Government of the People’s Republic of Bangladesh
Ministry of Road Transport and Bridges
Roads and Highways Department

QUALITY AUDIT GUIDELINES (QAG)

June 2017
Quality Assurance Audit (QAA) manual is intended to provide guidance, tools and information for managing audit activity. It helps in planning, conducting and reporting on QAA. Therefore, any authority that conducts audit needs to follow a manual.

In Roads and Highways Department, Director, Bangladesh Road Research Laboratory is responsible for the promulgation of audit and inspection policy and procedure through QAA. But there was no standard procedure of these audit activities. Hence, QAA manual was one of the fundamental needs for consistency in the audit procedure.

To maintain overall effectiveness of the audit process, audit should be carried out with a high degree of professionalism, transparency, using experience, skills and communication. Audit and inspection program must be fair and equitable in its application. This manual prescribes auditing policies and procedures and furnishes guidance in auditing techniques. All the officials of RHD are advised to follow QAA manual when preparing for and conducting Quality Assurance Audit.

To be an effective document, the manual must be consistent with actual procurement and construction practices in RHD. So, this needs to be changed and developed over time. We, RHD officials are responsible for keeping it up to date.

I wish Roads and Highways Department a positive and constructive experience with Quality Assurance Audit. Together, we will help to assure that the quality of RHD works is valued by relevant stakeholders and helps to support economic development of our country.

(Ibne Alam Hasan)
Chief Engineer
Roads and Highways
Department
Sarak Bhaban, Tejgaon, Dhaka
Foreword of Director, BRRL

The purpose of this manual is to establish internal policies and procedure for Quality Assurance Audit (QAA). The manual serves as a reference and guide for Quality Assurance Auditor and helps ensure that audit process is conducted in a consistent, fair and professional manner.

Quality Assurance Audit (QAA) manual has been developed to promote conformance with the Quality Assurance Plan (QAP) and RHD standards which collectively prescribe an acceptable level of quality work. It will also ensure that the audit policies and procedures are applied uniformly across the country.

This manual sets out step by step procedures for the implementation of audits from when a construction project is informed of the upcoming audit to the final submission of the audit report.

Development of the manual was entrusted to Mr. Md. Rafiqul Islam, Quality Assurance Auditor (senior consultant), BRRL. It was first drafted based on best practices used all over the world. It is then fine tuned in the light of experience in RHD works.

I would like to thank first of all Mr. Md. Rafiqul Islam, Quality Assurance Auditor (senior consultant), BRRL, who is the main contributor to this manual, for his efficiency, support, wisdom and consummate professionalism. I would also like to thank the officers of BRRL for willingly engaging with the development of the manual.

QAA manual will be reviewed, and revised (if necessary) time to time. Feedback is invited from user on areas which require clarification or further detail. All are encouraged to submit recommendation for constructive changes and improvement to the manual. I hope this manual will assist you in the preparation for and conduct of Quality Assurance Audit.

(Dr. Md. Abdullah Al Mamun)
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Bangladesh Road Research Laboratory
Mirpur, Dhaka
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PART A: GENERAL
1. INTRODUCTION

The Government of Bangladesh (GOB) through Roads & Highways Department (RHD) is aiming to enhance the traffic capacity and safety for efficient transshipment of goods as well as passenger trafficked on national and regional highway section. Government of Bangladesh has entrusted Road and Highways Department (RHD) with the responsibility of improving the quality highways of national importance. The primary mandate of RHD is time and cost efficient sustainable improvement of national highways from 2-laning to 4-laning, construction of new expressway, major bridges, fly over's, new grade separated intersections and major under passes on national network. The maintenance on arterial roads, bridges and culverts are to be completed in line with the quality of highest standard. At present the RHD owns the following national road network including bridges/ culverts.

RHD network

<table>
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<th>Road length by classification</th>
<th>Bridges and culverts:</th>
</tr>
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<tbody>
<tr>
<td>National Highway</td>
<td>Bridges: 4,507</td>
</tr>
<tr>
<td>Regional Highway</td>
<td>Culverts: 13,751</td>
</tr>
<tr>
<td>Zilla road</td>
<td></td>
</tr>
<tr>
<td>Total Road length</td>
<td>21,302.08 Km</td>
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</table>

Government of Bangladesh has taken certain policies to modernize the transport networks. To realize the vision 2021, highway sector needs massive expansion, a rough estimate shows an expansion to 30000km from 8000km.

