CAREC Road Safety Engineering Manual 1

ROAD SAFETY AUDIT

MARCH 2018

CAREC

ADB

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Abbreviations

ADB	–	Asian Development Bank
CAREC	–	Central Asia Regional Economic Cooperation
km	–	kilometer
RSA	–	road safety audit
RSE	–	road safety engineering
TA	–	technical assistance
TMP	–	traffic management plan
TOR	–	terms of reference

Purpose of this Manual

The Central Asia Regional Economic Cooperation (CAREC) countries committed to road safety at the 14th CAREC Ministerial Conference in Mongolia in September 2015. More recently the CAREC Road Safety Strategy 2017–2030 was endorsed by ministers from all CAREC countries during the 15th Ministerial Conference in Pakistan in October 2016. The strategy supports and encourages governments and road authorities to plan, design, construct, and maintain roads with road safety as a key and specific objective.

Among others, CAREC members endorsed the road safety audit process as an integral part of the planning, design, and construction of road projects within the CAREC program. Road authorities within the CAREC program are encouraged to implement road safety audit, and to build up expertise in this field.

This manual serves as a practical point of reference for the road safety audit process in CAREC countries. It is suggested that it be adopted for all CAREC road projects. Road safety audit shall be undertaken for all CAREC road projects in accordance with the approved strategy.

This manual presents and explains the road safety audit process. It is written to expand the understanding and to assist in the implementation of the road safety audit process in the CAREC program. It provides full information about the audit process for those who undertake the audits (practitioners) as well as for those who manage the audit process (policy makers). This information is essential for audit teams, project managers, and consultants as well as representatives of design institutes and road agencies.

The main topics in the manual for policy makers are as follows:

- how to select an effective audit team;
- an auditor accreditation scheme;
- key aspects for managing an audit: draft terms of reference (TOR), a suggested audit policy, and advice about how to respond to an audit report; and
- costs and benefits of road safety audit.

In addition, there are additional topics for practitioners:

- key steps in the audit process,
- how to write an audit report,
- four audit case studies that emphasize commonly found road safety issues in the CAREC program, and
- checklists for each audit stage.

This manual was prepared under a technical assistance grant for Enhancing Road Safety for CAREC Countries (TA 8804-REG) from the Asian Development Bank (ADB). The production of this manual was administered and managed by the CAREC Secretariat at ADB. The Secretariat team includes Ko Sakamoto, Oleg Samukhin, Ian Hughes, Charles Melhuish, Pilar Sahilan, and Debbie Gundaya. The principal author of this manual is Phillip Jordan.

I. What is Road Safety Audit and Why is It Needed?

A. A brief history of road safety audit

1. Road safety audit (RSA) evolved in the mid-1980s when a road safety engineering (RSE) team in a county in southern England began to question the number of newly built road projects that were appearing in the county's black spot list. The RSE team was responsible for investigating black spots in the county and its members were skilled in applying low-cost countermeasures to reduce crashes at hazardous locations. They were dismayed to find that so many recently completed road projects were on their list of black spots. After discussing this within the team, the team leader proposed that road safety would be improved if his team was allowed to check the design of all new road projects for safety before they were built. Put simply, he wanted to minimize the risk of the county building new black spots.

2. With support from the county surveyor, a department policy was developed that required all new road designs in the county to be checked and approved for safety by the RSE team prior to construction. Until "safety approval" was granted, the project was not permitted to proceed to construction.

3. This checking process became formalized as RSA, and the county RSE team became the world's first RSA team. The team applied its investigative skills in a proactive way to eliminate safety concerns at the design stage of road projects. The term "road safety audit" became an accepted name for a thorough and detailed examination of a road design from a road safety perspective.

4. Knowing the history of the RSA process gives an insight into how and why this process developed. In turn, this helps to understand why the audit process is an important part of the development of new road projects today. Similar procedures and policies spread throughout other British road agencies. The first road safety audit manual was published by the Institution of Highways and Transportation in 1990 to guide and encourage this process. Since then, the benefits of this new process have been recognized around the world as an important proactive process for producing safer roads.

B. What is road safety audit?

5. RSA is a formal, systematic, and detailed examination of a road project by an independent and qualified team of auditors that leads to a report with a list of potential safety concerns in the project.

6. RSA is a dynamic and structured process that requires a detailed examination of design drawings, an inspection of the location for the new road, a written report about the safety concerns identified by the audit team, and a subsequent response by the project manager stating why recommended actions have (or have not) been accepted, and what changes will be implemented.

7. A road safety audit is

- a formal process (not just an informal, quick check);
- conducted by persons who are independent of the design; and
- conducted by persons with appropriate training and experience.

8. RSA is defined as a formal examination of a road project because it follows a clearly defined process that concludes with a written report. The outcome of an RSA is a report that identifies road safety issues, and makes recommendations to remove or reduce the impact of these issues. Responsibility to implement these recommendations remains with the executing agency.

9. RSA needs a team of independent and qualified auditors. Each auditor must be independent of the project design, and each must be qualified in road safety engineering practices. Working as a team of auditors (rather than as a single auditor working alone) means the mix of educational backgrounds and experiences of the team leader and each member of the team increases the likelihood all potential safety concerns will be identified and recorded in the final report.

10. Later sections of this manual explain that an RSA is not

- a substitute for regular design checks,
- a check of compliance with standards,
- a form of crash (or black spot) investigation,
- a new name for a more detailed site inspection, and
- a way of assessing or rating a project as good or bad.

Standards are the right place to start, but we must always challenge whether something safer is possible. Adhering to standards does not always equal safety. Sometimes, there is no standard for a road-related issue. Other times, a standard is set for reasons other than road safety. And sometimes, our standards simply become old and outdated. National and regional standards should be continually monitored and updated.

C. The objectives of road safety audit

11. The first and most important objective of road safety audit is to minimize the risk of crashes, and to minimize the severity of any crashes that may occur on a new road project.

12. Secondary objectives of the audit process include the following:

- Minimize the risk of crashes occurring on adjacent roads.
- Recognize the importance of safety in road design so that the needs and perceptions of road users are met.
- Reduce the long-term costs of a new road project. Unsafe designs can lead to crashes, and crashes impose huge costs on communities. They can be difficult and expensive to correct later.
- Improve the awareness of safe road engineering principles by all involved in the process of planning, design, construction, and maintenance of roads.
- Advance the awareness of providing safe road schemes for nonmotorized as well as motorized road users.

D. Why is road safety audit needed?

13. The countries that were successful in their road safety efforts adopted national strategies that recognize the need for close cooperation and coordination between all stakeholders. Briefly, these countries found that road safety improves most effectively when traffic enforcement agencies, road managers, legislative bodies, health and education departments, and other stakeholders work in close cooperation and under the guidance of a national road safety strategy. They recognized that the road contributes to crashes; and that their highway agencies can eliminate black spots through detailed analysis of the crashes and with the implementation of low-cost treatments. They also implemented the road safety audit process during the design of new road projects to minimize the risk of building new black spots. These successful countries made sure the road is a sizable part of their road safety efforts.

14. We should not blame road users for causing all the crashes. Yes, they do make mistakes and some disobey the road rules, but our roads also contribute to crashes. Research indicates that up to 28% of crashes are due to the road environment; the road itself contributes to many crashes and/or increases their severity.[1] Highway engineers can contribute greatly to producing safer roads by making sure road safety is a high priority during design. This may cause them to question some national standards as they strive to add safety to their design.

15. Road safety audit is a recognition that highway engineers must do more to build safety into their new road projects. Experience has shown we need road safety audit for many reasons:

- There is too much reliance on national standards without determining if those standards are truly appropriate for safety.
- Some designs may include standards inappropriate for that type of road.
- Outdated national standards may mistakenly be used.
- Sometimes, a combination of diverse elements in the design may yield a result not the best in safety.
- There is often pressure to increase capacity of the road versus safety considerations.

[1] Roads and Traffic Authority of New South Wales. 1996. *Road Environment Safety: A Practitioners Reference Guide to Safer Roads.* Sydney.

- Sometimes, changes are made during construction that do not consider operational safety factors.

16. The countries that have achieved the most in road safety are those that have embraced road safety audit as a part of a successful road safety action plan.

E. Groups involved in a road safety audit

17. There are three main groups involved in the road safety audit process.

1. The client

18. The organization responsible for the project and which is deemed to be the owner of the road. While the client is usually a road authority, owning the road on behalf of the government, it can also be a private investor for toll roads. The client will ultimately decide what is to be done (and not done) in the road project. The project manager is the day-to-day representative of the client on technical matters.

2. The designer

19. An individual or team commissioned by the project manager on behalf of the client to design the road project. The designer may be a part of the client organization, a design institute, or may come from a separate consulting company. The designer provides a service to the client by designing the new road within the client's stated constraints.

3. The audit team

20. Usually comprises at least two people who are qualified as road safety auditors, and who are independent of the design and the proposal. The audit team is engaged by the project manager for the client. While the audit team may come from the client organization (provided team members are clearly independent of the project), they are most commonly from specialist organizations and consultancy companies. The audit team provides a service to the client by examining the drawings for safety issues.

21. When preparing TOR for an audit, or engaging an audit team to undertake an audit, it is necessary to be clear about the interaction of these three key groups. There must be shared cooperation through a clear understanding that all three groups are ultimately working to achieve one goal. However, the audit team is charged with injecting road safety expertise into the project, and there may be occasions when the team's recommendations conflict with constraints facing the other groups. Such situations are not uncommon, and they should lead to objective discussions among the groups.

22. On such occasions, the audit team should maintain its position and promote the most appropriate safety outcome regardless of the other constraints. The audit team does not have to concern itself with other factors (such as funding, environmental issues, national standards, road capacity, or political imperatives). The road safety audit team is the champion of the cause of road safety. Audit team members need to be clear and firm in focusing on safety in these meetings.

23. At the same time, the audit team should recognize that the client has the responsibility to weigh all competing factors, and to decide the way that will likely lead to success. The audit team puts forward its case for safety, but then leaves the client, project manager, and the design team to decide what will be done.

F. Prevention is better than cure

24. Road safety audit is a process of crash prevention; it aims to identify safety concerns in a road design so they can be discussed, resolved, and the necessary changes can be made while they still exist only as pencil lines on a piece of paper. By making changes early, at the design stage, road safety initiatives can be built into new road projects, and the risk to future road users of that road can be reduced.

25. The road safety audit process can best be summarized by the statement that prevention is better than cure. Audits are proactive. They do not use crash data. They try to prevent the first crash from ever happening on a new road.

26. A road safety audit is not a black spot investigation. Black spot investigations are reactive.

Black spot programs aim to reduce crashes at a location. They rely heavily on historical crash records to establish crash patterns at the location. These records provide a view of the crash history and, with an experienced black spot investigator, low-cost crash countermeasures can be developed and applied to reduce future crash frequency and/or severity.

27. So, while a black spot investigation applies to an existing road that has police crash data, a road safety audit is best undertaken before the road is built and with no crash history to call on.

28. The audit team uses the same technical skills and knowledge as the black spot investigator, but applies these in a proactive, rather than a reactive, fashion. The skills and knowledge involved in each may be the same, but the processes are quite different.

Road trauma is costing CAREC countries heavily. Safer roads are an important step toward reducing this burden.

II. Elements of the Road Safety Audit Process

A. What road projects are to be audited for safety?

29. Road safety audit is a positive process that assists road safety on any road. It is desirable to carry out audits on each road project within the Central Asia Regional Economic Cooperation (CAREC) network and on all other roads. Highway dualization, intersection improvements, bridge upgrades, new interchanges, bicycle projects, and pedestrian schemes are some of the many different road projects that benefit from audits.

30. It is also desirable to carry out audits on all classes of roads. Audits add safety to projects on expressways, international highways, national highways, arterial roads, urban roads, rural roads, and local streets.

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

32. A suggested road safety audit policy for road authorities in the CAREC program is provided in chapter IV-C of this manual.

B. The six stages of road safety audit

33. There are six internationally recognized stages during the planning, design, and construction of a road project at which a road safety audit can be conducted. They follow the accepted phases in the planning, design, construction, operation, and maintenance of a road:

- feasibility stage,
- preliminary design stage,
- detailed design stage,
- road works stage,
- preopening stage, and
- existing road (road safety inspections).

34. The earlier in the planning and design process an audit is carried out, the easier and cheaper it usually is to achieve effective changes to improve safety.

1. Feasibility stage

35. Safety audit inputs at the feasibility stage of a road scheme can influence fundamental issues such as the design standards, the route choice, continuity with the existing adjacent network, and the provision of intersections and interchanges.

2. Preliminary design stage

36. An audit on completion of the preliminary (draft) design examines features such as horizontal and vertical alignments, and cross-sections and intersection layouts. Careful auditing at this early design stage can help to reduce the costs and lost time associated with changes that may otherwise be brought about during later audits.

3. Detailed design stage

37. This audit stage occurs on completion of the detailed road design (final), but before the preparation of contract documents. Typical considerations include geometric layout, signs and line markings, signals, lighting, intersection details, safe roadsides, and provision for vulnerable road users. Attention to detail at this design stage can do much to reduce the costs and disturbance associated with last-minute changes that may otherwise be brought about with a preopening audit.

4. Road works stage

38. This stage of audit takes place during the road works. It examines the traffic management plans for each phase of construction of the road project (i.e., before the work begins), and it inspects for road safety at the road work site during the construction period. Typical considerations include the provision of an

advance warning zone, adequate lengths for transition zones, effective numbers of reflective signs, safe delineation devices, credible speed limits, temporary crash barriers, lighting, and diversions.

5. Preopening stage

39. This audit involves a detailed inspection of the new road project immediately prior to its opening. Although most road projects are constructed "under traffic," there is a time near practical completion, just before the contractor hands over the project, when a preopening stage audit is undertaken. The audit team should drive, ride, and/or walk over (as appropriate) the new road to ensure the safety needs of all road users are provided for. A nighttime inspection is particularly important at this stage to check signage, delineation, lighting, and any other nighttime- and/or low light-related issues.

