains the principles and practice of safety auditing and gives technical guidance on what can be a complex and demanding task. It has been written for all those persons involved in safety audits.

From now on safety audits will be a routine part of the planning and design process. They are not optional.

Safety auditing involves one set of professionals checking the work of other professionals. It is important that those doing the auditing approach the task with sensitivity, and that those whose work is being audited accept that this is necessary and worthwhile. If everyone takes safety auditing seriously we should see a significant improvement in the safety of the roads that we are building.

Minister or Permanent Secretary

1. OVERVIEW OF ROAD SAFETY AUDIT

1.1. Road Safety Audit

Road safety audit is a systematic and formal process of checking the safety aspects of road schemes before they are built. The objective is to identify potential safety problems, so that, where possible, the design can be changed to eliminate or reduce them. The audit is carried out by trained and experienced auditors who are independent of the scheme designers.

Road safety auditing follows the principle of ***"prevention is better than cure".*** An audit conducted at the planning or design stage allows a line on a plan to be changed, which is much cheaper than having to alter asphalt or concrete once the scheme has been built. Most countries have experience of having to make major alterations to a newly-built road because a significant safety problem was designed into the road. This can be avoided if all schemes are audited before construction. Experience from other countries suggests that at least a third of crashes can be prevented or their severity reduced by conducting road safety audits and acting on the findings.

Road safety audits are appropriate for all kinds of road construction, including rehabilitation and upgrading, as well as new-build. They can also help in assessing the safety of:

- arrangements for traffic control and signing at roadworks
- traffic management schemes
- major roadside building development (e.g., shopping malls, car parks, leisure centres, etc)
- existing roads

The earlier a road scheme is audited within the design and development process the better. For road construction projects there are five main audit stages:

1. Feasibility Study Audit
2. Preliminary Design Audit
3. Detailed Design Audit
4. Pre-opening Audit

Safety audits involve three parties with defined roles – the Auditor, the Designer, and the Client:

- *the Auditor* (audit team) is commissioned by the Client to perform the audit and produce an audit report which identifies the safety problems and suggests what should be done about them;
- *the Designer* is the party responsible for the design (often a consultant); they will be invited to comment on the audit report and, if necessary, will be instructed by the Client to alter the design;
- *the Client* is the road authority who commissions the audit and decides whether the audit recommendations should be accepted or rejected.

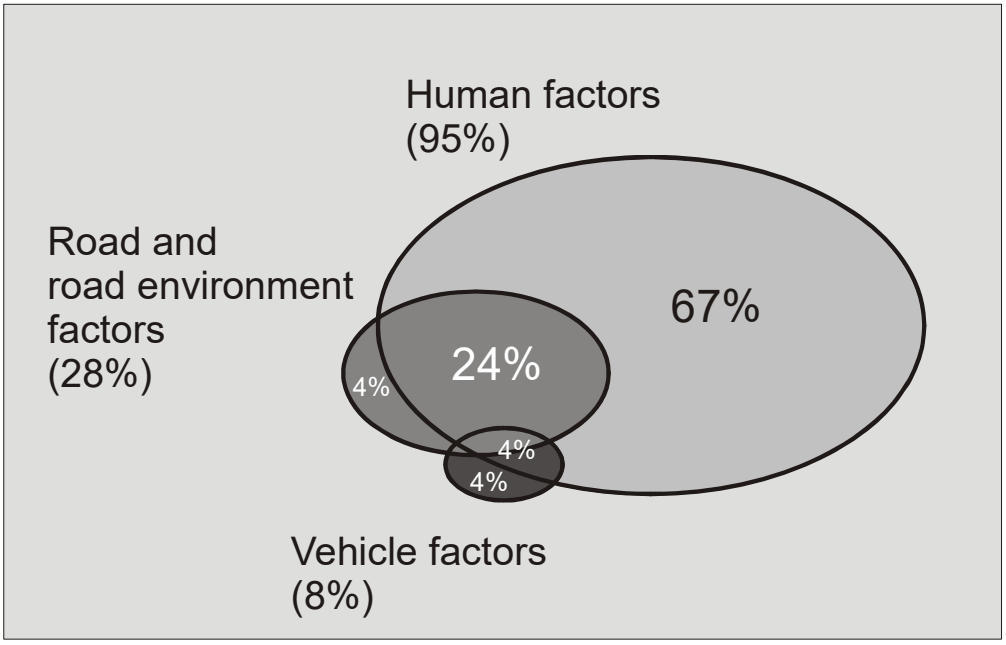
Road safety auditing can produce significant benefits at low cost if carried out in a formal and coordinated manner at all stages in the planning, design and implementation of a road project. The process requires management commitment, donor co-operation, skilled auditors, and an on-going training programme.

1.2. Road Defects as a Cause of Accidents

Although road defects are not the major cause of road crashes, efforts to improve road design, construction and maintenance are often highly cost-effective – and much easier than trying to improve the skills and attitudes of drivers. Research shows that there are three contributing factors to road crashes: (see also Figure 1)

- human factors (involved in about 95% of crashes)
- road and road environment factors (involved in about 28% of crashes)
- vehicle factors (involved in around 8% of crashes)

Figure 1. The three factors that contribute to road crashes



Source: Adapted from "Road Environment Safety; A Practitioners Reference Guide to Safer Roads", Road Traffic Authority of New South Wales, 1996

The three factors often combine in a chain of events that result in a crash. An example is:

Driver is tired ⇨ driver is on an unfamiliar road ⇨ road is wet ⇨ brakes on the car are poorly adjusted ⇨ driver is travelling too fast for the conditions ⇨ a sharp bend in the road is hidden by a vertical crest ⇨ there is no sign warning of the sharp bend ⇨ driver loses control, skids, runs off the road and crashes into a tree.

In this example the road defects (poor alignment, lack of warning sign) are not the major cause of the accident, but they would have been relatively easy to avoid (through auditing) – and experience shows that it only takes one of the links in the chain to be broken to prevent an accident or reduce its consequences.

1.3. Road Safety Engineering

All road authorities must have an on-going road safety engineering programme. This will comprise **'crash reduction"** activities, such as accident blackspot programmes, and **"crash prevention"** activities, such as road safety audits. Experience shows that it is necessary to put at

least three times more effort into blackspot programmes than auditing. The lessons learnt from the evaluation of blackspot schemes will be fed into the audit system. And experience from safety auditing will feed into the revisions of design standards. In this way the road authority will be acting both pro-actively and reactively to improve the safety of the nation's roads.

1.4. Limitations of Design Standards and International Consultants

Why should audits be needed when the road authority employs the best international consultants and insists on the use of high design standards? There are a number of answers to this question, including:

- **standards do not guarantee safety** – although conformity with standards and guidance (such as the Ministry's Road Design Manual (Road safety revision)) will help make the design safe, there will inevitably be many situations that are not covered by the standards – moreover a number of individual elements, all designed to standard, may, when combined, be unsafe.
- **foreign consultants tend not to take full account of the local operating environment –** they sometimes produce designs that would be adequately safe in their home country, but are often unsuited to the very different operating environment that exists in Uganda.
- **priority given to safety issues –** consultants vary in their attitude to safety – there are still some that believe there is no need to consider safety explicitly, or who take the view that Uganda cannot afford to pay for a high standard of safety; terms of reference for design work will in future give greater prominence to the need to consider safety aspects; one of the additional benefits of doing safety audits is that it sensitises consultants and road authority staff to the safety implications of design decisions.

Road safety audit is more than just checking for compliance with standards; it is checking "fitness for purpose". This means checking that adequate attention has been given to the safety needs of all the regular users of the road, especially the vulnerable road users, i.e., the pedestrians, the boda boda riders, the cyclists, the passengers waiting for transport, and the roadside vendors. And it also means checking that the design takes account of the realities of the operating environment, including road user indiscipline, the difficulty of law enforcement, the lack of access control, and the high proportion of vulnerable road users.

1.5. Audit Team

Road safety audits must be performed by a team (of at least two people) who have **experience and expertise in road safety engineering** and a knowledge of :

- highway design
- traffic engineering and traffic management
- road user behaviour.