Financial auditing of public funded projects is performed under the present auditing system. But it is the quality audit which had not received any attention in the past. The need for producing a guideline on quality auditing arose from the fact that, some of the recently implemented road construction projects have shown signs of either pre-mature failure and/or are in the process of failure before the design period.

This guideline document on quality auditing of road projects is a step in the right direction towards ensuring that the road projects undertaken in Bangladesh are appropriately designed and constructed. This quality audit guidelines processes and details the methodology which provides the framework for conducting a quality audit. The guideline will certainly go a long way in implementing road and bridge project in the right manner and introduce accountability on the part of all stakeholders- clients, consultants and contractors. The guidelines will be benchmarked against international standard of quality auditing to establish internal control mechanism in terms of quality of work as well as quality of investment in highway development sector.

Quality system is an internationally respected method for facilitating improvement efforts by providers of Ministry of Road Transport and Bridges (MRTB), and for providing the public with a level of assurance that the quality of our transport infrastructure is being attended to through external review.
The guideline is set out in eight parts:

1. Application and objective of the guidelines.
2. Preparation of auditing
3. Role and responsibilities of the technical auditor
4. Data requirements
5. Scope of post construction audit
6. Assessment of audit results
7. Reporting
8. References and appendices

It is expected that RHD will start thinking about carrying out quality audit of road and bridge projects for ensuring maximum benefits to the citizens against the investment incurred.

- To achieve the Sustainable Development Goals in 2030, rapid development of sustainable quality transport infrastructure is the top most priority. The most critical part is the implementation of quality infrastructure. Implementation of quality control management system in RHD will assist in achieving quality work. Quality auditing is a part of quality control management system.
- Quality audit is the process of systematic examination of a quality system carried out by an internal or external quality auditor or an auditor team. It is an important part of an organization's quality management system and is a key element in the ISO quality system standard ISO 9001.
- Quality audits are typically performed at predefined time intervals for ensuring the intent of the institution through a clearly defined internal monitoring procedures resulting in effective action which will in turn establish internal control mechanism.

2. APPLICATION AND OBJECTIVE OF THE GUIDELINES

- This quality audit guidelines will enable RHD to accomplish its objectives i.e. safe, economic and efficient road transport services to the people of Bangladesh by introducing a disciplined approach to evaluate and improve the effectiveness of road and bridge construction/maintenance management, internal control and adherence to laws, rules, regulations and agency policies.
- Within this context, the auditing of construction work is an essential activity for achieving benefits of infrastructure projects. It facilitates the government on the identification of relevant issues intended for finding solutions that might limit these projects within desired budget and schedule. Aside from these benefits, works auditing also results in financial benefit to the government.

The guidelines describe the basic concepts and standard procedures. Details of technical audit vary depending on the actual condition of the roads and bridges works to be audited.
Therefore the guidelines should not be rigidly applied. There must be a feedback mechanism and periodically this document should be reviewed and updated. Those who are involved in the quality audit should carefully examine if each stipulation can simply applied. Like any other guidelines, this guideline is intended to be used by relatively experienced auditors, preferably one with sufficient experience of highly complex technical infrastructure like major highway, expressway and major bridges. He/she may be allowed not to refer to, or even deviate from the procedures prescribed in this guideline, provided that such deviation is expected to lead to better results.

Standardization of procedures and/or formats/documents is very effective for preventing errors as well as easy for internalization of the users. Therefore the procedures and formats shown in this guideline should be adhered to as much as possible.

2.1. Legal basis and objective of quality audit

- This quality audit will be done in accordance with the mandate given by the RHD to Bangladesh Road Research Laboratory (BRRL). BRRL will perform the quality audit annually by engaging consultants/independent consultants or by any other means. Concerning types of government establishes two main types: financial and quality/performance audit.
- Financial audit focuses on determining whether an entity’s financial information is presented in accordance with the applicable financial reporting and regulatory framework. This is accomplished by obtaining sufficient and appropriate audit evidence to enable the auditor to express an opinion as to whether the financial information is free from material misstatement due to fraud or error. This financial audit shall be conducted outside of RHD jurisdiction.
- RHD through BRRL will conduct quality/performance audit that focuses on whether interventions, programs and institutions are performing in accordance with the principles of economy, efficiency and effectiveness and whether there is room for improvement.
- This mandate will provide a catalyst or “jump start” in developing and implementing sustainable road and bridge infrastructure system. It will result in the systems receiving high level support and top priority status.