6. Existing road (road safety inspections)

40. Some road authorities undertake road safety audits (often called road safety inspections) of existing roads and highways as a way of identifying high-risk locations for remedial action. Road safety inspections have value in countries where crash data is lacking or inaccurate, as they are one way to point authorities to high-risk locations.

41. Some road authorities in some countries tried to "catch up" with safety problems on the existing road network by auditing their main roads and highways as a matter of priority. This shows a commitment to road safety audit, but also shows that many road authorities perceive that the audit of an existing road is the "easiest" stage of audit. Unfortunately, a focus on existing road audits can undermine the awareness of road safety audits among some professionals. Some audits of existing roads find so many safety concerns that the cost to eliminate them is extremely high. It can leave a legacy of many audit reports recommending safety improvements that cannot be treated because of limited funding. There can also be a mistaken perception that road safety audits and accident remedial work are identical. Such misunderstanding can destroy the credibility of the entire road safety audit process. If there is too much misunderstanding of audits, it may lead an organization to disregard the process altogether.

42. International experience has shown that design stage audits provide safer roads for lower cost. Audits of designs have proven benefits and generally lower remedial costs. It is critical to the successful implementation of the road safety audit process in the CAREC program that all road authorities recognize road safety audit is vastly more effective when carried out early in the road design process.

C. Road safety audit is more than a compliance check with standards

43. Designers are expected to be familiar with the relevant standards, attempt to comply with them, and be aware if any standard cannot be achieved. Standards are important and their consistent use is essential for safety across a road network.

44. Complying with appropriate standards is likely to overcome a high proportion of otherwise potential safety concerns. However, the job of a road safety auditor is not to check that the designers have complied with the design standards for the new road. Checking a designer's compliance with standards is duplication of the work of the design team, and it is not the best use of an auditor's time and expertise.

45. While it is important to comply with standards, simply complying with the relevant design standards, to the exclusion of truly looking at the design job at hand, will not necessarily create a safe road network. There are many reasons for this, including the following:

- Standards are often a minimum requirement. Combining a series of minimum standards may leave no room for error, either on the part of the designer, the contractor, or the eventual road users.
- Design standards do not always adequately account for the human factor in traffic engineering.
- Standards often take many years to be revised and updated. Not all design teams have the most recent standards in their office, and therefore some designers may be using standards that are many years out of date.

- Design standards typically address the needs of the motor vehicle. Rarely do such standards consider bicyclists, pedestrians, or other vulnerable road users to the extent needed.
- Standards are developed for a range of reasons, and are sometimes heavily influenced (for example) by cost or traffic capacity factors. Safety may not be the prime consideration.
- Standards are usually developed to cover general or common situations. In practice, many road and traffic situations are simply neither general nor common.
- The standard may not be applicable to the circumstances in the design. Indeed, there may not be a standard for the situation at hand.
- Conversely, and despite all of these possible issues, that a road design does not comply with a particular standard may not necessarily result in an unsafe road.
- There is no finite cutoff between safe and unsafe; rather, degrees of safety can be achieved.

46. An audit should never be seen as a check that standards have been met. Instead, every road safety audit should be approached as an assessment of how future road users will use the new road and whether or not these road users may face safety issues when using the new road, whether driving, walking, or riding. In other words, the audit team's job is then to put itself into the shoes of future road users and assess how safety on the new road will work for them.

47. Experience shows that total reliance on standards is no guarantee of a safe road. There are many road and traffic situations for which no standards apply, and there are some situations that need more than a standard or traditional treatment. Situations such as these call for judgment by all parties, and this is one reason the process of road safety audit is both interesting and challenging, requiring the varied skills of a diverse team of experts to apply it successfully.

48. A good road safety audit is accomplished when the auditors

- focus on road safety issues only;
- keep in mind the needs of all road users, in all weather and time of day conditions;
- are thorough and comprehensive in their critical safety thinking;
- are realistic and practical in all their findings;
- do not rule out options because of cost. It is the project manager and client who will decide whether the investment is viable;
- produce the audit report promptly, usually within 2 weeks of the audit inspection;
- keep relevant standards and guidelines in mind while remembering that compliance with standards does not always guarantee the road will be safe; and
- remember that an audit is more than a compliance check with standards.

D. The benefits and costs of road safety audits

49. Road authorities will be reluctant to spend money on a road safety process that will cost more than it can return in benefits. Therefore, as with any other road safety initiative, it is important to be able to show that the benefits of the road safety audit process outweigh its costs.

50. The established benefits of conducting road safety audits include

- reduced "whole of life" costs of a road project,
- a reduced risk of using the road network,
- a reduced severity of any remaining crashes,
- a reduced overall cost of road trauma to the community,
- safer road networks developed (an important contributor to meeting crash-reduction targets),
- the development of increased understanding and documentation of road safety engineering,
- an enhanced level of the importance of road safety engineering,
- ongoing improvements to safety standards and procedures, and
- more explicit consideration given to the safety needs of vulnerable road users.

51. The costs of road safety audits include:

- the cost of doing the audit (this is mainly the cost of the audit team and is usually quite a low figure),
- design costs associated with any redesign work, and

- agreed inclusions in the road project recommended by the audit.

52. Five internationally recognized studies have demonstrated clearly and quantifiably the positive benefits of road safety audits (see Box 1).

Some CAREC highways are frequently used by large agricultural machinery. A road safety audit of proposals for these highways needs to consider all road users, including agricultural machinery.

Box 1: Five Studies of the Benefits and Costs of Road Safety Audits

- A study by Surrey County Council in the United Kingdom compared before and after crash statistics for a sample of audited schemes and nonaudited schemes. It found that audited schemes achieved an average saving per year of 1.25 casualty crashes compared with a saving of just 0.25 casualty crashes for nonaudited schemes. In other words, the audited projects were five times more effective at reducing crashes than the unaudited ones.
- A study in the United Kingdom compared the costs of implementing road safety audit recommendations at the design stage with the costs of making changes after each project was constructed. It found that the average saving from implementing changes at the design stage, rather than after the project was constructed, was approximately $22,000 per site.
- An evaluation study conducted in Denmark involved a cost benefit analysis of 13 projects that were subject to road safety audits. The benefits of audit were taken to be the savings in crashes that resulted from the implementation of audit recommendations. The savings in crashes were determined by using a general crash prediction method to estimate the crashes that would have resulted if the recommendations had not been implemented. The analysis gave a first-year rate of return of 146%.
- A study undertaken in Jordan considered a number of projects that were not subject to audit, but developed problems soon after construction. The study assumed that required remedial works following the completion of the projects would have been incorporated into the initial design if audits were undertaken, and estimated the number of crashes that would have been saved with audits. The study concluded that road safety audit would have provided a first-year rate of return of 120%.
- An Australian study showed the average benefit/cost ratio of audits of road projects at the design stage to be 36:1. The same study showed the average benefit/cost ratio for audits of existing roads to be 6:1.

Source: AUSTROADS AP-R209. 2002. *Evaluation of the Proposed Actions Emanating from Road Safety Audits.* Sydney, Australia.

III. Carrying out a Road Safety Audit

53. Road safety audits are undertaken to identify safety concerns in a road design, so those who are responsible for designing and building the road project can take appropriate measures at the earliest possible time to eliminate the identified safety concerns and so enhance safety on the road.

54. The road safety audit (RSA) process is made up of nine key steps illustrated in Table 1.

An experienced road safety audit team will always consider the safety needs of vulnerable road users.

Table 1: Key Steps in the Road Safety Audit Process

Road Safety Audit Step	Responsibility
1. Determine if an audit is needed.	Project manager
2. Select an audit team leader, who then engages the audit team.	Project manager and road safety audit team leader
3. Draft the pre-audit communication to provide information (drawings and design reports) about the project to the team leader, outlining the project and discuss the audit ahead.	Designer (via project manager) and road safety audit team leader
4. Assess the drawings for safety issues (the "desktop" audit).	Audit team
5. Inspect the site both during daytime and nighttime.	Audit team
6. Write the audit report and send to the project manager.	Team leader with assistance from audit team
7. Discuss the key safety issues and clarify outstanding matters during post-audit communication.	Project manager (plus designer) and road safety audit team leader
8. Write a response report, referring to each audit recommendation.	Project manager
9. Follow up and implement agreed changes.	Project manager (and designer)

Source: AUSTROADS. 2009. *Guide to Road Safety Part 6: Road Safety Audit*. Sydney, Australia.

A. Step 1: Deciding an audit is necessary

55. The road agency will decide, as part of its internal regulations, policies or staff instructions which road projects are to be audited. The decision may be based on the agency's road safety audit policy. A draft audit policy is included in chapter IV for reference.

56. If the road agency has yet to develop a road safety audit policy, consider the need for an audit based on the size of the project and the road hierarchy. For example, most road agencies require works on expressways, national highways, and primary arterials to always be audited, and at three or four stages. Projects on lesser roads may be audited at fewer stages.

57. As a general rule, the most appropriate number of audit stages for a particular road project usually depends on the size of the project and the class of the road. A large new road project on a major highway should be audited at each of the five recognized audit stages (chapter II-B). However, in comparison, projects on less busy and lower-speed roads may be audited at fewer stages (anywhere from a single stage of audit upward).

B. Step 2: Selecting the audit team

58. The project manager appoints the audit team leader (a senior road safety auditor), and specifies the number of members in the team. The senior road safety auditor should be an experienced professional on the national register of accredited auditors, where such a register exists (see chapter IV-E for a full description). The first task of the team leader is to engage a small audit team. Members should be qualified road safety auditors in the same national register.

59. When engaging the audit team members, the team leader should ask questions such as

- Is this auditor independent of the project?
- Has this auditor attended an approved audit workshop?
- Has this auditor the necessary skills for this size and stage of project?
- Is this auditor able to see potential safety concerns from different road users' points of view?

60. Successful road safety auditors will likely have experience in road safety engineering, and some may also have a background in the following:

- traffic engineering,
- road design and construction techniques, or
- road user behavior.

61. It is important to select auditors with relevant experience. Is the project an expressway or a local street? Is it an urban or a rural project? What stage of audit is involved? The most critical elements in any road safety audit are the judgment, technical knowledge, and skills of the audit team. There is no substitute for an experienced road safety audit team that understands the audit process, and is able to foresee potential safety concerns.

62. It is not surprising that most auditors are professional engineers. Invariably, one or more engineers will be needed in the team for design stage audits because of the need to examine drawings and the need to be able to think in three dimensions. But it is not usually a requirement of an accreditation scheme for auditors to be qualified engineers. Some auditors may have qualifications or experiences in fields as diverse as education, traffic enforcement, construction, maintenance, or traffic management. Their experience in road safety and their judgment in safety issues are more critical than their formal qualifications.

63. How many people should be in an audit team? This depends on the size of the audit task. Large road projects require at least two people; teams of more than four people may become unmanageable and inefficient. So, as a general rule, a team of two or three is about the right size for most audits. For minor projects on low-volume roads in low speed locations, an audit by one person may be satisfactory if approval is first given by the project manager, or if this is detailed in the terms of reference (TOR) for the audit.

64. The senior auditor should assemble an audit team that comprises members with varying specialist areas and varying lengths of experience. The road safety audit process itself is quite straightforward, but the skills necessary to undertake a worthwhile audit are quite substantial. The audit team needs to be able to interpret technical drawings, looking for any possible negative (unsafe) features included and, at the same time, any positive (safe) features left out.

65. Younger auditors may have different, but valid, views of a road design issue compared with older team members. Auditors with strong road design experience will usually look at different aspects of a design than those with a traffic engineering background.

66. There are some key things to remember when engaging an audit team:

- Start by appointing an accredited senior road safety auditor to be the team leader of the audit team. The team leader shall then appoint the remainder of the team.
- Team members may come from different organizations, and from differing professions. Each should be independent of the proposal, and each should be registered in the national auditor register (where one exists). An example of an accreditation scheme is set out in chapter IV-E of this manual for consideration in each country.
- It is better to use a road safety audit team, rather than a single auditor. A road safety audit is best performed by a team of two or three people who are sufficiently experienced in the areas of road safety engineering, crash investigation and prevention, traffic engineering, and road design.
- There are many benefits of engaging an audit team to undertake the audit rather than using a single auditor. The main benefits include:
  - » Different perspectives of the same issue can be gained. This comes from the diversity of backgrounds and from different experiences within the team.
  - » Cross-fertilization of ideas. When two or three professionals discuss safety issues in the office during the "desktop" audit or when on site, they help each other to develop clarity in their ideas and a wider view of the potential safety concerns in the project.
  - » Advantages of having more knowledge readily available on-site. If the audit team has members with quite different backgrounds, they can assist each other on technical issues. Two heads are better than one.
  - » Gender and age differences may also cause auditors to see safety issues differently. While it is not always possible to have a mix of ages and both sexes, it is desirable to engage audit teams that are of as wide a mix as possible.
  - » Some smaller projects on lightly trafficked and lower-speed roads may be audited by a single experienced auditor. However, road agencies are advised not to take shortcuts with safety, and to limit one-person audits to those road environments where risk will likely be low.
- The most significant aspect of good auditors is their ability to put themselves in the shoes of future road users. By empathizing the safety needs of all road users—motorized and nonmotorized, large and small—the auditor will be best positioned to interpret the drawings and to draw out the key safety concerns for the future.

67. The audit team also needs to be able to communicate clearly the safety concerns it finds in a report to the project manager. If the project manager cannot understand the safety concerns detected in the audit, there is a risk that decisions may be taken that could lead to either a waste of public funds or to unsafe outcomes for road users. Different views and expectations lead to a more complete and useful audit report.

68. To improve the likelihood of engaging a good audit team, road authorities should make clear (either in their internal instructions or in their TOR for the audit) that a road safety audit is to be performed by a team (minimum of two people) who are experienced and experts in the process.

69. Audits can provide an opportunity for less-experienced staff to be observers on a team and to learn about the process and the skills involved. This may be helpful in the early days of implementing the audit process, and while road agencies are endeavoring to build up their understanding and experience of the audit process.