Competence in safety auditing comes through hands-on experience. Training is helpful at the start but is only a base on which experience needs to be placed. The benefits of having a team are that two or more people are likely to spot safety problems that one person might miss. If the team members have different areas of expertise so much the better. Every audit can serve as a training exercise for novice auditors, and be an opportunity for all team members to gain more experience.

Successful auditors will be those who are able to read scheme drawings and visualise what the scheme will look like and how the different road user groups will cope with it. In other words

they will be able to "put themselves in the shoes" of each road user and visualise what it will be like: – for a pedestrian to cross the road at night – for a motorist to turn right in the junction – and all the other manoeuvres and actions that will take place on the road.

Road authorities have three options when appointing audit teams:

- **In-house audit teams –** cheap and easy to arrange but it may be difficult to build and maintain competency; the team can see the project through till completion
- **Design consultant –** auditors must not have been involved in the design, but it will still be difficult for them to be completely objective
- **Independent consultant –** probably the best option but also likely to be the most expensive.

1.6. Cost Implications

The average road safety audit is likely to be no more than three week's work for two or three auditors - this includes time for the site visit. Audits will not cost very much, especially if they are carried out by the road authority's own staff. Research in developed countries suggests that the benefit-cost ratio may be as high as 20:1. The same research shows that when the cost of implementing the audit recommendations is added in, the benefit-cost ratio will generally remain positive. Many audit recommendations will typically cost little or no extra money, and may even save money.

1.7. Problems and Issues

Experience of road safety auditing in both developed and developing countries has shown that it is not as straightforward as it might seem, and it is important to be aware of the most common problems, so that they can be avoided or minimised. The main problems and issues are set out below.

Issues of safety versus capacity and reduced journey time
There will sometimes be conflicts between the need to create increased capacity at low cost and the safety of road users. Road projects often have reduced journey time as their main objective and this too can conflict with safety needs. The safety audit does not itself provide the answer, but it highlights the issue, so that decisions can be made with a better understanding of the potential implications. In some cases it may be appropriate to refer such decisions to the Minister together with a full briefing.

Inadequate information about the scheme
Sometimes the Designer does not provide sufficient information to enable the Auditors to properly understand what is to be built. This can largely be avoided by requiring Designers to provide full section drawings (vertical and horizontal alignment) and large-scale drawings of all junctions, bridges, etc., as well as an explanation of what standards have been used, and how safety issues have been addressed. Drawings of standard cross-sections and standard junction layouts are unacceptable on their own. Designers should also be encouraged to show the location of traffic signs, safety barrier and other roadside furniture. Obtaining information about the scheme is sometimes made more difficult by the Designers being absent from the country when the audit is being done.

Project has not been audited at earlier stages

It is inevitable that some scheme designs that are now nearing completion will not have been audited at earlier stages. Auditors should not be afraid to identify problems arising from decisions made much earlier in the design process, or recommend that there needs to be a fundamental review of the design. This may place the Client in a difficult position.

Lack of time for auditing
The scheme preparation programme must allow sufficient time for audits to be done at the appropriate stages. The time between design completion and issue of the invitations to tender is particularly critical. This is frequently too short to enable a proper audit and follow-up to be done.

Arguments between designers and auditors
Arguments and bad feeling between the Designers and Auditors can be avoided if both of them know and accept their respective roles in the audit process. Auditors must be sensitive to the feelings of the Designers and should not question their competence, or demand that the design be changed. They must also explain their reasoning, and be sufficiently experienced to gain the respect of the Designers. For their part, the Designers must accept that independent safety experts be allowed to assess their design in the interests of improving its safety. Good communication and mutual respect between Auditors and Designers is important for successful auditing.

Reluctance to reject audit recommendations for fear of being blamed if accidents subsequently occur
It is quite valid for the client to reject an audit report recommendation on technical or cost grounds. However the person representing the Client may feel unduly pressured to accept all the audit recommendations because of fears that they will be blamed if they don't and accidents happen. They may also fear that they or their authority will be sued for negligence by the victims. These fears are generally groundless, but the risks can be reduced if the Client's representatives make sure that their reasons for rejecting any audit recommendation are soundly-argued and clearly recorded. Where the decision is finely-balanced or sensitive it may be prudent to refer the decision to the Minister together with a full briefing on the issue.

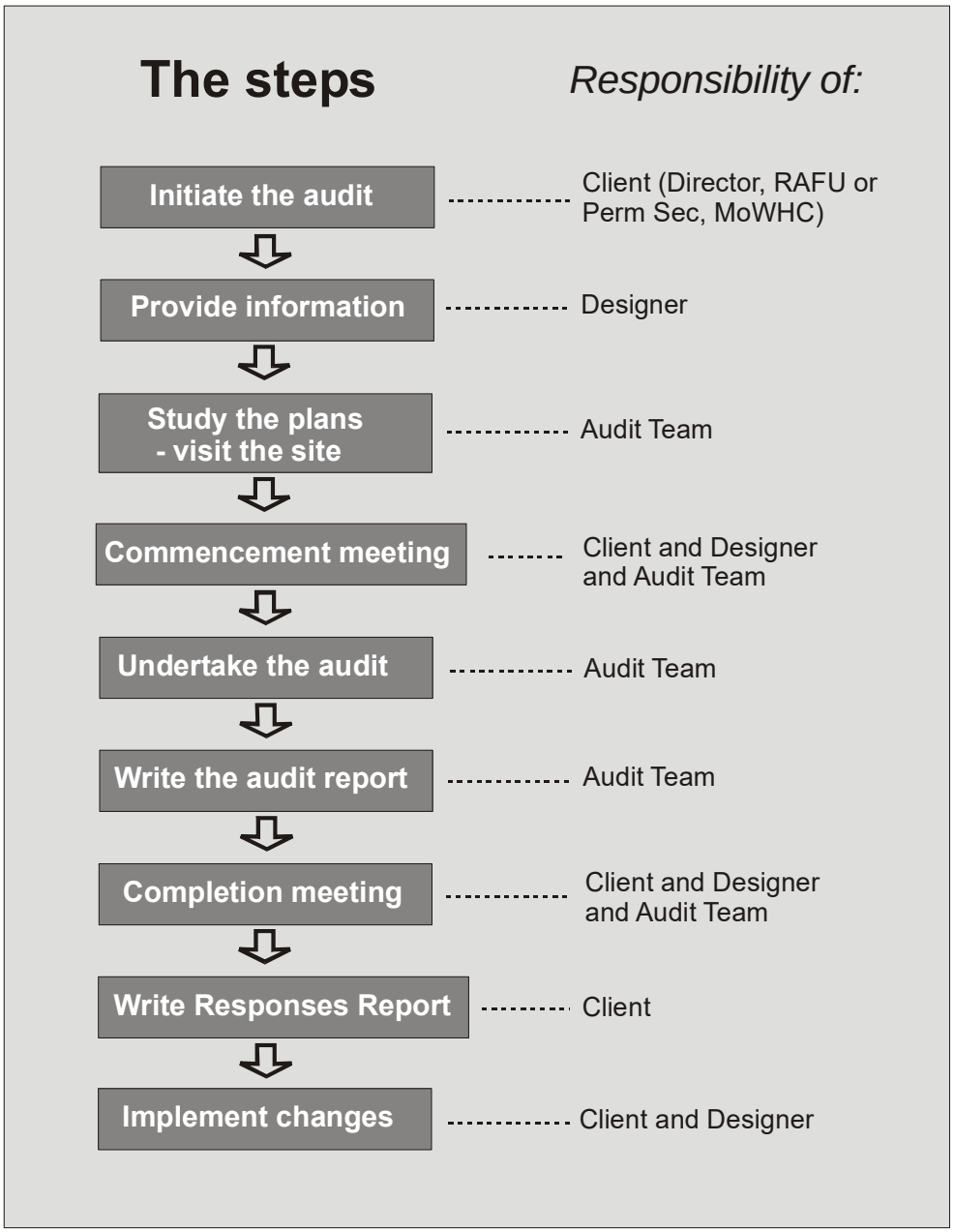
Changes to the scheme after the audit
Few road schemes get implemented exactly in accordance with the approved design. There are many factors that may result in design changes including land acquisition problems, the opposition of local people, construction difficulties, cost overruns, and others. All of these changes ought to be audited, but usually are not, and so the effectiveness of the audit is undermined. It is recommended that the head of the audit team try to follow the scheme's post-audit progress and, if changes are made which might compromise safety, he should report this to the Client, and suggest a re-audit. This will only be possible when the audit has been done by an in-house team. Ideally, the Auditor should attend the regular meetings between the Engineer's Representative and the Contractor, because it is often at this stage that design changes are made.