RHD field level offices need continuous BRRL support in solving complex technical problems.

2.2. Professional ethics as the basic principle.

Professional ethics is assumed as the basis of the condition of the contract. Likewise, the professional ethics is assumed in conducting technical audit. This concept is very important since technical audit cannot inspect every detail of road and bridge works. Majority of the tasks to ensure the quality of the works inevitably vested upon the staff of the implementing agency, especially the RHD field office which is responsible for administration/execution of the project. The guidelines assumes that the staff of this implementing agency (RHD)exerts every effort in accordance with his/her professional ethics, to attain the best quality of works with highest standard.

2.3. Type of quality audit and the methodology

Main type of Quality audit conducted by RHD shall be initial, intermediate, final and “Post completion” audit. However RHD may conduct the audits in timely manner on the works which are being executed for the purpose of monitoring and verification of actual manner of execution of works.
2.4. Method of quality audit:

- Quality audit conducted by RHD shall consist of audit on documents and audit on site condition. The objective of document audit shall be to verify that proper procedures of procurement and administration of the works have been practiced. The objective of the site audit shall be to verify that works have been actually executed in accordance with the conditions of contract.

3. PREPARATION OF AUDITING

3.1. Selection and appointment of audit team

Auditor team typically consists of (1) one team leader (2) one to four members of the auditor team. Since various aspects need to be audited, audit is to be conducted by a team of experts. The number of auditors and the expertise varies depending on the project to be audited. It is a mandatory that consultants/personnel with necessary expertise are engaged as the members of auditor teams. The team leader or chief auditor is to provide overall direction to the other team members. He/she shall assume the overall responsibility of the audit. He/she will take charge of some task of technical audit depending on his/her expertise.

The table below summarizes the typical composition of an audit team and major task of the member of the team.

<table>
<thead>
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<th>Position in the team.</th>
<th>Main task</th>
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| Team leader/chief auditor | • Lead other team member(s) in conducting the technical audit  
| | • Responsible for preparation of draft audit plan.  
| | • Conduct technical audit according to the TOR given by agency (RHD)  
| | • Responsible for preparation of draft audit report  
| | • Conduct technical audit on the subject of his expertise  |
| Auditor | • Conduct technical audit under the supervision of team leaders/chief auditor  
| | • Assist team leader/chief auditor in preparing draft plan, draft report and other documents |

3.1.2. Selections of consultant:

The consultant(s) as the team shall have sufficient experience to cover the following subjects:

I. Tendering / bidding for road and bridge works  
II. Site management/ Quality control/ materials test/query & survey  
III. Contract management/ certificate for payment/ handover

The number of consultants to be engaged for one time technical audit should be determined based on such factor as.

I. number and size of contract (volume of work)  
II. Type of work included (Asphalt pavement) concrete work for major bridge work, protective work, culvert, and bridge viaduct work etc.  
III. Total length of road section and numbers of bridges to be inspected.
3.2. Appointment of auditor and provision of letter of introduction

Each member of the auditor team shall be appointed by the BRRL (RHD). Letter of introduction for audit shall be issued and given to each member of the auditor team.

Each member of the audit team shall bring the letter of introduction and show it to the implementing authority which undergoes the technical audit.

The letter of introduction is especially important for the consultants engaged as the members of the auditor team to let him/her have authority and dignity. A consultant who is a member of auditor team may be engaged by the implementing agency to be audited. Naturally, he/she may have some element of prejudice to the implementing agency. Letter of introduction is important to remove this sentiment and encourage the consultant as the agent of BRRL (RHD).

3.3. Selection of projects to be audited

Projects to be audited shall be selected at random basis, but to cover at least 20% of the projects contracted in the financial year for auditing. Also, the selection shall be made for different classes of contract amount, type of works, and regions.

The projects to be audited are selected considering the following:

(i) The regions which has not undergone audit in the recent years shall be given high priority.
(ii) The number of regions to be audited shall be as equally distributed among zones as possible.

4. ROLE AND RESPONSIBILITIES OF THE TECHNICAL AUDITOR

The technical auditor will be appointed as early as possible after the appointment of the supervising consultant (only if there is a provision of supervising consultant) and immediately (preferably) before the start of the tender process and appointment of the contractor. This will allow the auditor the opportunity to assess the evaluation of the project as it progresses.