C. Step 3: Pre-audit communication

70. The project manager (or the design team) provides a copy of all the required drawings and project reports to the audit team leader to enable a thorough road safety audit to take place.

71. For some small projects, there may be only one or two A3-sized drawings. For other large road projects (on national highways and expressways), there may be hundreds of drawings and a number of detailed reports for the audit team to examine. It takes time and resources to gather all the current drawings and documents, and the project manager and design team need to provide accordingly for this when commissioning an audit.

72. The audit team leader will usually be sent the drawings attached to an e-mail and will be requested to offer a time frame and a cost for undertaking the audit. This is the common way that audits are initiated in those countries that have had many years of audit experience. Communication between the project team and the audit team is important to set the audit off on the right foot. This communication can take place via e-mail or a telephone linkup. In countries

where audits are still quite new, a commencement meeting is a useful option that enables the audit team leader to meet face-to-face with the project manager and/or the designer to discuss the audit.

73. Whatever form of pre-audit communication is used, the designer should explain if and/or where compromises may have been made in the design so the audit team leader can best understand the reasoning behind certain decisions that may have been made. The audit team should use this opportunity to request any additional information it requires. The audit team is also able to discuss times and duration for the audit.

74. As audits become more common in CAREC countries, more and more of this pre-audit communication will be via telephone calls and e-mail. Commencement meetings will become increasingly less essential, as they have in countries that now have extensive experience with the audit process.

D. Step 4: Checking the drawings and documents

75. The initial examination of the design drawings and documents is known as a desktop audit. This desktop audit involves the entire audit team reviewing the drawings and documents in the office, with the drawings often spread out across the desktop. The checklists (chapter VI) for the stage of audit can be used as necessary during the desktop audit.

76. This step may take from a few minutes up to a few days. It is an important step that allows the team to become familiar with the project, as well as to identify some safety concerns that may be obvious from the drawings.

77. An audit team leader should ensure the team takes time to closely examine all the drawings. The team makes annotations on the drawings as necessary, and marks issues to be closely examined during the inspection. The team leader makes a list of possible safety concerns to be checked on site, assisting the team to undertake the inspection in a focused, orderly, and timely fashion.

78. After the initial inspection, the desktop auditing is then repeated as required until the audit team is completely satisfied it has identified all safety concerns.

E. Step 5: Inspecting the site

79. The location of the new road proposal is to be inspected by the entire audit team during both daytime and nighttime.

80. This inspection involves taking the drawings out to the site and inspecting the entire site, trying to imagine what the finished road project will look like and how it will function. The team takes note of the topography, the traffic volumes and type, the nearby development, the operating speeds, and a host of other site-specific details. At this time, the audit team is required to put itself in the shoes of future road users of the new road project, including vulnerable road users. In so doing, the team tries to empathize with the variety of road users that will use the road when the work is completed.

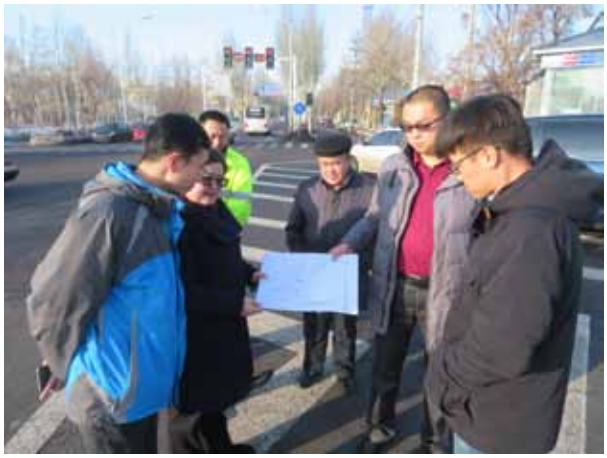
81. And always remember the inspection should be undertaken from the point of view of all potential road user groups, nonmotorized as well as motorized. The inspection should carefully consider the needs of pedestrians, bicyclists, and animal-drawn vehicles as well as the needs of those in cars, in trucks, in buses, or on motorcycles. Throughout the CAREC countries, there is a wide variety of road users, each with quite different safety needs that the audit team must consider and respond to.

82. During the time the audit team is on-site, it is always advisable to take lots of photographs. These assist the team to refer back to specific site details while writing its audit report.

83. Beyond the images, recording thoughts and ideas on-site can be a challenge. Pen and paper will work, but is often hard to manage in hot, dusty, windy, wet, or frozen conditions. Experienced auditors often record their observations verbally directly into a digital recorder or a smart phone. These allow more detailed observations to be recorded, and in a shorter time. They are easier to use on-site, and they give a digital record that can be stored in a computer or replayed later. Such devices also allow data to be georeferenced, or tagged for their geographic location.

F. Step 6: Writing the road safety audit report

84. Audit reports are succinct reports with brief, but technically clear descriptions of each of the safety



Inspect the site (day and night) to see what the current road and traffic conditions are like. Try to imagine how the proposal will operate, looking at all times for potential safety concerns.

concerns identified by the audit team expressed in clear language.

85. Writing the report is the responsibility of the audit team leader. The team leader may delegate sections to be written by team members, but most reports are prepared by one auditor. The draft report may then be passed around among team members so each person has the opportunity to provide inputs to the report, and make comments and corrections where necessary. But time must be managed, and the report should be promptly finalized and sent to the project manager. A 2–3-week period is usually the maximum allowed in most audit contracts for writing and finalizing an audit report.

86. To promote national acceptance and understanding of the audit process, it is best if audit reports follow an agreed format or template. Having a nationally accepted template can assist the team leader to write the report with clarity and consistency. Importantly, a nationally accepted template can allow a column in which project managers can respond to the audit findings and recommendations. (A standard template is used in the audit reports for the case studies given in chapter V of this manual).

87. Your audit report should be brief, accurate, and technically complete. It should contain:

- a title page with the name of the road project and its location;
- a brief description of the road project: what type of project, why it has been proposed, and the stage of the audit;
- names of the road safety audit team members;
- dates of the audit inspections and the weather conditions on-site at those times;
- a table of all the safety concerns found from the desktop audit as well as from the site inspection(s);
- a practical and clear recommendation for corrective action for each safety concern;
- digital photographs of important safety concerns;
- a statement signed and dated by the team leader on behalf of the team, indicating that the team has audited the drawings, inspected the site, and identified the road safety concerns noted in the report; and
- a list of all drawings, reports, and documents reviewed as part of the audit, including drawing numbers and dates. This may be useful for reference later as large road projects often have several generations of drawings. It may prove necessary, at a later time, to be quite specific about the actual drawing audited.

88. When an audit report contains a number of safety concerns, and the project manager needs assistance to prioritize those that should be acted on first, a risk assessment can help in this task. Risk is often defined as the likelihood of a potential issue multiplied by the severity of the consequence from the worst-case scenario outcome from that same potential issue.

89. Tables 2–5 outline a risk assessment option that is useful to assist an audit team to assign a level of risk to a safety issue found in an audit.

Table 2: Make an Estimate of 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 5 to 10 years
Improbable	Less often than once every 10 years

Source: AUSTROADS. 2009. *Guide to Road Safety Part 6: Road Safety Audit*. Sydney, Australia.

Table 3: Make an Estimate of Crash Severity

Severity	Description	Examples
Catastrophic	Multiple deaths are likely.	High-speed, multivehicle crashes on expressways A bus collision at high speed with a bridge abutment
Serious	A death and/or serious injuries are likely.	High- and/or medium-speed vehicle/vehicle collisions High- and/or medium-speed collisions with a fixed roadside object Pedestrian crashes on rural highways
Minor	Minor injuries only are likely.	Low-speed collisions, such as a rear end crash in a slip lane, or a pedestrian struck in a car park
Limited	Trivial injuries or property damage only are likely.	Very low-speed vehicle collisions A pedestrian trips on an uneven footpath A car collides with a median island in a car park

Source: AUSTROADS. 2009. *Guide to Road Safety Part 6: Road Safety Audit.* Sydney, Australia.

Table 4: Determine the Severity of a Safety Issue

Risk		Frequency of Possible Crash			
		Frequent	Probable	Occasional	Improbable
Severity of Possible Crash	Catastrophic	Intolerable	Intolerable	Intolerable	High
	Serious	Intolerable	Intolerable	High	Medium
	Minor	Intolerable	High	Medium	Low
	Limited	High	Medium	Low	Low

Source: AUSTROADS. 2009. *Guide to Road Safety Part 6: Road Safety Audit.* Sydney, Australia.

Table 5: Determine a Course of Action

Risk	Suggested Treatment Approach
Intolerable	The safety issue is to be corrected at any cost.
High	The safety issue is to be corrected (or the risk significantly reduced), even if the cost is high.
Medium	The safety issue is to be corrected (or the risk significantly reduced) if the treatment cost is moderate, but not high.
Low	The safety issue is to be corrected (or the risk reduced) if the treatment cost is low.

Source: AUSTROADS. 2009. *Guide to Road Safety Part 6: Road Safety Audit.* Sydney, Australia.

90. It is a qualitative assessment process, and it requires professional judgment at each step. However, if applied consistently throughout an audit, the assessment can help to direct the project manager to assign resources to the highest risk issues.

91. When writing the audit report, auditors should be guided by the following:

- List all the identified safety concerns (and the recommendations for each), either
  - » in order from highest risk to lowest risk;
  - » in groups of similar concerns (e.g., cross-sections, pedestrians); or
  - » by chainage along the project length.
- Clearly describe each safety concern and its location.

- Add photographs, if these can clarify a specific safety concern.
- Avoid being too specific with recommendations, unless absolutely certain the recommendation is the only one.
- In framing a recommendation, think about high and/or low cost and short-and/or long-term options.
- Be realistic in the recommendations, taking into account the level of risk associated with the safety concern and the cost likely to rectify it.
- Be constructive, clear, and practical about how the safety concern might be eliminated or lessened.
- Maintain technical credibility: an audit report can often demonstrate the technical skills and experience of the audit team, and especially of the team leader.
- Avoid redesigning any part of the project, as this is for the design team to do.

92. Remember that the audit team's written road safety audit report is intended to guide the decision-making process. However, it is the responsibility of the project manager and designers to make the final decisions about what advice to accept, and what and how best to proceed to implement changes in the design and the road project as a whole. Table 6 contrasts examples of recommendations with too much emphasis on redesign versus a more constructive set of recommendations that guides the designers.

Table 6: Some Examples of Audit Report Recommendations

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

Source: Asian Development Bank.

G. Step 7: Post-audit communication

93. The audit team leader will usually send the completed road safety audit report to the project manager, typically via e-mail. Questions about the report may then be raised by the project manager via e-mail or telephone. In some countries, while audits are still quite new, a completion meeting can be a useful option that enables the audit team leader to meet face-to-face with the project manager and/or the designer to discuss the audit findings.

94. If a completion meeting is needed, it is arranged by the project manager and involves

- the audit team leader,
- the project manager, and
- the designer/design team.

95. A completion meeting offers an opportunity for the audit team leader to outline the road safety audit findings and recommendations. This will usually involve a discussion of each safety concern, its risk rating, and its recommendations for improving the safety issue.

96. As audits become more common in CAREC countries, more of this post-audit communication will be via telephone calls and e-mail. Completion meetings will become less common, as they have in countries that now have extensive experience with the audit process.

97. This step in the audit process warrants a word of warning for the audit team leader. A project manager may request that an audit report be altered to have one or more safety concerns and/or recommendations removed from the audit report. On some occasions, there may be a request to alter or downgrade the findings. This is neither professional nor ethical. In such cases, the audit team leader must not entertain any suggestion of altering or downgrading a report to soften the audit findings. Such action would dilute the importance and the validity of the entire road safety audit process. Thankfully, such situations are rare. Project managers now recognize that audits offer positive help to a project. They know that, while the audit team assists with safety inputs, it is still the project manager who makes the final decisions about what changes and what does not.

A completion meeting may be useful to allow full discussion of the audit report with all parties concerned.

H. Step 8: Responding to the audit report

98. The project manager is required to respond in writing to each safety concern and each recommendation in the audit report. The project manager can respond in one of three ways:

- accept the safety concern and its recommendation completely, and develop solutions to overcome or reduce the safety concern;
- accept the safety concern but do not agree to the recommendation; in these cases, the project manager will seek alternative ways to resolve the safety concern; or
- not accept the safety concern or the recommendation, explaining clearly why.

99. Although the audit team injects road safety engineering expertise into a project, and assists the project manager and designers via their audit findings and recommendations, it remains the responsibility of the project manager alone to make the decisions about the way that will likely lead to success. The project manager remains responsible for deciding all solutions and for commissioning any redesigns.

I. Step 9: The way to success

100. Road safety audit raises the issue of safety associated with the project to the same (or higher) level as the other competing issues explicitly addressed within the current planning and design process. When the project manager receives the audit report, it is treated as another input that must be considered when optimizing the design.

101. It is neither always possible nor practical for the project manager to agree with all the audit recommendations as some of these may involve large additional expenses and/or may affect progress with the project. In practice, this challenge for decision makers usually only arises with expensive recommendations, with complex recommendations, and/or with recommendations that may have sensitive environmental or resettlement impacts; it happens less often with simple and/or low-cost recommendations.

102. As a guiding principle, when faced with an audit recommendation difficult to resolve, the project manager needs to consider:

- How often might crashes occur (daily, weekly, or yearly)?
- How serious might such crashes be (fatal, resulting in injury or property damage only)?
- What will it cost to remedy or at least reduce the problem? With most safety concerns, there are usually several alternative safety improvements.
- How effective can each alternative be expected to be?

103. The clearest way to address these considerations is to look to the risk rating given in the audit report (Step 6). This should guide the project manager with the first two points. The design team should be able to provide advice on the third point, and road safety engineering advice may be required for the fourth point.

104. A road safety audit achieves nothing for road users until its recommendations are discussed, decided, and implemented by the project manager.

105. In many audits, particularly while the project is still in the design stage, the changes can be made at low cost and with minimum administrative burden. At times, however, an audit may reveal safety concerns that cause difficult decisions to be made by the project manager. These are usually because the cost of remedial action will be high.