2. CONDUCTING ROAD SAFETY AUDITS

2.1. The Audit Process

The steps in the audit process are illustrated in the flow chart in Figure 2. It is important to follow the process as closely as possible in order to ensure that the audit is both formal and systematic. The process is the same whatever the type and scale of project being audited, but the amount of work involved in each step will vary.

Figure 2 Steps in the Audit Process



Source: adapted from "Road Safety Audit", Austroads,2002

2.2. Initiating the Audit

The Client will initiate the process by instructing that an audit be done. In most cases the instruction will come from the head of the Road Authority. However in the case of schemes undertaken wholly by the Ministry it will be the Permanent Secretary or his representative. The instructions will be issued in writing and will indicate the time scale for the work (normally one month). They will be copied to the Designer, and possibly the donor (if any).

The Client will also select the audit team and nominate one of them as the team leader. Significant projects require at least two people, and at least one of them must have road safety engineering experience. It is always useful to have people on the team who have good knowledge of the local travel patterns, traffic problems, and accident history. Audits at different stages call for different skills. For example, at the Detailed Design stage it is helpful to have someone who has sufficient design experience to check the details of signs, safety barrier, street lighting, etc. And at the Pre-Opening stage it is usual to include a traffic police officer with local knowledge.

2.3. Providing the Background Information

The Client will instruct the Designer to provide all relevant information to the audit team. This should include, at minimum:

- a project description
- an account of the design principles and standards that were used (e.g., design speed, standards for radii of horizontal curves, superelevation, standards for crest and sag curves, stopping sight distance, overtaking sight distance, percentage of route where safe overtaking sight distance is obtainable, etc.)
- a description of any departures from Road Design Manual standards and the reasons for them
- traffic data
- accident data
- full set of drawings showing details of the horizontal and vertical alignment
- signing and marking plans (essential for Detailed Design and Pre-Opening Stage audits)
- a copy of the previous audit reports (if any) and an account of any changes since the previous audit (if any).

2.4. Studying the Plans and Inspecting the Site

The Auditors will study the plans and other information, and try and understand what is proposed. It is essential for the audit team to visit the site in order to check for undocumented problems and visualise the future proposals and their effects. A night-time inspection is also highly desirable, as it will often show up extra problems. Based on their experience, and a check on whether design standards and general safety principles have been followed, the Auditors will then make a preliminary assessment of the accident potential of the project.

2.5. Holding a Commencement Meeting with the Designer and Client

The purpose of this meeting is to exchange information. It is an opportunity for the Auditors to clear up any doubts about what is proposed and find out the reasoning behind specific design decisions. There is also merit in getting the Designer's initial reactions to the problems that have been identified so far. It will often be necessary for the Client or his representative to explain the purpose and workings of the audit process to the Designers. Sometimes it is convenient and

helpful to combine the commencement meeting with the site inspection. If the Designers are not in Uganda at the time of the audit, the commencement meeting cannot take place. It may be possible instead to obtain information from the Designers by email or fax, but this is not a satisfactory alternative to a commencement meeting.

2.6. Undertake the Audit

There are various ways of organising the work, and this is a matter for the audit team leader and his team members. However, one method which is usually effective is for each team member to do their own audit and then meet to discuss their findings and put together the team report.

Auditors should remember to:

- consider the needs of all road users (including pedestrians (especially children), cyclists, and motor-cyclists) in all weathers and lighting conditions
- be thorough and comprehensive
- be realistic and practical (though they should not be too concerned about costs)
- keep to road safety aspects
- check compliance with standards and guidelines (including those in the Ministry's Road Design Manual (Road safety revision) whilst remembering that compliance with guidelines does not guarantee that the road will be safe.

It has been found that the use of checklists or memory prompts is a valuable tool in ensuring that nothing is forgotten during the audit. A provisional set of checklists is given in Section 7 – one for each audit type / stage. These will need to be refined as more audit experience is gained. Note however that they do not cover every possible safety problem, and they are not a substitute for knowledge and experience. Novice auditors may wish to record their findings against every item in the checklist. More experienced auditors may prefer to just read through the checklist before they start auditing – and perhaps afterwards as well.

2.7. Writing the Audit Report

The audit report sets out clearly what the problems are and makes outline recommendations on corrective action. It will usually refer first to general problems, such as inadequate cross-section, or lack of information on signing, and then give the findings and recommendations for problems at specific points along the road – presented in sequence from one end of the project to the other. The findings and recommendations should be described under three headings:

Observation – refer briefly to the problem feature, and locate it precisely (specify the chainage, or indicate on a copy of the scheme drawing)
Reason for concern – explain briefly why the feature increases the accident risk
Suggested response – give a clear indication of what needs to be done, but do not to be too specific or provide a detailed design; that is the job of the Designer.

It is also helpful to indicate whether a response is *Essential*, *Highly Desirable*, or *Desirable.* When assessing this, consider:

- how often the problem is likely to lead to a crash
- how severe the crash is likely to be.

See Table 1 overleaf for further guidance.

Table 1 – Determining the Response Rating

Crash severity	Frequency of crash			
	Frequent	Probable	Occasional	Unlikely
Catastrophic	*Essential*	*Essential*	*Essential*	*Highly Desirable*
Serious	*Essential*	*Essential*	*H Desirable*	*Desirable*
Minor	*Essential*	*H Desirable*	*H Desirable*	*Desirable*
Damage only	*H Desirable*	*H Desirable*	*Desirable*	*Desirable*

In some cases there may be no obvious solution to the problem, but the problem should still be identified in the report. There is no need to refer to the good points of the design, because the audit report is not giving an overall assessment.

The audit report should be thorough and comprehensive, but also concise. There is no need to describe the safety situation in Uganda, nor discuss general safety and highway design issues. The report should detail the specific safety concerns about the scheme, nothing else. Refer to the checklist below:

Checklist for audit reports

Introduction – details of:
- who requested the audit
- names of persons in the audit team
- drawings and documents submitted
- constraints, e.g., no signing plans available
- when the audit was done – date of site visit
- dates of meetings
- the technical terms used in the report (e.g. safety barrier, foreslope)

(there is no need to include completed checklists)

Safety concerns regarding general aspects of the design such as design speed, cross-section, superelevation, failure to manage speeds through trading centres, inadequate signing, etc.

Explain each concern under the headings: *Observation, Reason for concern,* and *Suggested Response;*
Specify whether a response is *Essential, Highly Desirable*, or *Desirable*.

Safety concerns regarding features at specific locations, such as an awkward bend, or a dangerous junction.

Explain each concern under the headings: *Observation, Reason for concern,* and *Suggested Response;*
Specify whether a response is *Essential, Highly Desirable*, or *Desirable*.

Concluding section
The audit team leader should sign and date the report.

Section 5 contains an extract from a sample audit report.

Once the report is ready it should be signed by the audit team leader and submitted to the Client.

2.8. Holding a Completion Meeting

Prior to the Completion Meeting the Client will send a copy of the audit report to the Designer with a request for a response on each of the report's recommendations. This may take some time, especially if more survey and research work has to be done. Once the Designer's report has been received the Client will request the audit team leader to attend the Completion Meeting together with the Designer. The purpose of the Completion Meeting is to enable the Client to get further information or clarification about the audit findings and to explore with the Designer what corrective action can be taken.