Gross deficiencies in design, bills of quantities or tender documents identified by the auditor and reported to the client, may need revisions. The technical auditor may, in addition to his specified duties, be called on to act as an advisor to the client on matters pertaining to the project.

The technical audit for a typical road and bridge construction project should be carried out in four stages as presented here; these stages are spaced through the duration of construction of a road and bridge project in order to develop an early warning system.

1. Project familiarization
2. Preliminary audit
3. Intermediate audit
4. Final audit
At the conclusion of each phase of an audit, the auditor should present his findings in a report to the client who may deem it necessary to hold a formal meeting with the Engineer/ (Executing Authority), to advise him of the major conclusions in the auditor’s report. It should be noted that obvious problems identified during the audit process (e.g., the use of inappropriate materials) should have been brought to the notice of the client for early intervention. Should there be any doubt as to construction requirements being fulfilled during the project and no remedial action having been taken; the final audit should recommend that a post construction technical audit be carried out. After the final audit, an exit conference to discuss the conclusions of the technical audit may be requested by the client. This should involve the client and auditor and other relevant parties invited by the client.

The technical auditor must be accountable for his duties to the client, and must fulfill all the obligations specified in the Terms of Reference (TOR) for his appointment.

4.1. Relationship of the auditor with the client, consultant and contractor

The technical auditor is appointed by the client, to whom he reports directly. Under no circumstances will the technical auditor advice or issue instructions to the contractor or supervising consultant. Communication should be focused on seeking clarification or information regarding the project, and should avoid any interference with smooth implementation of the project. The consultant, contractor and client must make available to the auditor any document, as and when required by him and relevant clauses in the tender documentation and/or letters of appointment will make provision for this.

The relationship between the auditor and the client must be documented in his agreement with the client. The auditor can review actions of the client during the project and any deficiencies or lack of performance should be noted in his report. This should make the process transparent, improve on internal practices and avoid problematic projects.

4.2. Project familiarization

The auditor should clearly understand the scope and complexities of the project by reviewing all contract documentation including drawings, specifications, materials reports and conditions of contract. The tender documents and price submitted by the contractor and the tender evaluation report should also be carefully studied and related to the contractors proposed programme as well as his resources. This will probably require consultation between the auditor and the client.

This stage should be carried out immediately after the auditor has been appointed and within two weeks of award of the construction contract. The auditor must visit the project site during this phase to acquaint himself with the ground conditions. A report should be submitted to the client highlighting the outcome of this phase in order to clarify details before the works proceed.

4.3. Preliminary audit

This phase should be carried out as soon as the contractor is properly established the base camp but within the first 3/ 4 months or 20 percent of the contract period, whichever is less. This phase should be carried out after construction has commenced so that all of the correct procedures can be established from the beginning of the project. In the first on-site audit, attention should focus on project management issues and construction methodologies. This will incorporate:
• A review of the SRE/ Resident Engineer's pro-activity, control and approval procedures;
• Adequacy of the materials field laboratory;
• Specific experience of staff;
• Site communications;
• Knowledge of condition of contract;
• Construction quality of work completed;
• Efficient performance attitude towards the project.

The auditor would also ensure/ verify that the assessment of the contractor has been done satisfactorily by the Engineer, regarding the following issues and aspects:

• Quality and appropriateness of the plant and equipment;
• Operator skills;
• Methods of working;
• Materials and source of materials supply;
• Site organization and site management;
• Quality and detail of the construction programme;
• Site safety;
• Quality assurance procedures, and
• The contractors project management processes and procedures.

The format and content of monthly progress reports and monthly meeting minutes should be reviewed to ensure that all the important matters are raised and reported. Proceedings of informal “technical” meetings should be assessed to ensure that no serious issues are being suppressed from public scrutiny.

This is a general guideline and does not exclude a review of other issues this is shown in appendix-A. However, this phase should culminate with the submission of a factual report to the client on critical issues. It should also include the auditor’s opinion on the construction supervision and the ability of the contractor to deliver on time and to meet all of his obligations. The report should include recommendations to the client on any actions that are considered necessary and should include all issues assessed and not only the critical ones.

4.4. Intermediate audit

The auditor should carry out an intermediate audit that concentrates on conformance with the specification and matters of effectiveness and ensures that the procedures that had been set up initially are running correctly. This audit will be carried out at a time approximately halfway through the project but not more than 6/7 months after completion of a preliminary audit. On large projects it may be necessary to carry out more than one intermediate audit and the timing and frequency of these should be specified in the Terms of Reference (TOR) for appointment of the technical auditor. The following should be addressed during the intermediate audit/ audits.