106. In these cases, the usual options available to the project manager include:

- Stage the improvement work over an increased period of time, possibly into the next financial year when more funding may be available.
- Seek an increase in the project budget to allow the desired countermeasures.
- Reduce the scope project by x% (maybe shorten the length of the new road or delete some other nonessential items) and place the savings into safety improvements.
- Do nothing. Make no change to the design and move on with the project. This means risking the consequences of future crashes at the site.

107. These are all valid decisions, provided they are committed to in writing, and with clear reasons given, in the response report. As long as all competing issues are clearly and fully considered for each identified safety concern, the audit team can be assured their careful work and reporting have been of value to the safety of the project.

Road safety audits add safety to road projects on all classes of roads, and for all road users.

IV. Managing a Road Safety Audit

108. Road safety audit is a process road authorities should embrace as part of an overall strategic approach to road safety. However, for those road authorities with little or no experience with road safety audits, there may be some uncertainty about how best to go about implementing the process of road safety audit in the planning, design, and construction of their road projects. This chapter provides guidance on these matters. It offers a draft terms of reference (TOR) and a draft audit policy for assistance in managing an audit.

A. Managing a road safety audit

109. The following points provide guidance to road authorities on the best way to successfully adopting the road safety audit process:

- Provide an opportunity for senior managers to hear about the audit process and to gain an appreciation of how it can help to produce safer roads. Seek a formal commitment from the management group to improving road safety. High-level support and empowerment are critical to creating a safety culture within the institution.
- Guided by the CAREC Road Safety Strategy, work toward the inclusion of road safety in the corporate plan.
- Develop a Road Safety Plan for the institution. Base it on the CAREC Road Safety Strategy (or the national road safety strategy, if there is one). Include road safety audit as a proactive process to minimize the risk of constructing new safety problems.
- Suggest that the management group nominate someone to champion the cause of road safety in the institution. Their nominee should be someone who has the knowledge and skills to actively champion the introduction of road safety audit in the organization.
- Seek management agreement to holding a meeting of technical staff in which important road safety audit issues can be discussed. In so doing, use their inputs to develop an audit policy and a set of basic audit practices, which best meet the organization's needs.

110. Points that may arise in the meeting include:

- How will the organization get adequate road safety audit skills and resources?
- What needs to be done for the audit process to be understood by senior executives, managers, designers, and potential auditors?
- Designers may initially take offense at having their work audited. How can this be addressed?
- How much training is required and for whom (managers, designers, potential auditors)?
- Which road projects can and should be audited? Only the largest projects, or only those on the busiest roads, or maybe urban only, or perhaps all projects above a certain cost? The national road safety strategy may be a good guide.
- How will road safety audit be incorporated into design and design and/or construct contracts?
- What proportion and/or number of projects will be audited? At what design stages will audits be conducted?
- Who will be conducting audits? Will these be outsourced? If so, how will auditors be found and decided on best value for money, skills, or experience? Who manages the national register of auditors? Who can give advice on these issues?
- How will audit recommendations be dealt with? Who will decide to accept or reject the more difficult recommendations? A formal process is required.
- How will audit findings be fed back into the design process to improve future designs?

(i) Get started.

111. One way to start this process and be in experienced hands is to call in a team of experienced road safety auditors to undertake some pilot projects of the road designs. Use their findings in a training workshop that includes managers, designers, and potential future auditors as participants. Designers and project managers quickly become keen audit supporters when they see for themselves some of the safety issues that arise in some road designs.

(ii) Stay the course.

112. Adhere to the agreed road safety audit policy to improve designs before they are built. Get feedback from the auditors, designers, and managers, and then modify the audit policy and the audit process to best suit the authority as experience grows.

(iii) Be ready.

113. Be aware that, in the early days of the implementation of the road safety audit process, some safety concerns may be missed, and some mistakes in managing the process may occur. It is important to take time to learn from these mistakes so the road safety audit process can develop and grow successfully within the organization.

(iv) Keep everyone informed.

114. Inform senior managers, as well as colleagues, about how the audit process is progressing in the organization. Give examples of where road users have benefited because of the road safety improvements generated through the audit process, and let them know how staff members are learning new skills as a result of the process.

(v) Keep it going.

115. Once the road safety audit process becomes established in the organization, there can be a tendency to believe high-quality road safety audits will continue to happen automatically. This tendency must be resisted. Remember to monitor the quality and the quantity of audit reports. Maintain a training and awareness program for staff, as well as consultants, traffic police, and others. Ensure the person allocated as the champion of road safety audit in the organization is empowered to promote the process.

B. Commissioning a road safety audit

116. The client for a road project, will usually appoint a project manager to oversee the project on behalf of the authority. The project manager will be required to comply with the policies of the authority, including the road safety audit policy.

117. The project manager will read the policy carefully, decide if the road project requires an audit, and, if so, how many and at what stages in the project development and design. A suggested road safety audit policy for use in road projects in the CAREC program is given in section C.

118. The project manager will then engage a senior road safety auditor who will be the leader of the road safety audit team. There are three attributes that the project manager must ensure when engaging the senior auditor:

- qualified: satisfy the requirements for registration in the national register of auditors, or have an internationally accredited qualification;
- experienced: demonstrated experience with the type of road project and the stage of audit; and
- independent: has no previous involvement in the planning or design of the road project.

119. The senior auditor then seeks colleagues to join and become the road safety audit team. Each team member must also be qualified, experienced, and independent. Without a qualified and experienced audit team, the audit report may fail to add value to the project.

120. If the team is not fully independent, they may be “too close” to the project. If so, and because they may know of the various design constraints and issues that led to the development of the design, they may not see the safety issues as other truly independent auditors would. In short, they may be too forgiving of some of the safety issues involved.

121. Keeping the above key attributes in mind, there are usually three main options available to the project manager for commissioning an audit.

(i) Engage an independent organization.

122. The project manager may engage an experienced organization to do the audit. This option ensures the audit is independent, and over time may lead to a competitive market in providing audit services to road authorities. This has become the preferred option in many countries.

(ii) Instruct the designer.

123. If this option is selected, the project manager must instruct the design consultant or design institute

to use only auditors who have not been involved in the design work. Nevertheless, it may be difficult for auditors to be completely objective because they work for the same organization that employs the designers. To some people, this may raise conflict of interest issues, even if the highest levels of professionalism are maintained.

(iii) Use your own staff.

124. This option has the advantage that it may not require a separate budget for the audit, and it can be quick and easy to arrange. Ensure the staff members used are experienced, accredited in road safety audit, and are independent of the original design. By adding to their practical audit experience, the staff members can develop their awareness of the audit process and they may, therefore, be more discerning when obtaining audits in the future. If the staff members have been trained in the audit process but lack experience, engage an auditor from outside the department or authority to join or even lead the team. This option offers a good method of raising awareness and skills in the audit process within the project team.

C. A suggested road safety audit policy

125. There is a need for all staff in a road authority to be clear about what road projects are to be audited, and at what stages these audits should be done. It is equally important to ensure that road safety audit becomes firmly established in a road authority. Both of these needs are best satisfied by establishing a road safety audit policy for the authority. Such a policy should detail:

- the type of road project to be audited; and
- the stage(s) of audit to be undertaken, and the reporting and responding systems.

126. The road authority will need to consider the resources available and the demands for the coming years in preparing its audit policy. Once agreed, the policy should be disseminated widely to all relevant parties within the road authority so staff members are aware of its importance and to confirm they use it to guide them in their audit work. The audit policy should be disseminated as well to any other professionals who have dealings with the authority on road- and safety-related matters.

127. An example of a draft road safety audit policy for a national road authority is given in table 7.

All [insert name of road authority] road projects will be road safety audited at the following stages according to the class of the road, in accordance with the procedures contained in the current edition of the [CAREC Road Safety Audit Manual] and/or [any comparable manuals that exist in your country].

Table 7: An Example of Road Safety Audit Policy for a National Road Authority

Audit	Expressways and International Highways	National Highways	Major Roads (Urban/Rural)	Local Streets and Village Roads
Feasibility	✓	Optional	Optional	Not applicable
Preliminary design	✓	Optional	Optional	Not applicable
Detailed design	✓	✓	✓	✓
Road works	✓	Optional	Optional	Optional
Preopening	✓	✓	✓	✓
Road safety inspections (existing roads)	According to local policy and resources			
Number of audits	5	Minimum 2	Minimum 2	Minimum 2

Source: Asian Development Bank.

During a road safety audit, remember that what may look obvious in summer may look quite different in the winter snow.

128. Always remember this policy is a "living" or a "fluid" document, meaning that at no time is this document to be considered finished or "set in stone." Rather, it should be reviewed and updated as experiences with the road safety audit process grow within the road authority.

D. Draft terms of reference for commissioning a road safety audit

129. Box 2 provides a draft TOR for use when engaging consultants or others to carry out a road safety audit.

130. The draft TOR is included here to assist client representatives to be quite specific about what they want from the audit team. An audit only adds value to a project when it is carried out by an experienced audit team in accordance with a clear set of requirements (the TOR) from the client. This draft TOR requires selected details of the audit to be inserted where shown.

Box 2: Draft Terms of Reference for a Road Safety Audit

TERMS OF REFERENCE FOR A [*insert stage name*] **STAGE ROAD SAFETY AUDIT OF** [*insert name of the road project*]

Background

The [*insert name of road authority*] has developed a proposal to [*insert a brief description of the type and location of the proposal*] to provide improved capacity and traffic performance along this corridor as well as increased safety for all road users.

The Task

The task in this assignment is to carry out a [*insert stage name*] stage road safety audit of the proposed [*insert name of project*] so potential road safety problems can be identified, discussed, and minimized before the project is completed.

The audit shall be undertaken in accordance with {*name of national road safety legislation, strategy, action plan*} and the process detailed in the current edition of the *CAREC Road Safety Audit Manual*.

Scope of Services

The scope of services required of the audit team will include, but is not necessarily limited to, the following:

- The audit should be undertaken by an audit team of at least two auditors.
- The team leader should be a registered senior road safety auditor in at least one national register of road safety auditors.
- The team leader should attend a commencement meeting with the project manager and designer to obtain full information about the proposal and an understanding of the background to the project.
- Documents provided by the project manager prior to inspecting the site and again prior to finalizing the audit report should be reviewed.
- Daytime and nighttime inspections of the entire site will provide a better understanding of the existing traffic situation and an insight into how the finished project will look.

continued on next page

Box 2: continued

- The auditors should consult the appropriate checklist in the *CAREC Road Safety Audit Manual*, but they should not limit their audit to the concerns listed therein. They shall look at the safety needs of all future road users of this location, especially vulnerable road users.
- A concise road safety audit report should be prepared in the format outlined in the current edition of the *CAREC Road Safety Audit Manual.*
- The audit report should include a clear description of all safety issues identified. It should contain practical recommendations for each safety issue of an appropriate and specific nature.
- The team leader should sign and send the audit report electronically to the project manager.
- The team leader should attend the project manager's completion meeting to answer questions about the audit findings, the audit recommendations, and to discuss possible design changes.

The following information will be made available by the road authority to the audit team leader: [*insert the list of reports, drawings, data, photographs, or other background information.*]

Note: As experience grows with road safety audits, you may decide to hand over the drawings and reports without holding a commencement meeting. Similarly, you may decide there is no need for a completion meeting once the audit process is well-established in your organization.

Qualifications and Experience

The audit services are to be provided by a team comprising two or more road safety engineering specialists; at least one (the team leader) should be a registered senior road safety auditor in a national register of accredited road safety auditors. The audit team requires sound knowledge of road safety engineering and practical experience in highway design and traffic engineering.

Required Inputs [*Adjust these requirements to suit the scale and complexity of the project.*]

The assignment is expected to take up to .... person-days, as follows:

..... person-days for reviewing the reports and/or drawings and attending the commencement meeting
..... person-days for inspecting the site (daytime and nighttime inspections are required)
..... person-days for preparing the road safety audit report

Reporting

The senior road safety auditor should submit the completed and signed road safety audit report to the project manager in electronic format by [*write submission date for the audit report.*]

Any questions about the proposal or the audit are to be directed by the senior auditor to [*insert name of the responsible engineer*] via telephone [*insert number*] or e-mail [*insert e-mail address*].

Source: Asian Development Bank.

Vulnerable road users should be a key consideration in every road safety audit.

E. A register of road safety auditors for CAREC roads

131. Project managers need ready access to a register of accredited road safety auditors so they can quickly commission a senior auditor (team leader) to commence the work. Most of the countries where a road safety audit has been operational for many years have a national register of auditors. Most are administered by the national highway authority, and most require the applicants to demonstrate an awareness of the audit process as well as some years of practical road safety engineering experience.

132. It is a matter for each CAREC country to establish its own national register of auditors, but it is suggested these two factors should apply.

133. To be registered as a senior road safety auditor, an applicant should

- have completed an approved road safety audit training workshop,
- have a minimum of 3 years' practical experience in a road or road safety-related field, and
- have completed at least five road safety audits under the guidance of a senior road safety auditor, of which at least three of the five audits must be at a design stage.

134. To be registered as a road safety auditor, an applicant should:

- have completed an approved road safety audit training workshop, and
- have a minimum of 2 years' practical experience in a road- or road safety-related field.

135. An approved road safety audit training workshop should be at least of 2 days' duration, presented by an experienced road safety auditor, and contain a program of presentations that detail the audit process as well as some of the technical topics important in most audits. These technical topics may include safety in geometric design, vulnerable road users, signs, delineation, safety at road works, and roadside hazard management.

136. A valuable exercise desirable for each workshop is an audit case study in which the participants are given drawings for a nearby road project. They are required to examine the drawings, inspect the site, and prepare a brief audit report of their safety findings. With a case study, they learn by seeing and doing—the essence of a practical workshop.

V. Case Studies

137. Four audit case studies are part of this manual to showcase some of the safety concerns that typically arise at different stages of audit, and on different types of CAREC road projects. The focus in these case studies is on design stage, preopening stage, and road works audits. They show audits of four different road projects and four different types of road.