It is important that the Auditor and the Designer respect the fact that the Client alone will make the decision on whether and what action is to be taken to correct the safety problems identified by the audit. There is no need to reach agreement between all three parties. The Client may decide on the corrective action at the meeting or afterwards. In some circumstances the Client may wish to consult the donor (if any) before making a final decision.

2.9. Writing the Responses Report

The Client (or his representative) will then write the Responses Report which sets out his response to each and every problem identified by the audit, and indicates what corrective action (if any) is to be taken. This is a very important stage in the process and must not be omitted or rushed. It is possible that this report may be presented in court as evidence – as might happen when an accident victim is taking legal action against the road authority on the grounds of negligence. The Responses Report should reflect the road authority's concern for safety, and, if any audit recommendations are rejected, it should give sound reasons for doing so.

Copies of the Responses Report will be sent to the audit team leader and the Designer. The Client will instruct the Designer on the corrective action to be taken.

2.10. Follow-up

Where the audit is of a Detailed Design it is desirable for the audit team leader to continue to provide advice and technical support to the Designers and those responsible for implementation. This will only be possible if the team leader is a member of the Client's staff. Many things will happen which will cause the design to change, and, if possible, the audit team leader should try and keep track of what happens. If he feels that changes are being made that compromise safety, he should alert the project manager, of the need to audit these changes. One simple way for the Auditor to monitor design changes during construction is for him to read the notes of site progress meetings.

3. THE AUDIT OF ROAD DESIGNS

3.1. Introduction

One project can have up to five road safety audit stages. Audit stages 1 to 3 focus on the *initial design* (planning), *draft design,* and *detailed design.* Audit stages 4 to 5 occur after the project completion – inspection before the project is opened to traffic, and regular audits or monitoring of existing roads. It needs to be stressed that **the earlier a road project is audited the better**.

Small projects usually do not have separate draft and detailed designs. Depending on the size and scope of the project, one or more of the first three stages are merged. A five-stage audit is only undertaken for major projects.

3.2. Stage 1 - Feasibility Studies

Audits at this stage can influence fundamental issues such as design standards, cross-section, route choice, impact on surrounding road network, and the number, location and layout of intersections. If a wrong or inappropriate decision is made, it will probably be impossible to correct the problem at a later stage in the design process.

Feasibility studies sometimes recommend phased construction – for example, it may be proposed that the road is designed as a dual carriageway but is built initially as a single carriageway. Auditors should be aware that this often involves design compromises that adversely affect safety. Interim designs need more attention, not less.

3.3. Stage 2 - Preliminary Design

The preliminary or draft design will determine the standards, the cross-section, the alignment, and the layout of junctions. The audit will check all these elements, but will also look at the wider issues, such as:

- Have the needs of all likely road users been considered?
- Is property access catered for?
- Are local traffic movements catered for safely?
- Are the connections to the existing road network adequate and safe?

3.4. Stage 3 – Detailed Design

This audit occurs on completion of the detailed road design but before the construction contract documents are prepared and the land acquisition fixed. It is a chance to check all the details, including signs and markings, safety barrier, roadside obstacles, pedestrian facilities, connections to existing roads. Check also the interaction of the detailed elements – for example, check that the lighting columns are behind the safety barrier not in front. Attention to detail at this stage can help reduce the cost and nuisance of last-minute changes during construction. However, it is often difficult to get sufficiently detailed information because many minor decisions will be left for the supervising engineer to make during the construction phase.

3.5. Stage 4 – Pre-Opening Stage

This audit takes place immediately before the road is opened to traffic, and involves a detailed

inspection of the road and all the signs, and other road furniture. The objective is to check for any hazardous feature that was not apparent at previous stages, and check that all the design details have been correctly implemented. It is useful to have a local traffic police officer take part in the inspection, as they are likely to have a good understanding of how the local people will cope with the new road. They can also be asked to arrange for an increased police presence in the first few days after opening.

A 'post-opening' audit can also be done after the road has been open for a few days. This will show how the road is actually being used, and, if there are any problems, they will probably be apparent already. It may be possible to make minor changes before the contractor demobilises.

4. OTHER TYPES OF ROAD SAFETY AUDIT

4.1. Audit of Roadworks

Roadworks tend to have an above-average number of accidents. Reasons include:

- drivers not seeing the roadworks – especially at night
- drivers and pedestrians not adjusting their behaviour to suit the changed conditions
- confusion over the route to take through the roadworks – conflicting messages
- poor or non-existent traffic control
- little or no provision for pedestrians and other vulnerable road users
- narrow traffic lanes and other hazards
- inadequate protection for workers.

The Ministry of Works, Housing and Communications is making efforts to promote greater safety at roadworks. The Traffic and Road Safety (Safety at Roadworks) Regulations are in preparation and these will, for the first time, impose a legal obligation on anyone working in the road to adequately protect and sign their works. The Regulations refer to a code of practice (Safety at Roadworks Code of Practice) which sets out what should be done; this will be published shortly. The Ministry has also adopted new General Specifications for Roads and Bridgeworks which include comprehensive and detailed requirements for the management of roadworks on the Ministry's road projects. Although these standards and specifications will be helpful, they are no guarantee of safety. Standards cannot cover all possible situations, and road contractors may have difficulty interpreting them. Consequently there are benefits in having major roadworks audited. This of course applies to major maintenance works as well as rehabilitation and new-build.

The focus of roadworks audits should be:

- advance warning
- guidance by means of signs and devices
- speed control
- clear and efficient traffic control
- protection of workers
- safe access for construction vehicles.

The Safety at Roadworks Code of Practice provides a clear guide to what is required including illustrated plans of control arrangements for all the main types of roadworks.

4.2. Audit of Traffic Management Schemes

It is advisable to do safety audits of major traffic management schemes. When the existing circulation patterns are altered by means of one-way systems, road closures, parking restrictions, etc., there is potential for accidents. Audits of traffic management schemes should focus on:

- potential problems with one-way systems especially at connections with two-way streets
- whether there is adequate signing – for both drivers and pedestrians
- potential problems caused by increased speeds on one-way streets.

4.3. Audit of Building Development

Large building and land use developments usually generate considerable vehicular and pedestrian traffic, so they have a major impact on the surrounding road network. The layout of the site, and the design of the car parks, access roads, footpaths, etc., is critical for the safety of both visitors and the passing traffic on the surrounding network. Audits of building development will typically focus on:

- the vehicular and pedestrian access
- the safe provision of public transport services
- the safety impact of any congestion caused by the vehicles entering or leaving the development
- the generation of pedestrian movements across surrounding roads
- the adequacy of the parking provision (to avoid parking overflow onto surrounding roads)
- speeds within the site and at access points
- pedestrian / vehicle conflicts within the site and at access points

4.4. Safety Review of Existing Roads

Road safety audits can be done on existing roads – they are generally called *Safety Reviews* or *Safety Assessments* to avoid confusion with audits of projects that are yet to be built. Some road safety engineers prefer to rely on accident blackspot studies to improve the safety of existing roads. However, the disadvantage of accident blackspot studies is that they look only at *past* crashes, and these may not necessarily be a good indicator of *future* crashes. This is especially true of lightly-trafficked rural roads – the lack of accidents in the past is no guarantee that there will be none in future. Note also that accident records are far from accurate. There may have been accidents on the road that we do not know about.

Experience suggests that safety reviews should be done in conjunction with blackspot studies, not instead of them. It is recommended that the audit be done before looking at the accident records, so as not to bias the findings. If the review identifies a safety problem at a site which has no history of accidents, the client should be cautious about ordering corrective action. Nevertheless, if it is a known and obvious safety problem (e.g. an unprotected parapet end) it may be worth treating it.

Safety reviews help identify unsafe, inconsistent, outworn, and outdated elements in the road environment. This makes them especially useful when planning major maintenance or rehabilitation projects.