• Review the preliminary audit and the subsequent actions by the SRE/RE and contractor resulting from the preliminary audit.
• Review of as-built records, relevant correspondence and minutes of meetings;
• Inspect and check both the completed work and work in progress.
• Completed work should conform to the typical plans;
• Assess the consultant's quality assurance procedures, in particular the laboratory equipment, test methods and general procedures;
• Road works:

Ascertain the MDD of embankment, sub-grade, sub-base and base course tests, the quality of materials like gradation of aggregates for base course, asphalt concrete, and conducting of AIV, ACV/10% fines, L.A test, Flakiness, Elongation, Durability and Water absorption of materials. Penetration grade Bitumen, asphalt layers test (bituminous material cores) and following the results of tests on bituminous material cores shall comply with the following requirements. The compacted layer thickness as measured from each core shall comply with the thickness requirements stated in the drawings and shall be compatible with the level tolerances stated in contract specification. Non-conformities test report shall be listed in appendix-B and corrective action shall be appendix-C.

4.4.1. Compliance criteria: bituminous material cores

The results of tests on bituminous material cores shall comply with the following requirements:
• The average air void content of the cores taken from an area of bituminous base course or wearing course material shall be not less than 3.0% and not greater than 6.0%.
• The air void content of each core taken from an area of bituminous base course or wearing course material shall be not less than 2.5% and not greater than 7.5%.
• The compacted layer thickness as measured from each core shall comply with the thickness requirements stated in the drawings and shall be compatible with the level tolerances stated in contract specification.

4.4.2. Bridge works:

• Ascertain the quality of cement/ reinforced concrete/reinforced steel/ H.T steel, bridge bearing, pile load test, Concrete Cube test/ Cylinder test/ Slump test/ Pile integrity test/ Standard method of curing of concrete test/ Bridge bearing test etc.

The construction methods and the care and diligence employed by the contractor should be carefully assessed.

4.4.3. Progress

Review progress against the programme and review the history of programme changes (reasons and responsibilities for delays should also be assessed).

Financial

• Check the current estimate against the tendered price using both the Engineers and the contractors management systems;
• Check measurement records and the latest payment certificates and ascertain whether disputes and claims are being dealt with in terms of the contract;
• Check materials on site by sampling and testing and inspection of materials and records;
• Check that all payments to the contractor are as per the contract conditions.
The above assessments/information’s should be presented to the client as a summary report highlighting any actions necessary to ensure successful completion of the project. If there are clear indications from the initial and intermediate audits that there are likely to be problems, the issuance of the Taking over certificate should be held at the client’s sole discretion (without contravening the contract), until the post construction audit is completed, bearing in mind the consequences of this action. It is suggested that provision for this be made in the contract conditions and should be reviewed in terms of the standard conditions of contract.

4.5. Final Audit

This should commence at least four weeks before issuance of the substantial completion certificate and should be completed before the site staff is completely demobilized from site. If an earlier starting time for the final audit is possible without causing disruptions to the project, then it should be encouraged.

The purpose of the final audit is to determine conformance with all aspects of the contract. The principal sources of information will be the as-built plans, test records, measurement and payment data, site correspondence and minutes. Both the actions of the Engineer and the contractor should be assessed.

A principal output of the final audit should be a recommendation for any further testing that is required to assess the quality of the works (post construction audit). The required field and laboratory investigation would follow this immediately and should be concluded within 6 to 8 months of issuing the substantial completion certificate. This is necessary so that deficiencies identified by the post-construction audit can be taken up with the contractor prior to expiry of the defects liability period.

A full report on the project would be presented to the client summarizing any further testing considered necessary and indicating any contractual obligations that have not been fulfilled by either the Engineer or the contractor or any other outstanding matters.
PART B: PRACTICAL ASPECTS
5. **DATA REQUIREMENTS**

5.1. **General**

During any quality audit, all available information must be collected for evaluation. The four phases of a technical audit summarized in section 4 and discussed more fully below lead up to defining the extent of any possible post-construction technical audit, following the final audit.

A full technical audit, after construction has been completed (post construction), is the only phase that would require extensive laboratory and fieldwork. The input in the four phases (Familiarization, Initial, Intermediate and Final) comprises predominantly a performance review and discussions with limited time spent on site. This would include visits to the site offices and a brief visual evaluation of the project in progress.