138. The case studies have been shortened to highlight the relative differences in the typical safety concerns that might be identified at an early stage versus a later stage of audit. In some cases, they are composite reports of a number of similar audits undertaken on similar roads and/or highways for the same stage of audit. Examples have been sourced from several CAREC member countries to show situations known and typical for the CAREC program.

139. The main audit findings are summarized and are presented in a standard tabular format. The tabular format is a widely accepted way to present safety concerns together with a risk rating and a recommendation for each concern. This format is a good model to use as a standard for presenting audit findings.

140. As with any road safety audit report, the findings are presented to assist with the injection of road safety into a road project. They are not a criticism of the professionals responsible for the design or the works. These four case studies demonstrate several key points that may assist in understanding the audit process:

- Having an audit team of two or three accredited auditors is highly desirable. More pairs of eyes on site mean more chances to uncover a safety concern.
- Auditors need to be experienced in all aspects of road safety engineering: from safety barriers to signs, from vulnerable road users to geometric design. An auditor needs to appreciate and understand the drawings, and be able to assess the safety impacts the new road may have on all road users.
- Design stage audits offer opportunities to make safety improvements, while the concerns are still "mouse clicks on a computer screen." At this stage, changes are easier and usually of lower cost than changes detected at later audit stages. The earlier, the better with audits.
- Road work audits are important for the safety of road users and road workers. Substantial improvements can be made at very low cost through audits of road work sites. Action to rectify unsafe work sites often needs to be undertaken quickly. A client should prepare for this.
- Preopening stage audits are useful, but they often report safety concerns that could have been revealed if an earlier audit had been undertaken. Changes after a project is finished usually require extra work and additional expenditure to rectify. Sometimes this may lead to disputes between the contractor and the client about responsibility for the cost of rectification and/or improvement. This is one more reason for keeping very good records of road safety audit findings and agreements.

A. Case study 1: A Detailed Design Stage Audit of the Proposed Duplication of a National Highway

(i) Title

141. The complete technical title of the audit, including its location and aims.

(ii) Audit team

142. The name and the role of the team leader and each audit team member.

(iii) Project background

143. The project includes the design, construction, widening, and upgrading of a national highway. It involves upgrading and duplicating an existing national highway along the same alignment from the capital city to the western border crossing. The road commences in the capital (Km 4+560) and ends at the border post at Km 61+552. It is 57 kilometers (km) in length, of which some 43.5 km will be four-lane divided highway. From the roundabout at West Gate to Km 48, the highway is being upgraded to a class I, four-lane

divided road. For the final 13.5 km, the road will be built to a class II, two-lane highway according to the Trans Asian Highway design standard. The road is a major international route for road traffic and the transport of goods. The highway is generally quite flat with generous horizontal alignment. It passes through 1 large town and 12 villages.

(iv) Audit details

144. The road safety audit included four daytime and two nighttime site inspections: on Wednesday, 5 December; Friday, 7 December; Monday, 10 December (day and night); and Monday, 17 December (day and night). The weather during the inspections was varied. It was fine, sunny, and mild on the first 2 days; cool and dry on the third day; and wet, cold, and with light snow on the final day.

145. The audit findings are provided in table 8.

The existing single carriageway highway near Km 21 shows typical road user groups.

Table 8: Case Study 1–Findings of a Detailed Design Stage Audit of the Proposed Duplication of a National Highway

Km	Safety Concern	Risk	Photo	Recommendations	Client Response
Safety Concerns with the Proposed Duplication of the National Highway					
From Km 5+400 to Km 6+300	This section of road passes through a village, and it will be subjected to high-speed traffic once the road is built. There will be a risk of high-speed collisions between through traffic and pedestrians in this village. It warrants speed management to maintain speeds at or below 40 km/h because of the high numbers of pedestrians in this village. The drawings do not show any "traffic calming" treatments proposed.	Very high		• Install a "gateway" on both approaches to this village. • Install flat-topped road humps at spacings of approximately 150 m through the village. Ensure humps are located close to bus stops and the police station, that they are well-signed, marked, and lit. • Provide a physical median through the village (to serve as a refuge), but DO NOT install barrier or fencing on the median.	
From Km 13+500 to Km 14+300	This village is located at the end of a long, straight, downhill section of road (from the capital) and a long, straight, flat section of road (from the southwest). Speeds will be high through this village once the highway is duplicated. The highway takes a right-hand curve in this village, and a major side road continues straight. The village warrants speed management to maintain speeds at or below 60 km/h because of the many pedestrians in this village. The drawings are silent about this.	Very high		• Install a "gateway" on the three approaches to this village. • Install flat-topped road humps at spacings of approximately 150 m through the village. Ensure humps are located close to bus stops, mosques, and schools; and that they are well signed, marked, and lit. • Provide a raised concrete median 2 m wide through the village to serve as a pedestrian refuge. • DO NOT install barrier or fencing on the median.	

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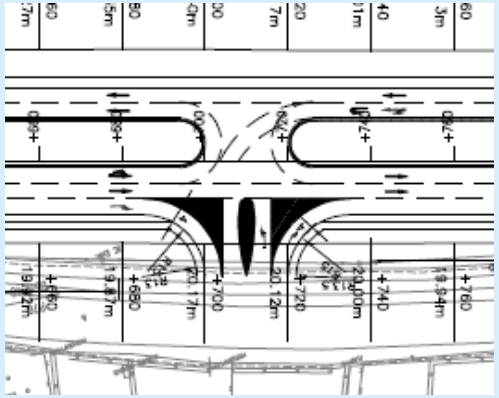
Table 8: continued

Km	Safety Concern	Risk	Photo	Recommendations	Client Response
Km 14+080	The design for the roundabout proposed for this key intersection in this village has insufficient deflection from the west and from the south to cause drivers to slow sufficiently. This lack of adequate deflection will increase crash risk at the roundabout.	Medium	 Source: China Road and Bridge Corp.	• Review this design, and attempt to improve deflection for these approaches. • If this is not possible, reconsider the use of a roundabout at this intersection. Seek alternative traffic control options instead.	
Km 15+710	At Km 15+710, a median opening and a T junction are proposed for access to the Village Access Road. The median opening will also serve as a U-turn opportunity. However, there are no sheltered left turn lanes proposed in the median for either direction. There will be a high risk of rear-end collisions at this location as vehicles slow down to turn from the "fast" lane.	Medium	 Source: China Road and Bridge Corp.	• Provide sheltered left turn lanes on both approaches to the break in the median. • Ramp down the median W-beam barrier at least 50 m in advance of the junction on each approach, so pedestrians are given good access to the median (to use it as a refuge) and sight lines are kept open for turning vehicles.	

continued on next page

Table 8: continued

Km	Safety Concern	Risk	Photo	Recommendations	Client Response
Km 23+150	There is a large mosque on the southern side of the road. During Friday prayers, hundreds of men attend this mosque, parking their vehicles on both sides of the road. The drawings show no parking, and no pedestrian facility is to be provided, although both are needed. It will be more dangerous for pedestrians walking across the new duplicated highway due to increased speeds on it. The highway needs to be kept open for through traffic.	Very high		Consider providing off-road parking close to the mosque for use by those attending the mosque. If this is not possible, seal the shoulders of the highway (2 m wide) for at least 250 m either side of the side road leading to the mosque to encourage orderly parking. Construct an all-weather footpath between the mosque and suitable breaks in the W-beam barrier on the southern side of the highway to permit pedestrian access to parked vehicles.	
Km 61+200	Drivers approach the border, but the drawings show no new advance warning signs to alert drivers to the customs post ahead. There is a need for drivers to slow down and prepare to stop, but some will have been travelling at high speed for some distance and may not be thinking of what is ahead. The drawings are silent about any action in this regard.	Low		Install signs (at 2 km, 1 km, and repeated at 500 m) in advance of the border to inform drivers of the border ahead and their need to prepare to stop.	

Km = kilometer, km/h = kilometer per hour, m = meter.

Note: The audit team carried out this detailed design stage road safety audit according to the *CAREC Road Safety Audit Manual.*

SIGNED:

{INSERT NAME HERE} Team leader on behalf of the Road Safety Audit team {DATE}

Source: Asian Development Bank.

B. Case study 2: A Detailed Design Stage Audit of the Reconstruction of a 300-km Section of a National Highway

(i) Title

146. The complete technical title of the audit, including its location and aims.

(ii) Audit team

147. The name and the role of the team leader and each audit team member

(iii) Project background

148. Currently this highway is a category III/IV road with two lanes (one in each direction). It is in poor condition and, due to the amount of heavy traffic, bridges and culverts are failing. A proposal exists to upgrade a 300-km section of the road to Category II standard on the existing alignment. The highway passes through rural areas and traffic speeds are high (observed to be up to 120 km/h during the site inspection). Most of the highway is quite straight and flat, with only a few short undulating sections.

(iv) Audit details

149. The road safety audit was undertaken by a team of two accredited auditors. It included a daytime and a nighttime site inspection on Wednesday, 15 June. The weather during the inspection was fine, sunny, and warm or hot.

150. The audit findings are provided in table 9.

An intersection on a recently rehabilitated section of A-27, 25 km north of the start of the proposed works.

Table 9: Case Study 2–Findings of a Detailed Design Stage Audit of the Reconstruction of a 300-km Section of a National Highway

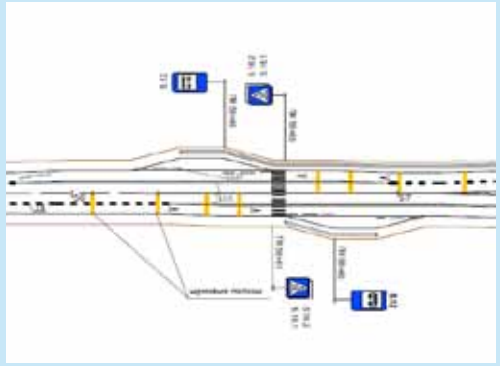
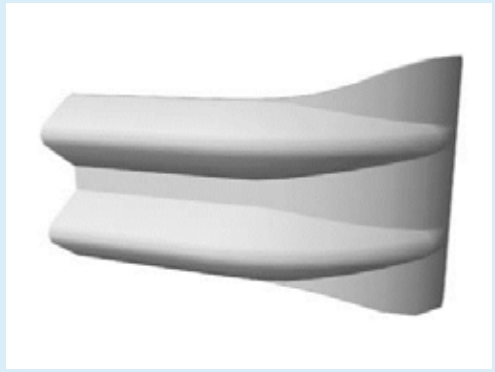
Km	Safety Concern	Risk	Photo	Recommendations	Client Response
Safety Concerns with the Proposed Reconstruction of the National Highway					
General	Throughout the scheme, pedestrian crossings have been proposed to link communities with bus stops. In most locations, these crossings straddle four lanes with no refuge for crossing pedestrians. Users of the crossings will effectively have to cross with no control in a single phase. The presence of the second lane will encourage overtaking in the vicinity of the crossings and potentially higher speeds. These combined factors will increase the risk of conflict between pedestrians and vehicles.	Very high	 Source: TOP Geodezia, Almaty.	• Reduce the carriageway from four to two lanes at these locations. • Provide appropriate lengthened entry and exit tapers to negate the need for extra lanes. • Any acceleration lanes for adjacent junctions should terminate in advance of the bus stops, not continue through the bus stop location.	
General	The standard drawings show the crash barrier terminals to be provided throughout the scheme will be the "fish tail" type. These terminals, when facing oncoming traffic, are a considerable roadside hazard and a "spearing" hazard. They cause injury to vehicle occupants should an errant vehicle strike them.	Medium	 Source: Matthew Chamberlain.	• Provide passively safe terminal ends for all barrier terminals. • Ensure the standard drawings are altered so "fish tail" terminals are removed and an approved passively safe terminal shown instead.	

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Table 9: continued

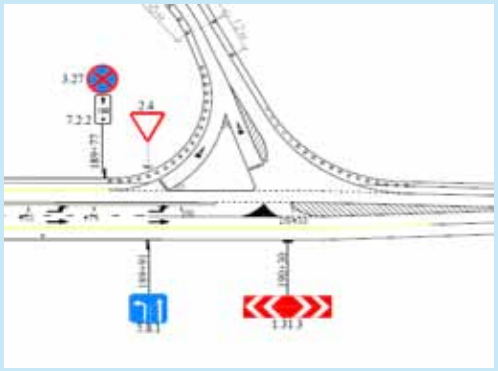
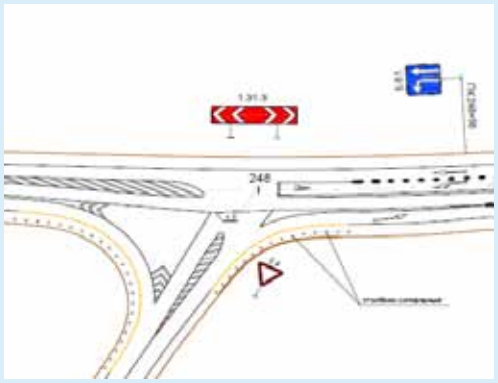
Km	Safety Concern	Risk	Photo	Recommendations	Client Response
Km 190	A side road joins the main line here at an acute angle and the exit and entry radii are very relaxed, increasing the entry speeds of vehicles entering from the side road. This also will encourage high-speed movements onto the side road. This problem is exacerbated by the size of the junction and the lack of any physical islands within the junction; only road markings are proposed. This will increase the risk of "give way" conflicts. It will also increase the risk of vehicles entering the side road at high speed and losing control.	High	 Source: TOP Geodezia, Almaty.	• Provide tighter radii to cause drivers to reduce speed on their approach to the main line, and also while entering from the main line onto the side road. • Reduce the size of the junction to encourage lower vehicle speeds. • Provide a physical (not painted) island within the junction to deter vehicle from crossing into opposing lanes.	
Km 248	A side road joins the main line at an acute angle here. The exit and entry radii are very relaxed, which will increase the entry speeds from the side road. They will also encourage high-speed entry movements into the side road. This will increase the risk of "failure to give way" conflicts as well as vehicles potentially entering the side road at high speed and losing control.	High	 Source: TOP Geodezia, Almaty.	• Provide tighter radii to cause drivers to reduce speed on the approach to the main line, and also when entering from the main line onto the side road.	