5. CASE STUDY

The case study is an audit of the detailed engineering design for a scheme to strengthen the Kampala – Gayaza road. The road commences at the Kalerwe roundabout and for the first 4.5 km it passes through built-up suburbs. This section had an ADT of 10,618 in 2001. There is a lot of roadside activity, including a busy market at Kalerwe. There is a considerable volume of pedestrian movement along and across the road. After chainage 4+850 the road takes on a more rural character with much less vehicular and pedestrian traffic. Key aspects of the design, such as the cross-section, were derived from the results of a feasibility study that considered various design options. As no road safety audit was done of the feasibility study the design decisions made at that time cannot be excluded from this current audit.

A small extract from the audit report is shown below. It details some of the problems identified on the first 1.4 km of the scheme (see scheme drawing overleaf).

1. Observation: **Highly Desirable**
The design provides for a single carriageway road, which from ch. 0+000 to ch. 4+850 will be carrying in excess of 13,000 ADT by 2005.
Reasons for concern:
The volume of traffic is close to the capacity of a single carriageway road and there is likely to be severe congestion during peak traffic periods. Severe congestion will result in undisciplined behaviour by drivers with consequent increased risk of crashes.
Suggested response:
Review the case for providing a higher capacity road from ch. 0+000 to ch. 4+850.

2. Observation: **Essential**
From ch. 0+000 to 2+000 there are very high volumes of pedestrians moving along and across the road. There is no specific provision for pedestrians other than a wide shoulder. This shoulder will be shared by parked vehicles and pedestrians. There is no control over access to and from the roadside areas.
Reasons for concern:
It is expected that there will be a high degree of conflict between pedestrian movement and vehicles parking / unparking and leaving / entering the carriageway. The presence of parked vehicles on the shoulder may result in pedestrians walking in the traffic lane to get past them. The level of conflict is likely to give rise to many collisions.
Suggested response:
Segregate the pedestrians from the vehicular traffic and at the same time control access to and from the roadside areas. This can be achieved by means of raised footways or dividers between traffic lane and shoulder.

3. Observation: **Essential**
From ch. 0+000 to 1+167 there is an open side drain on both sides of the road. The drain is 1.4 m wide and up to 1.2 m deep. There are very high volumes of pedestrians moving along and across the road. There is no proposal to provide street lighting.
Reasons for concern:
This wide, deep open drain will be a dangerous trap for pedestrians and cyclists, especially at night. It is also a hazard for drivers of motor vehicles who are traversing the shoulder to get access to roadside premises.
Suggested response:
Cover the drain.

4. Observation: **Desirable**

At ch. 0+739 there is an intersection with Mawanda Road. Mawanda Road approaches the Gayaza road on a downgrade and, although no traffic data is given, it is believed to be well-trafficked (and may gain traffic once the Northern By-Pass is completed). No specific design is given for the intersection but it is assumed that it will be constructed to the design "Typical Major Junction" shown on dwg. KAWO-PP-001. This design does not provide for channelisation in the minor road arm.

Reasons for concern:

Without channelisation in the minor road turning vehicles may take unsafe paths ("cutting the corner").

Suggested response:

Provide a channelising island in the Mawanda Road approach. This will also help to alert drivers to the presence of the junction as they descend Mawanda Road. It will also be beneficial to pedestrians crossing the mouth of Mawanda Road.

5. Observation: **Highly Desirable**

At ch. 1+260 the existing pipe culvert carrying the Nsooba River is to be replaced by a box culvert. The road level is about 2.5 m above river level. The specific design is not indicated but it is assumed that it will be constructed to the design "Typical Box Culverts in Urban Area" shown on dwg. KAWO-DT-026b. This design does not provide for a parapet at the edge of the culvert. There are high volumes of pedestrians moving along the road on this section.

Reasons for concern:

Without a parapet there is a risk that pedestrians (children especially) may be at risk of falling off the culvert's footway into the river.

Suggested response:

Provide a pedestrian parapet along both sides of the culvert.

6. Observation: **Highly Desirable**

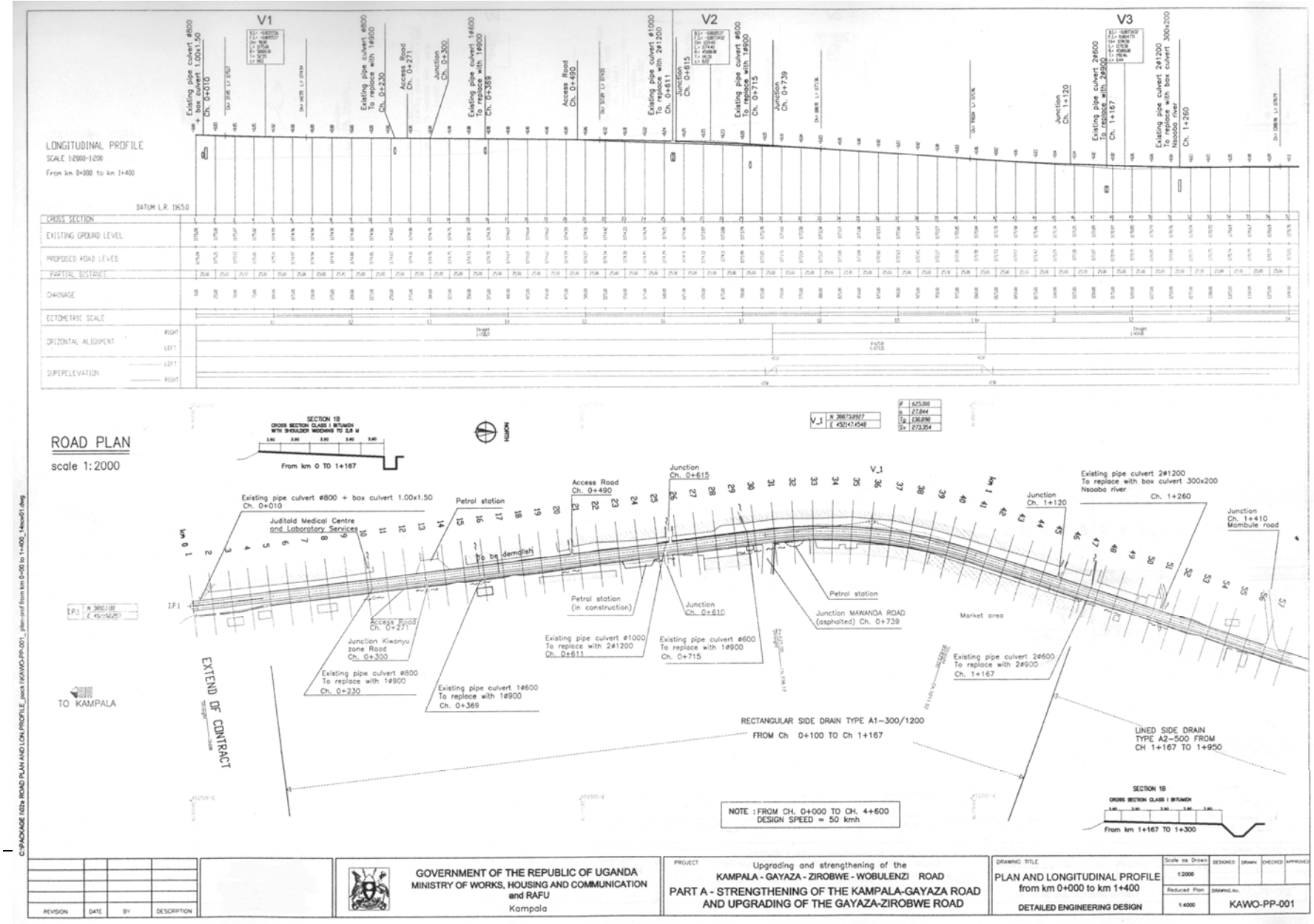
There is no provision for street lighting. From ch. 0+000 to 2+000 there are high volumes of pedestrians moving along and across the road, as well as considerable traffic movements between the road and the roadside areas.

Reasons for concern:

This section of the road is busy at night, and darkness will increase the risk of collisions, especially between vehicles and pedestrians.

Suggested response:

Consider providing street lighting from ch. 0+000 to 2+000.