5.2. **Project Familiarization**

During the project familiarization phase of a technical audit, as much as possible of the existing information regarding the design and progress of the project should be obtained.

This will include:
- Consultant's design and drawings;
- Materials reports;
- Tender documentation including tender evaluation report;
- Bills of quantities;
- Ownership of plant;
- Contractors resources, program and cash flow;
- Visit to site by the auditor before the contractor has mobilized /commenced actual works on site.

All of the necessary data should be made available to the auditor by the roads department and the consultant. Discussion with the designers and client’s engineers may also be necessary.

5.2.1. **Consultant’s Design and Drawings**

All of the drawings and design documents pertaining to the project should be assessed. It is not the duty of the quality auditor, however, to determine whether the design is appropriate for the specific situation. The appropriateness of the project includes diverse considerations such as:
- Planning;
- Political;
- Social;
- Environmental;
- Cost-benefit prioritization issues.

These would normally have been assessed in-house by the roads department prior to tender and it can be assumed that they were considered to be appropriate. This applies equally to issues such as hydrology, drainage, geometric design and safety.

The technical auditor must, however, familiarize himself fully with the background to the project, the pavement design, material types, qualities and quantities (from materials reports) and specific issues relevant to the project. Special cognizance should be taken of any unusual characteristics such as extreme sub-grade conditions, unusual pavement designs or layer thicknesses, perched water tables, saline areas, etc.
5.2.2 Tender Documentation

The audit team shall carefully assess the tender documentation whether the provisions of Public Procurement Act, 2006 and Public Procurement Rules, 2008 and subsequent promulgations are strictly followed. Special conditions of contract should be noted, particularly as they apply to quality control/assurance testing.

It is not within the scope of work of the technical auditor to evaluate the tender prices or process, but aspects that might influence project management or quality of construction need to be highlighted during assessment of the tender documentation. Any examples of apparent negligence should also be noted.

Proposals to use unconventional construction plant or techniques should be noted. Special conditions such as the use of proof rolling should also be identified to ensure that the results of compaction trials are obtained, assessed and properly recorded.

5.2.3 Bills of Quantities

During the audit, the bills of quantities should be assessed by the auditor to identify unusual quantities, spurious prices and to generally familiarize the audit team with the pricing of the project. Aspects likely to result in claims (usually based on past experience) should be noted.

5.3. Preliminary audit

The preliminary audit will require a visit to the site where establishment and methodology issues are generally audited. During this visit the following aspects should be accessed through observation and discussions with site staff:

Management issues (e.g., work schedule, documentation, construction programme, etc);

- Construction methodologies;
- Site laboratories;
- Plant;
- Staff;
- Safety;
- Quality assurance;
- Site instructions.

The availability and quality of documentation (e.g., work programme, laboratory methods, control and approval procedures, etc) and communication among the respective parties should be evaluated.

Problems or deficiencies identified should be brought to the notice of the client as soon as possible in order to rectify methods that could affect the final product. Assessment of the above information should provide the auditor with a good indication of the expected quality of the final project.

5.4. Intermediate audit

The intermediate audit is probably the most important phase in terms of identifying inconsistencies and deviations from conformance with the specifications. It is essential that the following data be obtained, through the client. It shall be specified in the tender documentation that all information will be made available to the auditor for auditing purposes.
• Laboratory test results;
• Daily/weekly/monthly construction records;
• Quality assurance data;
• Site correspondence, site instructions and minutes of meetings, engineers orders, etc.;
• Variation orders and contractors claims;
• Measurement and payment certificates;
• Project management issues;
• Efficiency of contractor’s plant and machinery.

In addition, any other documentation originating from the project should be reviewed. This may include ad hoc reports emanating from the roads department, particularly relating to in-house material testing, quality assurance records, etc.

5.4.1 Laboratory test results

Routine laboratory test results should be inspected to ensure that the correct materials are being utilized, the materials are generally within specification and the laboratory testing is of the expected frequency and quality (QC/ QA). The auditor should inspect the laboratory equipment for calibration and check test procedures methodology for compliance with the project specifications.

5.4.2 Construction records

Daily/weekly/monthly construction progress records should be inspected to identify problems resulting in slow progress as well as periods with greater than expected progress. Unless additional resources were employed, very rapid progress may be indicative of short cuts being taken.