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Table 9: continued

Km	Safety Concern	Risk	Photo	Recommendations	Client Response
Km 277	There is an existing narrow bridge across a wide river (500 m) here. It has large concrete parapets that are roadside hazards. It is the only such bridge along this highway and, as such, it may surprise some drivers. The drawings are silent about any safety improvements at or along this narrow bridge. W-beam safety barrier is needed to shield the side slopes, and there is a need to delineate the bridge to reduce the risk of side swipe collisions at night.	High		• Install a pair of "Narrow Bridge" warning signs approximately 100 m ahead of the bridge on each approach. • Install "width markers" on each parapet 2 m above the road surface to delineate the corners of the narrow bridge. • Install lengths of W-beam barrier to shield the side slopes on both sides of the highway. • Stiffen the barrier over the last 10 m by reducing the post spacings to half. • Affix the barrier firmly to the parapets.	
Km 297.7	Pedestrians walk along a small side road on the right) from a village to the highway to catch minibuses. They cross the highway to do this. However, the drawings do not show anything to assist them with their crossing of the highway. Traffic speeds at the location are high and may increase after the rehabilitation. A pedestrian crossing is not appropriate due to the low volumes of pedestrians and the high speed of traffic. A refuge island offers the safest option for all.	Medium		• Ensure the safety of these pedestrians is discussed and resolved before the designs are completed. • Consider installing a length of divided road (up to 200 m long) with a median at least 3 m wide to provide a refuge for crossing pedestrians. • Install appropriate warning signs on both approaches —for the median and the pedestrians. • Consider a shelter for pedestrians.	

Km = kilometer, m = meter.

The audit team carried out this detailed design stage road safety audit according to the *CAREC Road Safety Audit Manual*.

SIGNED:

{INSERT NAME HERE} Team leader on behalf of the Road Safety Audit team {DATE}

Source: Asian Development Bank.

C. Case study 3: Roadworks Stage Audit of the Upgrading of Two Sections of an International Highway

(i) Title

151. The complete technical title of the audit, including its location and aims.

(ii) Audit team

152. The name and the role of the team leader and each audit team member.

(iii) Project background

153. This project involves upgrading the two most westerly sections of this international highway. The first is an existing divided highway that is to be improved to a class I, four-lane divided highway. It extends between the border crossing (Km 256.7) and the outskirts of the border township at Km 252.1. The work in this section involves rehabilitating both carriageways, replacing four damaged culverts, constructing curb and channel at three key intersections, and replacing two old bridges. The second section is between Km 252.1 and the bridge over the river at Km 240.9. The work involves widening and upgrading this 11.2 km section of highway to a class II, two-lane highway according to the Trans Asian Highway design standard.

154. The project has a total length of 15.8 km. The highway is in undulating area for most of this length, but the first 3 km (from the bridge westward) are in hilly terrain with sharp horizontal curves, and steep grades. The highway is used by many trucks and buses, some cars, motorcycles, pedestrians, and some animal-drawn vehicles.

155. The construction work commenced in the first week of May. A roadworks stage audit was undertaken as a condition of the contract. It involved a desktop audit of the Traffic Management Plans (TMPs) submitted by the contractor as well as an audit of the initial TMP when set up. This report details the key findings from the roadworks audit.

(iv) Audit details

156. The road safety audit included a desktop audit of the TMPs between 10 and 11 April. A site inspection took place on Monday, 11 April (day and night) for the audit team to become familiar with the highway at this location. The weather during this inspection was overcast and warm. A further site inspection took place on Tuesday, 10 May, the first day on which the TMPs were in place and just as construction work commenced. This site inspection took place during the afternoon and into the late evening. The weather was fine and warm or hot.

157. The audit findings are provided in table 10.

Table 10: Case Study 3–Findings in a Roadworks Stage Audit of the Upgrading of Two Sections of an International Highway

Km	Safety Concern	Risk	Photo	Recommendations	Client Response
Safety Concerns Identified in the Desktop Audit of the Traffic Management Plans for the International Highway					
General	There are inadequate numbers of reflective warning signs shown in the TMP. The existing highway has speeds of up to 80 km/h in parts, and it is possible some drivers could miss seeing an advance warning sign on the left side of the highway. All warning signs should be duplicated (on both sides of the road) in the advance warning zone.	High	 Source: *CAREC Manual 2.*	• Duplicate all road work signs used in this project by ensuring that a matching sign is placed on the right side of the carriageway to match the sign(s) installed on the left side.	
General	There are no speed restriction or repeater speed restriction signs shown in the TMP. Consistent application of a 40 km/h speed limit through each work zone is recommended for the safety of road users and road workers.	High	 Source: *CAREC Manual 2.*	• A uniform 40 km/h speed restriction is recommended through the work site. • Ensure that reflective size "A" 40 km/h speed restriction signs are installed in the advance warning zone, and then continue to remind drivers of this limit by installing pairs of repeater 40 km/h speed limit signs every 1 km.	
From Km 252.1 to Km 256.7	The TMP shows inadequate transition lengths at locations where two lanes were being reduced to one (typically in advance of sections where traffic is to be diverted onto the other carriageway). The TMP is unclear what devices are to be used to provide guidance in the transition zones. It must be ensured that highly visible, forgiving devices (such as traffic cones) are the only acceptable device to use for this.	High	 Source: *CAREC Manual 2.*	• Use the *CAREC Safer Road Works Manual* to determine the necessary length of the transition zones for these locations. Traffic will be travelling at about 60 km/h and have to merge (2 lanes into 1 lane), thus, a zone length of some 100 m will be required.	

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Table 10: continued

Km	Safety Concern	Risk	Photo	Recommendations	Client Response
From Km 252.1 to Km 256.7	No "Two Way Traffic" warning signs are shown in the TMP to warn and/or inform drivers in both directions when counterflow arrangements exist. One "Go Slow" sign is in place but it is general and gives no warning of the risk of head-on collisions. Allowing drivers to forget they are on a two-way road sets up a high risk of head-on collisions.	High		• Redesign the TMP to show the installation of duplicated, reflective "Two Way Traffic" warning signs at spacings not exceeding 500 m through the counterflow section of the duplicated highway. • Ensure the warning signs face both directions of traffic.	
General	No workers were sighted wearing reflective or high visibility clothing on-site during the site inspections. This is a requirement in the contract and is essential for personal safety.	Medium		• Ensure the contractor provides reflective high visibility clothing for all workers. • Ensure all workers wear this clothing. • Monitor the situation periodically and check that all workers wear the high visibility clothing at all times while working.	
Km 256+200	Concrete-filled barrels are used as delineators and to hold some "Diversion" signs at this work site. These are roadside hazards and are highly dangerous if struck by a small vehicle or a motorcyclist.	Medium		• Direct the contractor to remove these concrete-filled drums and replace them with conspicuous but forgiving traffic control devices (such as plastic traffic cones, bollards) and reflective metal signs.	

Km = kilometer, km/h = kilometer per hour, m =meter, TMP = traffic management plan.

Note: The audit team carried out this roadwork stage road safety audit according to the *CAREC Road Safety Audit Manual.*

SIGNED:

{INSERT NAME HERE} Team leader on behalf of the Road Safety Audit team {DATE}

Source: Asian Development Bank.

D. Case study 4: A Preopening Stage Audit of a 120-km Section of a National Highway in the Western Province

(i) Title

158. The complete technical title of the audit, including its location and aims.

(ii) Audit team

159. The name and the role of the team leader and each audit team member.

(iii) Project background

160. The national highway links the capital with the nation's second largest city and onward into the border. One section of the highway (120 km in length) was recently rehabilitated as a category III road with two lanes (one in each direction) as a part of a national program of improving national highways. Most of the highway is quite straight and flat, with only a few undulating areas. The highway passes mainly through rural areas, and there are several villages along the route. Near the midpoint of this section of highway is a rocky hill section that has led to lower design parameters for rehabilitation. The highway passes through this hill section for approximately 8 km. It has several steep grades (some up to 12%) and some sharp horizontal curves (four are 180° curves each with a radius of 50 m or less). Traffic speeds in the hill sections were observed to be around 60 km/h, and in the flat open areas, around 90 km/h–110 km/h during the site inspection.

161. No earlier audits were undertaken for this road project. A preopening stage audit was requested to ensure road safety was adequately considered. Some truck drivers expressed some concerns for safety in the hill section, while the client sought the audit to assist with decision making during the 12-month "maintenance period" when the contractor is required to maintain the highway.

(iv) Audit details

162. This preopening stage road safety audit included a daytime and a nighttime site inspection on Monday, 29 November. The weather during the inspection was windy, but generally fine and cold. The audit team comprised three accredited road safety auditors.

163. The audit findings are provided in table 11.

The highway links two large cities. A length of the highway was rehabilitated as a category III road. The preopening audit has examined the highway from the point of view of safety for all road user groups.

Table 11: Case Study 4–A Preopening Stage Audit of a 120-km Section of a National Highway in the Western Province

Km	Safety Concern	Risk	Photo	Recommendations	Client Response
Safety Concerns along the Newly Completed National Highway in the Western Province					
General	Curves are delineated inconsistently. Several have too many CAMs installed, some have CAMs in one direction only (the other direction is not delineated), and there are several curves (especially in the hill section) that need CAMs but have none. Such inconsistent delineation can cause drivers to be surprised at sharp curves; run-off-road crashes can result.	High		• Undertake a review of the delineation (especially the use of CAMs) throughout the length of the highway. • Ensure all curves with a radius less than 150 m have at least three CAMs (with standard spacings) installed on the outside of the curve to face both directions of travel. • Remove redundant CAMs.	
General	The line marking is clear and correct at the beginning of the newly completed road. However, the edge lines are not continuous in the second half of the highway. Loose gravel and sand from the shoulder are obscuring most of the edge lines installed. This leads to safety issues due to reduced daytime and nighttime delineation.	Medium		• Sweep the road pavement and the shoulders to keep the road free of gravel and sand, and to make visible the edge lines installed. • Then, complete the edge lines as shown in the contract drawings.	
General	W-beam barrier is installed at each of the six bridges along this highway to shield the side slope on each approach. However, none of these sections of barrier were stiffened nor correctly affixed to the bridge parapets. There is a risk of "pocketing" into these bridge parapets.	Medium		• Ensure the barrier is securely attached to the bridge parapets as described in the *CAREC Roadside Hazard Management Manual.* • Reduce the post spacings in the final 10 m before each bridge to half of the original spacing. Use double-nested railing as necessary to prevent "pocketing".	

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Table 11: continued

Km	Safety Concern	Risk	Photo	Recommendations	Client Response
Km 10–14	At the large cross-intersection at Km 10.8, many items of agricultural machinery enter and leave the highway. They travel slowly along the highway for about 3 km to either the local petrol station or the next side road junction near Km 13.6. However, the shoulders are unsealed, and the drivers try to stay on the highway to minimize dust. Because they are slow-moving and large machines, they are difficult to overtake. Head-on and rear-end collisions may result.	Low		• Pave the shoulders of the highway between Km 10+00 and Km 14+00 to a width at least 2 m to provide an option for drivers of large machinery to use. • Install advance warning signs on the highway to advise drivers of the possibility of machinery using the road. • Install two street lights at the crossroad at Km 11.8 and another two at the side road junction near Km 13+60 to highlight turning vehicles.	
Km 45	There is a school on the right (north) side of the highway near Km 45. It is approximately 600 m outside the nearby village, and it appears most of the young children attending the school walk along the edge of the highway from the village. With an unpaved shoulder and nearby long grass, children sometimes walk on the road pavement. This exposes them to a risk of a collision with fast-moving traffic.	Medium		• Discuss options with the school. • Pave the shoulders between the village and the school (at least 2 m wide). • Construct an all-weather footpath (and possibly cycling path) within the road reservation (right side). This off-road path should be at least 3 m wide and should have a sign indicating it is for pedestrians and cyclists only.	
Km 60–64	There are steep, undriveable roadsides in the hill section between Km 60 and Km 64 (approximately). Some W-beam barriers are installed, but are too short in four places, leaving unsafe side slopes unshielded. These side slopes are a serious risk to the occupants of errant vehicles. The slopes cannot be "softened" due to the topography. High-quality delineation and more safety barriers are needed.	High		• Improve delineation by installing CAMs (minimum of three per curve in both directions) on the four tightest curves. • Seal the shoulders on the outside of these curves; match the shoulder slope to the super elevation of the curve. • Increase the length of W-beam barrier at the four locations. Ensure all side slopes greater than 3 m deep and within the 5 m clear zone are shielded by barriers.	

CAM = Chevron Alignment Marker, Km = kilometer, m = meter.

Note: The audit team has carried out this preopening stage road safety audit according to the *CAREC Road Safety Audit Manual.*

SIGNED:

{INSERT NAME HERE} Team leader on behalf of the Road Safety Audit team *{DATE}*

Source: Asian Development Bank.

VI. Checklists

A. Road safety audit checklists: How and when to use them

164. Checklists are intended to reduce the risk that important safety concerns may be overlooked during an audit. However, they cannot be a substitute for knowledge or for experience. The use of checklists also requires sound judgment. Checklists should, therefore, be considered as a list of reminders to help in audits. The CAREC program has many different road projects on many different types of roads, and in a wide range of topographical locations. These checklists may, or may not, be fully applicable to all road projects. New safety concerns may be added as and when experience shows a need to update the checklists.

165. They include references to the typical road types and road projects common in the CAREC program at present. They also make references to the wide variety of road users that use CAREC roads. The checklists remind audit teams to always consider the safety needs of the vulnerable road users in equal measure to the safety needs of motorized road users.

166. These checklists are intended to be photocopied. It is recommended that originals are kept intact for use during subsequent audits.

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

The photocopies can be taken on-site and used as necessary. The completed checklists are kept by the audit team for future reference.