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REVISION	DATE	BY	DESCRIPTION

GOVERNMENT OF THE REPUBLIC OF UGANDA
MINISTRY OF WORKS, HOUSING AND COMMUNICATION and RAFU
Kampala

PROJECT
Upgrading and strengthening of the
KAMPALA - GAYAZA - ZIROBWE - WOBULENZI ROAD
PART A - STRENGTHENING OF THE KAMPALA-GAYAZA ROAD AND UPGRADING OF THE GAYAZA-ZIROBWE ROAD

DRAWING TITLE
PLAN AND LONGITUDINAL PROFILE from km 0+000 to km 1+400
DETAILED ENGINEERING DESIGN

Scale as Drawn	DESIGNED	DRAWN	CHECKED	APPROVED
1:2000				
Reduced Plan 1:4000	DRAWING No. KAWO-PP-001			

6. COMMON SAFETY CONCERNS

Auditors should bear in mind the key principles for achieving a safe road environment:

- PROVIDE safely for all road users
- INFLUENCE the driver's choice of speed
- ENSURE that there are no nasty surprises
- GUIDE, INFORM and WARN the driver about the road ahead
- BE CONSISTENT in the way roads and intersections are designed and signed
- CONTROL the driver's passage through conflict points and other difficult sections
- FORGIVE the driver's mistakes or inappropriate behaviour

The safety performance of new roads in Uganda is generally good, but there are some safety concerns, including (in order of importance):

Failure to adopt speed management techniques. The practice has been to adopt one design speed for the whole road and design for that throughout, and then rely on traffic signs to impose speed limits in trading centres. Badly-designed rumble strips and road humps are added as an after-thought. Speed management involves setting the safe speed for each section of the road and then designing each element (cross-section, alignment) to reinforce that speed.

Failure to provide adequately for the needs of vulnerable road users. Schemes are getting better but the needs of pedestrians, cyclists, and boda boda, are still not getting the priority they deserve. Consequently, they are the majority of accident victims.

Poorly-designed intersections. Intersections tend to be designed so as to obtain maximum capacity (rarely necessary in rural Uganda) and this often results in excessive speeds and difficulties for pedestrians.

Road is hard to read. The lack of road markings, reflective road studs, marker posts and signs makes it hard for drivers to read the road, especially at night.

Insufficient clear and safe overtaking opportunities. There is a need to maximise the sections with good, safe overtaking opportunities and avoid creating situations with marginal overtaking sight distance (dilemma zones).

Unforgiving roadsides. High embankments, steep foreslopes, open drains, and carriageway edge drops all make the roadside more hazardous than it need be. Safety barrier is being used to protect vehicles from some of these hazards but the design and installation could be improved.

Poor access control. New and improved roads attract new roadside development, and this appears to be unplanned and poorly controlled. As the number of individual plot accesses increases so will the number of crashes. In the long-term the safety performance of the road may be seriously compromised.

7. CHECKLISTS

Road Safety Audit Checklists - Stage 1 – Feasibility Studies

	Issue	Assessment
1.1	**Project function and scope:** Is the scheme consistent with the development plans for the area? Is the scheme consistent with the planned road hierarchy for the area? Will the scheme adequately cater for: - cars? - motorcyclists? - pedal cyclists? - pedestrians? - heavy vehicles? - buses?	
1.2	**Major generators of traffic** Does the scheme serve major generators of traffic safely? Are there any developments, planned or committed, that may affect the new road?	
1.3	**Network effects:** Have any harmful safety effects of the scheme on the surrounding road network been adequately dealt with? Does the scheme relieve routes or sites with bad accident records?	
1.4	**General design issues:** Is the design appropriate for the road's function, category, traffic mix, design year traffic volume, etc? Is the design speed appropriate? Can any sudden change in the speed regime be safely accommodated? Are the joins with the existing road network handled safely? Will the route permit the achievement of alignment standards (horizontal and vertical)? Does the route fit in with the physical constraints of the landscape? Will the road be affected by adverse weather - high winds, mist, etc.? Any unusual features (bridges, etc.) that may have reduced standards?	
1.5	**Intersections and access control:** Is the frequency of intersections and their type appropriate for the road function, design speed, traffic volumes and turning movements?	

	Are the proposed intersections at locations where sight distances and other design requirements can be met? Are there any properties with direct access? If so, are they necessary, and in safe locations?	
1.6	**Staging:** Will the scheme be carried out in stages? Will intersections be built in interim or final form? Have design compromises been made which might affect the safety of the interim stages?	
1.7	**Evaluation of alternatives:** Does the evaluation of alternatives include an assessment of safety performance?	

Road Safety Audit Checklists - Stage 2 – Preliminary Design

	Issue	Assessment
2.1	**General topics:** Have the circumstances changed since the last audit (e.g. traffic volume, traffic mix, development plans, etc.)? Has the general form of the project design remained unchanged?	
2.2	**Design standards:** Is the design speed and speed limit for each section of the road appropriate to the function of the road, the traffic mix, and the road environment?	
2.3	**Cross-sections** Are the widths of the lanes, shoulders, medians (if any) in accordance with standards and adequate for the function of the road and the mix of traffic likely to use it? Does the cross-section help to reinforce the speed limit? Are the needs of pedestrians and cyclists adequately catered for? Is there a need to separate through traffic from access traffic in towns? Are there narrow sections (e.g. at bridges, culverts)? Are these avoidable? If they are unavoidable, are they handled as safely as possible? Are overtaking / climbing lanes provided if needed? Are changes in cross-section (e.g. at terminal points) handled safely? Will the carriageway drain adequately?	
2.4	**Shoulders and roadside areas** Are the shoulders of appropriate width and construction? Are any lay-bys, rest areas, etc. located and designed safely?	
2.5	**Alignment** Does the horizontal and vertical alignment give sufficient forward visibility for the selected design speed? Are there any substandard (inconsistent) elements? Does the horizontal and vertical alignment fit well together? Does the alignment provide regular, safe overtaking opportunities? Does the alignment avoid creating situations where the forward visibility is marginal for safe overtaking (dilemma zones)? Does the alignment help to reinforce the speed limit?	
2.6	**Intersections:** Can the number of intersections be reduced to improve safety? Are intersections so close together that there may be a	

	"see-through" problem? Is the intersection in a safe location (especially regarding visibility requirements)? Is the type of intersection (priority, control, etc.) suitable for the function of the two roads, the traffic volume, the traffic movements (vehicular and pedestrian), the approach speeds and the site constraints? Is it the safest alternative – for all road users? Are the intersections all of the same type? If not, will this be confusing for drivers? Will the layout and function of the intersection be understood by drivers as they approach? Does the layout broadly conform to the standard layouts given in the Road Design Manual (Road Safety Revision)? Is the route through the intersection as simple, clear and logical as possible? Is there adequate provision for channelling (and protecting) where necessary the different streams of traffic? Is there proper "lane balance", and "through lane continuity"? Are there any "trap lanes"? Is the layout of the intersection adequate for all permitted vehicular movements and for all types of vehicle? Does the layout encourage slow, controlled speeds at and on the approach to STOP and GIVE WAY signs / lines? Is there adequate provision for pedestrians and cyclists? Does the intersection design permit adequate signing?	
2.7	**Pedestrians and other special road users** Have pedestrian needs been satisfactorily considered (check whether there is evidence of a survey having been done)? Have the needs of cyclists and motorcyclists (including boda boda) been considered, especially at intersections (check whether these vehicles were covered by the traffic surveys)? Have the needs of bus users been considered?	
2.8	**Major traffic generators / access control** Does the route serve major generators of traffic safely? Are accesses to major traffic generators located near to hazards (e.g. intersections, sharp bends, sections with restricted visibility)? Risk of queues? Can accesses to existing properties be used safely? Are there any properties with direct access? Is there an alternative to direct access?	
2.9	**Bridges** Is the outline design satisfactory from a safety viewpoint	

	(continuation of full carriageway and shoulder width, provision for pedestrians, cyclists, etc)?	
2.10	**Railway crossings** If the road crosses a railway, is an at-grade crossing acceptable given the road function, speed, traffic volume, etc? If an at-grade crossing is acceptable is it located where visibility is adequate? Will there be adequate visibility to queue tails? Does the crossing need to be equipped with barriers and signals?	
2.11	**Staged development** Will the scheme be carried out in stages? Will intersections be built in interim or final form? Have design compromises been made which might affect the safety of the interim stages?	

Road Safety Audit Checklists - Stage 3 – Detailed Design

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

	shielded by safety barrier? If there is a median is it free of hazardous objects? If not, can they be removed, or protected? Is there a need for roadside parking? Are any lay-bys, rest areas, etc. located and designed to safe standards? Have the side drains been designed to a safe standard for vehicles and pedestrians? Are culvert ends (headwalls) located outside the clear zone, or have they been designed not to be a hazard, or has adequate protection been provided? Is the design of kerbs appropriate for the speed of traffic and the road environment?	
3.6	**Alignment** Does the horizontal and vertical alignment give sufficient forward visibility for the selected design speed? Are there any substandard (inconsistent) sections? Are substandard sections adequately signed? Are changes in speed handled safely? Does the horizontal and vertical alignment fit well together? Does the alignment provide regular, safe overtaking opportunities? Does the alignment avoid creating situations where the forward visibility is marginal for safe overtaking (dilemma zones)? Does the proposed treatment at bends make appropriate and safe provision for: transition curves, superelevation and carriageway widening? Does the alignment help to reinforce the speed limit? Is the design free of sight line obstructions (fences, street furniture, safety barrier, signs, landscaping, bridge abutments, parked vehicles)? Is visibility adequate at any pedestrian crossings? Is there sufficient visibility on the approach to intersections? Check that drivers will be able to read the road ahead. Are there any awkward surprises or visual illusions that could confuse drivers? If so, can they be avoided? If not, are they handled safely? Does the vertical alignment put excessive demands on the power of heavy vehicles? Has it been designed so that maximum grades are interspersed with recovery grades?	

3.7	**Intersections:** Will the layout and function of the intersection be understood by drivers as they approach? Does the layout broadly conform to the standard layouts given in the Road Design Manual (Road Safety Revision)? Is there proper "lane balance", and "through lane continuity"? Are there sufficient lanes for the volume of traffic? Is the route through the intersection as simple, clear and logical as possible? Is there adequate provision for channelling (and protecting) where necessary the different streams of traffic? Is the layout of the intersection adequate for all permitted vehicular movements and for all types of vehicle? Are the lane widths adequate (check need for widening on curves)? Are the traffic (channelising) islands sufficiently large to avoid being a hazard (especially at night)? Does the shape guide vehicles into the correct travel path? Are there any "trap lanes"? Can they be avoided? If not, are they signed adequately? Does the layout encourage slow, controlled speeds at and on the approach to STOP and GIVE WAY signs / lines? Are the sight lines at and on the approach to STOP and GIVE WAY lines and other critical decision points adequate and unobstructed? Are there are awkward differences in level on the approach to and within the intersection? If there is likely to be queuing, will approaching vehicles be able to see the queue tails in time to stop safely? Are there any 'local' features that may affect the safe use of the junction? Is there a need to provide for U-turns? If so, does the layout permit safe U-turns? Is there adequate provision for pedestrians (clear, convenient crossing points, refuge islands, dropped kerbs, etc)? Is there a need to use pedestrian barrier to channel pedestrians to safe crossing points? Is the intersection safe for cyclists? Are there acceleration and deceleration lanes? If so are these really necessary? If they are necessary, are they designed in accordance with the standards in the Road Design Manual (Road Safety Revision)? If there are merge situations, are they arranged so that the traffic joins the mainline from the nearside, i.e. from the left?	

	Is the intersection adequately and correctly signed in accordance with the Traffic Signs Manual? Does the intersection need to be lit? If lighting is to be provided, are the lighting columns in a safe place? **Additional checklists where intersections include:** **Traffic Signals** Can the signals be clearly seen on the approach to the intersection? Do measures need to be taken to reduce speeds on approach to the intersection? Is there any confusion when groups of signals are placed close together (see-through effect)? Is there a need to fit signal hoods to prevent drivers seeing signals that do not apply to them? Will the signals be hidden in bright sunshine? Are the signal heads fitted with backing boards? Are the signal lamps the correct size? Are there at least two signal heads (primary and secondary) controlling each traffic movement? If there are two or more lanes on the approach, is there a need to provide a second primary signal - on a traffic island? Is there likely to be any confusion over which signal controls each movement? Is there sufficient lateral clearance between signal heads and the carriageway? Do the signal colours, arrangement, signal sequence, and signal timings conform to accepted practice? Are they in accordance with the Traffic Sign Regulations and the advice in the Traffic Signs Manual and Road Design Manual? Does the signal phasing prevent any unexpected conflict situations? Is it necessary to have protected right turns? Is the "intergreen time" between conflicting phases sufficient for safe operation? Can the junction be used safely if the signals are not working or are switched to amber? Is there a phase to accommodate pedestrians? Are the settings and timings adequate for safe use? Can pedestrians get confused about which signal applies to them? Is the intersection properly marked in accordance with the advice in the Traffic Signs Manual? Is the stop line perpendicular to the centre line? Is the control equipment located in a safe place where it	

	will not interfere with visibility and is unlikely to be hit by errant vehicles? Is there safe parking for the maintenance vehicle? **Roundabouts** Is the geometry simple and easily understood by drivers on the approach to the roundabout? Is the size of the roundabout sufficient for the volume and mix of traffic and the number of entries? Is the central island sufficiently conspicuous? Are there too many entries for safe, efficient operation? Are the entries and exits spaced far enough apart? Does the design deflect entering traffic sufficiently to ensure that entry speeds are no greater than 50 km/h? Is the visibility for entering traffic and circulating traffic adequate? Has the centre island been designed to be forgiving to errant vehicles? Has adequate provision been made for pedestrians to cross the arms of the roundabout? Have the needs of cyclists been considered? Is the signing and marking in conformity with the guidance given in the Traffic Signs Manual? Are the markings adequate? Is there a need for dedicated lanes? **Grade separated** Are the deceleration tapers adequate? Are the acceleration lanes adequate? Is the vertical alignment correct? Can the drivers see the intersection? Is the merge/diverge point clearly identifiable for drivers on the mainline? Is joining traffic inter-visible with the mainline? Are there any accesses on the slip road? Can they be relocated? Is the slip road long enough to accommodate peak traffic flows without queuing back onto the mainline? Do embankments need safety barriers?	
3.8	**Traffic Signs:** Is the level of signing appropriate for the road? Is there an over-reliance on signs (instead of better geometric design)? Do the signs (incl. road markings) conform to the Traffic Signs Regulations and the advice given in the Traffic Signs Manual? Can the signs be seen and are they of sufficient size? Do the signs convey the correct message? Are signs located in appropriate and safe places?	

	Do signs give adequate information to drivers? Do the signs need to be protected with safety barrier? Are gantry signs needed? If gantry signs are used can they be seen at night? Do they need to be externally illuminated? Does the scheme make provision for removing unnecessary, wrong or outworn signs? Are the road markings correct? Are the criteria for the use of no overtaking centre lines specified, and, if they are, are they correct for the traffic speed on each section? Will traffic island markings need to be reinforced by rumble strips? Do the markings need to be made of thermoplastic? Will reflective pavement markers (road studs) be needed? Should roadside marker posts (delineators) be provided in order to improve the "readability" of the road?	
3.9	**Bridges** Is the design satisfactory from a safety viewpoint (continuation of full carriageway and shoulder width, provision for pedestrians, cyclists, etc)? Will pedestrians have a clear and safe path onto and off the bridge? Does the parapet need to function as a safety barrier? If so, will it perform satisfactorily? Has the parapet been designed for safety (height, limit on size of openings, etc.)? Are the parapet ends properly shielded?	
3.10	**Safety barrier** Are safety barriers provided where necessary? Is the safety barrier designed in accordance with the advice given in the Road Design Manual (Road safety revision)? Specifically, are the terminals of a safe design? And is the barrier long enough to be effective? Is the transition from one type of barrier to another (e.g. guardrail to concrete barrier, and guardrail to rigid bridge parapet) handled correctly?	
3.11	**Provision for Pedestrians** Are footways provided where needed? Is there a network of footways and safe crossing points serving the main pedestrian movements? Is there a need for special provision outside schools, hospitals and other major generators of pedestrian movement? Does the footway network enable pedestrians to avoid major conflicts with vehicular traffic? Are the main crossing points in safe locations? Is there good intervisibility between pedestrians and drivers?	