167. There are six recognized stages of audit, including the road safety inspection of existing roads. Checklists for each stage (feasibility, preliminary design, detailed design, road works, preopening, plus road safety inspections of existing roads) are provided in table 12.

168. Use the checklists as follows:

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

- The NA (not applicable) column is provided for completeness as there will be many occasions when some items on the checklists are not relevant to the proposal being audited.
- Add notes in the comments column as necessary to remind of safety issues, where they are located and specifically what they are.
- Some auditors may elect to use digital recorders or mobile phones to record their observations while on-site. This is often easier than writing notes on the copies of the checklists, and it can provide an opportunity for more details to be recorded in a shorter period of time.




Road safety audits add safety to road projects on all classes of roads, and for all road users.

B. Road safety audit checklists

Yes = likely to be satisfactory for safety

No = there are possible safety issues

NA = not applicable

Table 12: Checklists for Road Safety Audit

Feasibility stage				
Issue	**Yes**	**No**	**NA**	**Comments**
1. Road design standards				
Considering the class of terrain and the function of the proposed road, are the design standards being used "safe and practical"?				
Will the design speed be "safe" with regard to horizontal and vertical alignments, sight distances, merging, or weaving?				
Will the likely speed limit on the proposed road be compatible with the design speed?				
2. Alignment				
Is the proposed horizontal alignment as safe as practical?				
Is the proposed vertical alignment as safe as practical?				
Is the proposal consistent with the adjacent road network?				
Will all necessary turns (including U-turns) be able to be made safely?				
Will sight distances be satisfactory, especially at intersections and property accesses?				
3. Cross-section				
Will the proposed cross-section be "safe" for the expected volume and mix of traffic?				
In particular, if duplication is involved, is the cross-section wide enough to provide sheltered turn lanes within the median?				
If a median is proposed, will it be wide enough for the safe installation of street lighting either during the proposed works or later?				
Is the cross-section wide enough for paved shoulders (desirably 1.5 meters wide) along both sides of the road?				
Does the cross-section avoid unsafe compromises at bridges and other narrowings? (Note: It is desirable for safety to continue full width shoulders across bridges and through narrowings.)				
Are overtaking and/or climbing lanes proposed, if needed?				
Are all roadside hazards (existing and proposed) managed "safely"? (Note: Check if a clear zone has been used during the development of the proposal and assess if that clear zone will be adequate.)				
4. Interchanges				
Will the type of interchange be understood by road users?				

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Table 12 continued

Issue	Yes	No	NA	Comments
5. Intersections				
Is the number and location of proposed intersections suitable for the function of the new road, the surrounding road network, and access for all traffic, including public transport and emergency vehicles?				
Will the intersection layouts be understood by road users?				
Is the proposal free of all Y junctions?				
Is the proposed intersection traffic control as safe as practical?				
Are there sufficient intersections and U-turn openings in the proposal to minimize wrong way movements?				
6. Vulnerable road users (pedestrians, bicyclists, motorcyclists, and animal-drawn carts)				
Will pedestrians (particularly the young, old, and disabled) be able to safely walk along both sides of the road? (Note: Consider the expected traffic speeds on the new road.)				
Will pedestrians (particularly the young, old, and disabled) be able to safely cross the road? (Note: Consider the expected traffic speeds on the new road.)				
Will all vulnerable road users have connectivity along their route, and lateral clearance to motor traffic?				
Is the proposal free of "squeeze" points where vulnerable road users may be exposed to traffic?				
7. Providing for public transport				
Has the proposal provided for all forms of public transport that will use the new road?				
If bus lay-bys are to be provided, are they located at places where passengers are most likely to use them?				
Are all-weather footways proposed to and from bus stops and other key public transport locations to assist passengers?				
8. Matching in to the existing road network				
At the interface between the new and the existing road, has sufficient attention been given to safety matters?				
Is the interface between the new and the existing road well away from any hazard, such as a crest, a bend, a roadside hazard, or where there may be poor visibility?				
If the proposal cuts across established paths, such as village roads or pedestrian walkways, has attention been given to providing safe alternative routes for the users of those paths?				
9. General road safety issues				
Is the proposal located in an area that will be free of special events, festivals, market places, or other intermittent activities that could present special safety needs along the new road?				
Are railways level crossings suitably identified and safe?				
Are off-road service centers needed and proposed?				
Are sufficient rest areas proposed?				
Will the new road be as safe as practical, given the local weather conditions (sunrise, sunset, fog, snow, and dust storms)?				
Has the proposal taken into account the safety of animals on the road, including those crossing from adjacent forests or fields?				

Preliminary design stage				
Issue	**Yes**	**No**	**NA**	**Comments**
1. Vertical and horizontal alignments				
Will horizontal and vertical alignments be safe and consistent, especially at interchanges and intersections?				
Will all merge, diverge, and weaving areas be safe?				
Is the interface between the new and existing road well away from any hazard, such as a crest, a bend, a roadside hazard, or where there may be poor visibility?				
2. Cross-section				
Will all lane, shoulder and median widths be safe for the expected volume and mix of traffic?				
In particular, is the cross-section wide enough to provide sheltered turn lanes within the median?				
Will the median be wide enough for the safe installation of street lighting, either during the proposed works or later?				
Will the median be wide enough and clear enough to be an effective pedestrian refuge?				
Are shoulders proposed to be paved?				
Are shoulders continuous across bridges and flyovers?				
Are overtaking and/or climbing lanes being provided, especially in hill sections?				
3. Visibility and sight distance				
Are sight and stopping distances adequate throughout the proposal?				
Is the design free of sight restrictions (maybe due to buildings, trees, signs, or rock slopes)?				
4. Staged works				
If the scheme is to be constructed in stages, are the stages arranged to ensure maximum safety?				
If the scheme is a stage toward a wider or dual carriageway, is the design adequate to clearly impart this message to drivers? (Always look for misleading things that could confuse drivers or riders.)				
Is the transition between single and dual carriageway (either way) handled safely?				
5. Interchanges				
Are all features of each interchange design safe?				
Are all gore areas in the interchanges safely treated?				
6. Intersections				
Are the number and distribution of proposed intersections suitable in relation to the function of the new road, the surrounding road network, and access for all traffic, but especially public transport and emergency vehicles?				
Is each intersection easily identified and understood from all approaches?				

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Table 12 continued

Issue	Yes	No	NA	Comments
Are sight lines within each intersection adequate and free of obstruction by fixed objects such as buildings, overpass structures, traffic signs, or vegetation?				
Is the design free of all Y junctions?				
Is the proposed traffic control at each intersection ("Stop" and/or "Give way," roundabout, and traffic signals) as safe as practical?				
Are there sufficient intersections and U-turn openings in the design to minimize wrong way movements?				
7. Roadside hazards				
Has the roadside hazard strategy been followed?				
Are there any roadside hazards which appear to have been unintentionally left in the design?				
Are crash barriers proposed where only necessary?				
Is the type of barrier proposed suitable for this location?				
Do the standard drawings indicate the barrier terminals will be a suitably safe type?				
Do the standard drawings indicate a safe connection of the barrier to bridge abutments, together with the necessary reduction in post spacings to stiffen the barrier and prevent "pocketing"?				
8. Vulnerable road users (pedestrians, bicyclists, motorcyclists, and animal-drawn carts)				
Will pedestrians (particularly the young, old, and disabled) be able to safely walk along both sides of the road? (Note: Consider the expected traffic speeds on the new road.)				
Will pedestrians (particularly the young, old and disabled) be able to safely cross the road? (Note: Consider the expected traffic speeds on the new road.)				
Will all vulnerable road users have connectivity along their routes, and lateral clearance to motor traffic?				
Is the design free of "squeeze" points where vulnerable road users may be exposed to traffic?				
9. Providing for public transport				
Does the design provide for all forms of public transport that will use the new road?				
Are bus lay-bys proposed for places where passengers are most likely to use them?				
Are all-weather footways proposed to and from bus stops and other key public transport locations to assist passengers to safety get to and from?				
10. Road maintenance vehicles				
Will road maintenance vehicles be able to work safely on the new road?				
11. Drainage				
Will the road be well-drained?				
Will the drains be covered, or located behind crash barriers?				
12. General road safety considerations				
Will the new road be as safe as practical, given the local weather conditions (sunrise, sunset, snow, fog, and dust storms)?				

Detailed design stage				
Issue	**Yes**	**No**	**NA**	**Comments**
1. Horizontal and vertical alignments				
Will horizontal and vertical alignments be consistent with safe visibility requirements?				
Are vertical alignments suitably safe for all road users, especially large trucks and buses that can lose momentum on long steady uphill grades?				
Is there adequate provision for "safe" overtaking?				
2. Typical cross-sections				
Will all lane, shoulder, and median widths be safe for the expected volume and mix of traffic?				
In particular, is the cross-section wide enough to provide sheltered turn lanes within the median?				
Will the median be wide enough for the safe installation of street lighting either during the proposed works or later?				
Will the median be wide enough and clear enough to be an effective pedestrian refuge?				
Are shoulders proposed to be paved?				
Are shoulders continuous across bridges and flyovers?				
Are overtaking and/or climbing lanes being provided, especially in hill sections?				
Will safe provision be made for broken down vehicles, and emergency vehicles?				
3. New and/or existing road interface				
Will the transition from the existing road to the new scheme be safe?				
4. Staged works				
If the scheme is to be constructed in stages, are the stages arranged to ensure maximum safety?				
Is the transition between single and dual carriageway (either way) handled safely?				
5. Intersections				
Is the type of intersection (crossroads, T, roundabout, and signals) appropriate and safe?				
Will the design be free of sight obstructions due to structures, fences, trees or parking.?				
Will the traffic signal controls at the intersection(s) be clearly seen and understood?				
Will the traffic signal phasing be safe?				
Is adequate time proposed for all traffic and pedestrian movements at the signals?				
Do pedestrians have push buttons to activate the signals, together with suitable pedestrian signals on each corner of the intersection?				
With roundabouts, is adequate deflection provided for all approaches?				

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Table 12 continued

Issue	Yes	No	NA	Comments
Are correct signs shown for all approaches to the roundabout?				
For other intersections, are "Stop" and/or "Give way" signs shown and correctly located for maximum visibility?				
6. Interchanges				
Are sight lines open and free of obstruction at all merges and diverges?				
Are the distances between decision-making points sufficient for safety?				
Is the signing scheme for each interchange clear, and will it be easily understood by road users?				
Are all roadside hazards in the interchange treated in accordance with the roadside hazard management strategy?				
7. Adjacent land				
Will all accesses to and from adjacent land and/or properties be safe?				
Is fencing provided in rural areas to keep animals from straying onto the road?				
8. Roadside hazards				
Has the roadside hazard management strategy been followed?				
Are safety barriers provided only where necessary?				
Is the type of each proposed barrier suitable for its location?				
Do the standard drawings indicate that the barrier terminals will be a suitably safe type?				
Do the standard drawings indicate a safe connection of the barrier to bridge abutments, together with the necessary reduction in post spacings to stiffen the barrier and prevent "pocketing"?				
9. Vulnerable road users (pedestrians, bicyclists, motorcyclists, and animal-drawn carts)				
Will all vulnerable road users have connectivity along their routes, with suitable lateral clearance to motor traffic?				
Will pedestrians (particularly the young, old, and disabled) be able to safely walk along both sides of the road?				
Is the design free of "squeeze" points where vulnerable road users may be exposed to traffic?				
Will pedestrians (particularly the young, old, and disabled) be able to safely cross the road?				
Are all concrete curbings low enough to be "friendly" to pedestrians?				
Are dropped curbs provided at all intersections and mid-block locations where pedestrians are to cross?				
If formal crossings are proposed, are these conspicuous on each approach?				
Are the correct signs and line markings proposed for each pedestrian facility?				
Will each crossing facility be illuminated at night so pedestrians can be well seen by drivers and/or riders?				
If mid-block traffic signals are proposed, will these have pedestrian push buttons?				

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Table 12 continued

Issue	Yes	No	NA	Comments
Are pedestrian paths to be provided through medians to permit pedestrians to cross "at road level" and to assist disabled pedestrians with improved access?				
10. Signs, line marking, and delineation				
Do all signs (regulatory, warning, and direction) shown in the design accord with the 6Cs of good signage?				
Will all larger (more than 100 millimeter diameter) sign supports be located outside the clear zone, or else be frangible?				
Is good delineation (curve warning signs, advisory speed signs, guide posts, and chevron alignment markers) provided where required?				
Do the standard drawings show guide posts to be made of plastic? Do the drawings also indicate high-quality reflective material atop each guide post?				
Is the proposed line marking clear and consistent through the project? Is thermoplastic line marking proposed?				
11. Parking				
Have paved and marked areas been provided for parking?				
Will the parking be adequate and safe?				
12. Emergency service vehicle access				
Has provision been made for safe access and movements by emergency vehicles?				
Are median openings frequent, visible, and well-signed?				
13. Lighting				
Are the critical locations (intersections, pedestrian facilities, bus stops) proposed to be lit?				
Do the standard drawings indicate the lighting columns will be frangible?				
If the columns are not frangible, are other actions proposed to make these safe for road users?				
14. Drainage				
Does the design provide adequate drainage?				
Will drains be covered, located outside the clear zone, or shielded behind safety barriers?				
15. General road safety considerations				
Will the new road be as safe as practical given the local weather (sunrise, sunset, snow, fog, rain, and wind)?				
Will the road surface be free of gravel and sand, and have good skid resistance?				