	Do the main crossing points have features / facilities to help pedestrians (e.g. "dropped kerbs", refuges, "build-outs", zebra crossings, signal-controlled crossings, etc.) Is there likely to be any confusion about who has right of way at crossing facilities? Does the signing and marking conform to the Traffic Signs Regulations and the advice in the Traffic Signs Manual? Are there any obstructions (signs, lighting columns, safety barrier, etc) in the footways? If so, can they be removed or moved? Is it necessary to channel pedestrians to safe crossing points using pedestrian barrier? If pedestrian barrier is used is it of a safe design (not dangerous when hit by vehicles)?	
3.12	**Access to Properties:** Can accesses to existing properties be used safely? Are there any special measures that need to be incorporated into the design to ensure safety (i.e. near schools, public areas, or commercial centres	
3.13	**Utilities:** Is there adequate clearance for overhead power lines? Can utility apparatus be accessed safely? Can maintenance vehicles be parked safely? Are power boxes and access chambers located in a safe place (e.g. away from traffic lanes)	
3.14	**Vegetation and landscaping:** Are there any trees/vegetation/landscaping located where they may interfere with visibility and affect the safety of road users?	
3.15	**Lighting schemes:** Is lighting required and, if so, has it been adequately provided? Does the lighting adequately illuminate critical points, such as pedestrian crossings, refuges, merge and diverge areas, STOP and GIVE WAY lines, etc.)? Will the lighting scheme mislead drivers in any way (e.g. regarding priorities at intersections, or alignment)? If there are sites with night-time accident problems, are these covered by the lighting scheme? Are the lighting columns located where they are less likely to be hit by out-of-control vehicles (as far as the need for even illumination allows)? Are the lighting columns of a design that makes them as little a hazard as possible? Is there adequate clearance between the lighting column and the edge of the carriageway? Do lighting columns on a median need to be protected by safety barrier?	

3.16	**Construction and maintenance:** Check that traffic can use the route safely during construction? Are access points to/from the site located in a safe location? If road closures are necessary are diversion routes safe to use by all types of road user? Can access to structures be carried out safely? Can maintenance vehicles stop in a safe place?	

Road Safety Audit Checklists - Stage 4 – Pre-Opening

	Issue	Assessment
4.1	**General topics:** Have any changes been made during construction that may lead to safety problems? Has the design been correctly translated into physical form? Check that no roadside hazards have been installed or overlooked. Is safety adequate for: pedestrians of all ages, bicycles, truck and bus movements, motorcycles, cars?	
4.2	**Drainage:** Is the drainage of the road and its surroundings adequate? Are culverts and headwalls in a safe place or are they protected by safety barriers? Are there any areas of deep water that are not protected by barriers?	
4.3	**Environmental:** Is planting located to avoid obstruction to visibility and sight lines? Will planting cause problems when mature (i.e. size of trunk or canopy spread)? Does planting obscure pedestrian movements near the edge of the road? Check that no natural feature creates a danger by its presence or loss of visibility.	
4.4	**Roadside:** Are there any obstructions remaining in the clear zone? Are there any "open windows" through which out-of-control vehicles could fall? If so, can they be closed, or shielded by safety barrier? Are the kerbs of the correct type?	
4.5	**Safety barriers:** Are they located in the most beneficial locations to prevent accidents? Are the terminal arrangements safe? Are guardrail beams overlapped correctly? Check mounting height and lateral clearance. Check that transitions between barrier types are safe. Check that no other hazards have been overlooked. Do safety barriers restrict visibility? Are there any features that could create a safety problem?	
4.6	**Access to property and developments:** Are all accesses safe for their intended use? Are all accesses adequate, in terms of design, location and visibility?	

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

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

Road Safety Audit Checklists - Safety Review of Existing Roads

	Issue	Assessment
5.1	**General topics:** Review previous road safety audit (if carried out). Are there any issues still causing concern? Do the Police have any concerns over accidents that may have occurred since opening (is there a predominant accident type that could indicate problems due to the road alignment)? Is there any confusion between the road and the adjacent network? If a service road is present does the service road operate safely? Is there any problem with headlight glare? Has there been any change of use of existing developments on or near the road that has affected traffic safety? Is the surface of the road free from defects that may result in safety problems (i.e. loss of control or skidding)? Is the pavement free from areas where ponding of surface water may occur?	
5.2	**Drainage:** Is the drainage of the road and its surroundings adequate? Are culverts and headwalls in a safe place or are they protected by safety barriers? Are there any areas of deep water that are not protected by barriers? Are there sufficient drains / outlets to ensure that water does not hold on the surface? Is the crossfall sufficient to remove surface water? Are there any drainage channels close to the edge of the running lanes that present a danger?	
5.3	**Environmental:** Does vegetation obstruct: • Traffic signs; • Visibility at junctions; • Stopping sight distances on the mainline; • Footways / crossing points? Are mature trees located in a safe place or do they need protection?	
5.4	**Roadside:** Are there any obstructions in the clear zone? Are there any "open windows" through which out-of-control vehicles could fall? Is there any roadside activity that may cause road safety problems?	

	Are the kerbs of the correct type? Is the safety barrier adequate (type, length, design, installation, etc)? Are pedestrian facilities used as intended? Are bus stops and parking facilities used in a safe manner?	
5.5	**Speed management** Does the geometric design (cross-section, alignment, etc.) reinforce the speed limit? Is the traffic exceeding the speed limit? Is there a need for speed management measures?	
5.6	**Cross-section** Are the lanes, shoulders, medians etc., of adequate width? Does the cross-section change with different speed limits?	
5.7	**Alignment:** Is sight distance adequate for the speed of traffic using the route? Is the horizontal and vertical alignment suitable for the 85th %ile speed of traffic? If not:- • Are there sufficient warning signs? • Are reduced speed limits present? Are there any sections of road that may cause concerns? Consider: • Is the alignment clearly defined? • Have all old road markings been removed? Are there sufficient clear overtaking sections? Are there sections with marginal visibility for overtaking (dilemma zones)? Are there sections where the alignment is dangerous (e.g. sharp curves after long straight sections, sharp curves after crests, long downgrades)? Is the design of curves adequate (check superelevation, transitions, carriageway widening)?	
5.8	**Intersections:** Are intersections located in safe places? (Check in relation to horizontal and vertical alignments) Is the layout of intersections obvious on each approach? Does the layout accommodate all types of vehicle? Is the visibility from the side road adequate? Is the method of control appropriate? (Priority/signalled) Are dedicated turning lanes adequate (i.e. lengths and widths) to accommodate volume and mix of traffic?. Is the signing on the approach to an intersection adequate? Is there adequate provision for pedestrians and cyclists?	

	Where there are signals: Do they operate correctly? Are they clearly visible (in all conditions)? Can signals only be seen by those who should see them? Are control boxes located in a safe place?	
5.9	**Pedestrian facilities** Are there adequate, safe facilities for pedestrian movement?	
5.10	**Bridges** Is the cross-section of the approach road maintained across the bridge? Are there safe facilities for pedestrians and cyclists? Is the bridge parapet safe (height, design, containment, etc.)? Are the ends of the bridge parapet adequately protected?	
5.11	**Traffic signs** Are all the necessary signs in place? Are they readable? (consider in all conditions). Are they located in a safe place? Do they give the correct message? Is there any confusion in the message they give? Do posts need protection? Is edge delineation adequate? Are road markings correct and in good condition? Are reflective pavement markings correct and in good condition?	