Road works stage				
Issue	**Yes**	**No**	**NA**	**Comments**
1. Traffic management plan (design and implementation)				
Has a traffic management plan (TMP) been prepared for the road work site?				
Has the TMP been approved by the supervision consultant or other authorized person?				
Does the contractor have an appointed safety officer who is responsible for road safety at the work site, including checking the condition of the installed TMP every day?				
Does the TMP provide adequate and correct signage, delineation, and work site protection (barriers) for all road users under all traffic conditions?				
Has the TMP been installed correctly at the road work site?				
Is the advance warning zone have adequate signs to alert approaching road users of the presence of the road works?				
Is the transition zone have correct and adequate signs and delineation to guide approaching road users into their correct path?				
Are appropriate controls in place at the work zone to ensure traffic is kept safely out of it and away from the workers?				
Does the termination zone have adequate signs to advise road users they are past the road works, and may return to normal road and/or highway speeds?				
Are flagmen and/or traffic controllers highly conspicuous and placed where they can give clear instructions to approaching drivers and/or riders in advance of the work site?				
2. Speed control				
Are the speed restriction signs conspicuous?				
Are there sufficient numbers of repeater speed restriction signs through the length of the work site?				
Is the speed on the sign appropriate for safe traffic movement through the work site?				
Have local police been requested to enforce the speed limit on the sign through the work site?				
Are speeds managed (through signs, enforcement, and, if necessary, road humps) so vehicle operating speeds that pass within one traffic lane width of any workers are 40 kilometers per hour or lower?				
3. Signs, signals, line markings, and delineation				
Are all necessary warning, direction, and regulatory signs in place as shown in the TMP?				
Do all signs satisfy the 6Cs of good signage practice?				
Are all unnecessary existing road signs during the works covered to avoid distraction or misinformation?				

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Table 12 continued

Issue	Yes	No	NA	Comments
Are all "Road worker" signs removed or covered when work is finished for the day? (Note: Signs must be credible; it brings other signs into disrepute to leave "Road worker" signs in place if no workers are present.)				
Are temporary traffic signals clearly visible to the approaching drivers and/or riders?				
If the signals generate traffic queues, can the end of the queue be easily seen by approaching drivers and/or riders?				
Are line markings consistent and clear through the length of the work site for both day and night?				
Is delineation through the site safe for all road users under all anticipated conditions?				
With several layers of asphalt typically to be laid for new roads, are temporary line markings used on each new layer to guide drivers and/or riders as an interim safety initiative, especially at night?				
4. Diversions from one carriageway to the other				
If traffic is to be diverted from one carriageway onto the other, do the advance warning signs provide clear guidance about the diversion ahead? Are they well-located to alert all approaching road users?				
Is the transition zone delineated (with plastic cones and other forgiving devices) to reduce the number of traffic lanes well before the carriageway ends?				
Is the carriageway (on which the work is to take place) fully and clearly closed off to all traffic?				
Is the carriageway (on which the work is to take place) fully closed at all intersections? Are drivers and/or riders from the side roads given adequate warning of the two-way traffic operation on the open carriageway on the main road?				
Are all drivers and/or riders in both directions on the open carriageway adequately reminded they are on a two-way section of road (such as with "Two Way" warning signs)?				
Is the management of all two-way traffic sections through the road work site safe for all road users for both day and night?				
For works that will take many months to complete, has a suitable paved surface been provided along with correct lane markings to guide drivers and/or riders through diversions?				
5. Road surface				
Is the road surface suitable for safe movement by all road users, especially small vehicles?				
Are paved surfaces swept and kept free of gravel and sand?				
Are unpaved surfaces graded regularly to provide a suitable surface commensurate with the posted speed limit?				
Have signs and markers been used to highlight changes in road surface for approaching drivers and/or riders?				

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Table 12 continued

Issue	Yes	No	NA	Comments
Have signs and markers been used to highlight locations where layers of asphalt end, causing sudden changes in the road surface for approaching drivers and/or riders?				
6. Safety barriers				
Are all safety barriers necessary, and are they installed correctly?				
Have safe terminals suitable for the operating speeds through the work site been placed on the end of each section of barrier?				
7. Work site access				
Are work site access points located with adequate sight distances for entering and/or exiting work vehicles?				
Are all site access points closed off to unauthorized traffic?				
Are appropriate traffic controls in place where works traffic and public traffic interact?				
8. Road worker safety				
Are all workers and supervisors at the works site wearing good quality reflective vests and/or jackets at all times?				
Is there a suitable safety zone in advance of and beside the work site?				
9. Vulnerable road users (pedestrians, bicyclists, motorcyclists, and animal-drawn carts) through the work site				
Are pedestrians, bicyclists, and other vulnerable road users able to move safely through the road work site?				
Are vulnerable road users able to cross the road, with at least the same level of confidence and safety they had before the work started?				
In particular, is safe access across the road provided for the young, the elderly, and the disabled?				
Have all-weather footways been provided to assist public transport users to reach their stops without walking through the road work site?				
10. Safety at night				
Are the road works conspicuous to all road users after dark?				
Are travel paths obvious to all road users after dark?				
In particular, do carriageway closures have suitable advance warning zones and transition zones conspicuous and clearly delineated for nighttime?				

Preopening stage				
Issue	**Yes**	**No**	**NA**	**Comments**
1. New and/or existing road interface				
Is the interface between the new road and the existing road as safe as practical?				
Where drivers and/or riders depart the new road and return to the existing network, are they provided with sufficient delineation and line markings to compensate for possible increased speeds?				
2. Intersections				
Are sight lines free of obstructions at all intersections?				
Are the intersection layouts clear and visible from all approaches?				
Are correct advance warning and direction signs installed on each approach to each key intersection?				
Are traffic signals conspicuous, functioning properly and safely?				
Are the signal timings reasonable and likely to maximize driver and/or rider compliance?				
Are the signal phasings reasonable and safe, with no conflicting movements?				
Are pedestrian signals installed at each intersection? Are they easy to see, with adequate walk time and clearance time?				
Are roundabouts visible and recognizable from all approaches?				
Are correct advance warning and direction signs installed on each approach to each roundabout?				
At other intersections, are “Stop” and/or “Give Way” signs conspicuous and correctly installed to make priority clear?				
3. Interchanges				
Are sight lines open and free of obstruction at all merges and diverges?				
Are the distances between decision-making points sufficient for safety?				
Are all gore areas treated safely?				
Are the direction signs for each interchange clear and easily understood at the anticipated operating speeds?				
4. Signs, line markings, and delineation				
Do all signs and pavement markings satisfy the 6Cs of good signage and line marking practice?				
Is there a need for any more signs to warn, inform, guide, control, or delineate?				
Have all unnecessary and redundant signs and markings (including those from the road works) been removed?				
Do speed zones have clear signs with speed restriction signs of a suitable value?				
Are road markings continuous, correct, and conspicuous?				
Have potentially confusing situations been removed or resolved safely?				

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Table 12 continued

Issue	Yes	No	NA	Comments
Are plastic guide posts correctly installed in accordance with the layouts shown in the standard drawings?				
Are chevron alignment markers installed where necessary, and in accordance with the layouts shown in the standard drawings?				
Is there consistency and uniformity of delineation and markings throughout the scheme?				
5. Roadside hazards				
Has the roadside hazard management strategy been followed in this project?				
Have initiatives been taken to delineate the road to maximize the chance vehicles will remain on the road?				
Are all roadside hazards adequately treated?				
Is a barrier installed only where necessary?				
Is a barrier correctly and safely installed?				
Are all bridge abutments and culverts safely treated?				
6. Vulnerable road users (pedestrians, bicyclists, motorcyclists, and animal-drawn carts)				
Do all vulnerable road users have connectivity along the road, with suitable lateral clearance to motor traffic?				
Will pedestrians (particularly the young, old, and disabled) be able to safely walk along both sides of the road?				
Is the new road free of "squeeze" points where vulnerable road users may be exposed to traffic?				
Will pedestrians (particularly the young, old, and disabled) be able to safely cross the road?				
Are all concrete curbings low enough to be "friendly" to pedestrians?				
Are dropped curbs provided at all intersections and mid-block locations where pedestrians are to cross?				
Are the number and placement of the pedestrian facilities adequate and safe for the situation and the pedestrian numbers?				
Is each pedestrian facility clearly marked and conspicuous on each approach?				
Are the correct signs and line markings installed at each pedestrian facility?				
Is each crossing facility well-illuminated at night so pedestrians can be seen by drivers and/or riders?				
Do all mid-block traffic signals have pedestrian push buttons?				
Are medians in urban areas free of barriers, suitably wide, and with a suitable surface to act as an effective pedestrian refuge?				
Are pedestrian pathways provided through medians to permit pedestrians to cross "at road level" and to assist disabled pedestrians?				
Are bus stops located where passengers will use them?				
Are bus stops well-delineated and lit?				
Are bus stops paved for all-weather use?				

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Table 12 continued

Issue	Yes	No	NA	Comments
7. Drainage				
Is the road well-drained?				
Are drains covered, or located outside the clear zone?				
8. Landscaping				
Is the landscaping "safe" in terms of roadside hazards? (Note: Any tree with a trunk in excess of 100 millimeter diameter is considered a roadside hazard, if within the clear zone.)				
Does the landscaping permit clear sight lines at all intersections, pedestrian facilities, and median openings?				
9. Access to property and developments				
Are all accesses to and from adjoining properties conspicuous and as safe as practical?				
Is fencing provided and adequate to keep animals off the road, especially in rural areas?				
10. General road safety considerations				
Is the new road as safe as practical, given the local weather (sunrise, sunset, snow, fog, and dust storms)?				
Is the road surface free of gravel and sand? Does it have good skid resistance?				
Have batter slopes of cuttings been treated to minimize the risk of rocks falling onto the new road?				

Road safety inspections (of existing roads)				
Issue	**Yes**	**No**	**NA**	**Comments**
1. Sight distances				
Are all sight distances adequate for the speed of traffic using this road?				
Are safe overtaking opportunities provided?				
Are U-turn provisions conspicuous and safe?				
2 Intersections				
Are all intersections clear and visible?				
Are all traffic signals conspicuous, functioning properly and safely?				
Are roundabouts visible and recognizable from all approaches?				
3. Interchanges				
Are sight lines open and free of obstruction at all merges and diverges?				
Are the distances between decision-making points sufficient for safety at the operating speed?				
Is the direction sign scheme for each interchange clear and easily understood at the operating speed?				
4. Cross-sections				
Are lane widths, shoulder widths, and bridge widths, safe for the traffic volume and mix?				
Are medians and islands adequately wide for the safety of users?				
Are the shoulders suitable for use by all vehicles and road users, including pedestrians, cyclists, and animal-drawn vehicles?				
Is appropriate super elevation provided on curves?				
5. Roadside hazards				
Has the roadside hazard strategy been followed?				
Are all roadside hazards located outside the clear zone?				
Are safety barriers used only where necessary?				
Are all safety barriers correctly and safely installed?				
6. Drainage				
Is the road well-drained?				
Are all drains outside the clear zone covered, or behind suitable barrier?				
7. Signs, line markings, and delineation				
Do all signs and pavement markings satisfy the 6Cs of good signage and line marking practice?				
Is the speed zone safe, and with clear signs?				
Are pavement markings conspicuous, continuous, and correct?				
Is the road well-delineated, with warning signs, plastic guide posts, and/or chevron alignment markers installed as necessary, and spaced in accordance with guidelines?				
Is there a need for more signs to warn, inform, guide, control, or delineate?				

continued on next page

Table 12 continued

Issue	Yes	No	NA	Comments
8. Vulnerable road users (pedestrians, bicyclists, motorcyclists, and animal-drawn carts)				
Do all vulnerable road users have connectivity along the road, with suitable lateral clearance to motor traffic?				
Are pedestrians (particularly the young, old, and disabled) able to safely walk along both sides of the road?				
Is the road free of "squeeze" points where vulnerable road users are exposed to nearby moving traffic?				
Are pedestrians (particularly the young, old, and disabled) able to safely cross the road?				
Are all concrete curbings low enough to be "friendly" to pedestrians?				
Are dropped curbs provided at all intersections and mid-block locations where pedestrians are to cross?				
Are the number and placement of the pedestrian facilities adequate and safe for the situation and the pedestrian numbers?				
Are all the formal crossings clearly marked and conspicuous on each approach?				
Are the correct signs and line markings installed at each pedestrian facility?				
Is each crossing facility well-illuminated at night so pedestrians can be seen by drivers and/or riders?				
Do all mid-block traffic signals have pedestrian push buttons?				
Are pedestrian pathways provided through medians to permit pedestrians to cross "at road level" and to assist disabled pedestrians?				
Are bus stops located where passengers will use them?				
Are bus stops well-delineated and lit?				
9. Access to property and developments				
Are all accesses to and from adjoining properties "safe"?				
10. Lighting				
Is all lighting adequate and safe?				
Are the lighting columns frangible? If not, are they located outside the clear zone?				
11. Parking				
Is sufficient parking provided clear of through traffic?				
12. General road safety considerations				
Is the road as safe as practical given the local weather conditions (sunrise, sunset, snow, fog, storms, and wind)?				
Is the road surface free of gravel and sand? Does it have good skid resistance?				
Is the pavement free of potholes or loose material, which could result in safety problems?				

6Cs = conspicuous, clear, comprehensible, credible, consistent, and correct.

Source: AUSTROADS. 2009. *Guide to Road Safety Part 6: Road Safety Audit*. Sydney, Australia.

CAREC Road Safety Engineering Manual 1

Road Safety Audit

Research indicates that up to 28% of crashes are due to the road environment. The most important objective of road safety audit is to minimize crashes, and to minimize the severity of any crashes that may occur on a new road project. The series of CAREC road safety engineering manuals came from the endorsement of the CAREC Road Safety Strategy 2017–2030 by member countries. The strategy supports and encourages CAREC authorities to plan, design, construct, and maintain safe roads. This manual also explains the road safety audit process as it can apply in CAREC road projects. It provides information about the audit process for those who undertake the audits (practitioners) and for those who manage the audit process (policy makers).

About the Central Asia Regional Economic Cooperation Program

The Central Asia Regional Economic Cooperation (CAREC) Program is a partnership of 11 member countries and development partners working together to promote development through cooperation, leading to accelerated economic growth and poverty reduction. It is guided by the overarching vision of "Good Neighbors, Good Partners, and Good Prospects." CAREC countries include: Afghanistan, Azerbaijan, the People's Republic of China, Georgia, Kazakhstan, the Kyrgyz Republic, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. ADB serves as the CAREC Secretariat.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to a large share of the world's poor. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

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