5.4.3 General structural concrete (work process review)

• Minutes from the prep our meeting (attend if possible).
• Forms for support, tightness, form release agent, defects in the lumber, and removal of debris.
• Approvals of the formwork and false work and means of checking deflections during concrete placement operations.
• Approved mix design and source of materials; verify proper sequence for adding admixtures.
• Condition, tying, and support of the reinforcing steel and other imbedded items such as conduits, void spaces bolts for railings, etc; ensure damage to coatings is repaired.
• Inspection and record procedures used for documenting that reinforcing steel and other imbedded items are placed in accordance with the plans and that the number, sizes and splice lengths of bars are verified and correctly summarized for pay purposes.
• Record heat numbers of reinforcement delivered and installed; verify correlation to test reports or certifications.
• Methods used in placing and finishing the concrete.
• Air content and strength testing.
• Time between batching and placement of each load of concrete.
• Procedures for assuring that the riding surface, curbs, and walks etc. conform to the proper grades and cross section.
• Final finishing and curing procedures.
• Fabrication, erection, alignment, and quality of workmanship in the railings.
5.4.4 Evaluate hot-mix asphalt pavements work process review

Prior to observing work, examine plans and prepare meeting minutes. Use these notes to become familiar with work processed to be observed. Discuss procedures established to maintain continuous and effective inspection at all points of work and proper liaison between quarry, plant, and paving operations. Verify that plant production has been designed to meet delivery, lay down, and compaction rates (i.e., continuous production with minimal stops and starts)

- Equipment, to determine whether its type, size, and operation comply with the contract requirements, if applicable.
- Backup equipment in case of breakdowns,
- Procedures for checking and maintaining payment records for asphalt and the asphalt mix and for documenting that all items paid for are actually incorporated into the pavement; pay particular attention to criteria established to define acceptance.
- Diaries, plant and reports, and other day-to-day records of the operations.
- Use of control charts operations.
- Operation of cold-feed proportioning, the dryer, screening, and batching equipment.
- Mixing time.
- Substrata condition ahead of the placement of the hot-mix asphalt (i.e., tack or prime coat, cleaning, patch in, absence of raveling, etc.)
- Adequacy and effectiveness of the contractor’s operations and the STA’s inspection of the laying operations.
- Continuity in the delivery, lay down, and compaction (minimal stops and starts).
- Temperature of the mix versus required range (plant and lay down).
- Thickness and calculated spread rate.
- Slope pavement (eliminate edge drop-offs for errant vehicles).
- Density results.
- Finished section smoothness, cross-section, and transitions.
- Grade match into manholes, curb and gutter, and water valves.
- Work zone safety and control.
- Uniformity of gradation, asphalt content, and other mix properties.
- Applicable contract warranties.

5.4.5 Paving operations work process review

Allow sufficient time to become reasonably familiar with all the operations involved; this should include the beginning and ending of the day's operations.

Verify:

- Type of equipment used and if in compliance with contract requirements.
- Mixing and delivery time is in compliance with contract requirements.
- Adequacy of batch design and batch control.
- Tests for slump, or consistency, and curing concrete test specimens; when possible, witness flexural or compressive tests.
- Frequency and adequacy of control tests.
- Theoretical yield against actual yield to ensure conformity with the specified mix proportions.
• Method of placing concrete.
• Finishing operations including micro and macro texture.
• Curing operations.
• Joint forming, sawing, depth of cut, uncontrolled cracking before or during sawing operations, cleaning, and sealing operations.
• Surface smoothness.
• Pavement thickness as determined from core measurements.
• Applicable contract warranties.

5.4.6 Quality assurance data

Routine density/compaction, thickness and quality control/assurance measurements should be inspected to ensure that the correct quality was achieved. Calibration and control records of nuclear density testing equipment should be inspected. The auditor may take samples or carry out testing to check construction quality if so dictated by his assessment.

5.4.7 Site correspondence

All relevant site correspondence and minutes of monthly meetings should be carefully assessed. Construction problems will usually be identified at these meetings, and disputes between the Client, Consultant and the Contractor can often be indicative of potential problems. Delays due to water or material shortages, compaction problems or other construction issues could all lead to potential “shortcuts” that are not easily identified when construction is complete.

All correspondence associated with progress of the project should be reviewed to identify how smoothly the project is progressing. A full set of site instructions must be obtained.

A high degree of rejection of work by the consultant could indicate that the contractor experienced difficulties meeting the specification giving warning of potential problems this is shown in appendix-B and C.

5.4.8 Variation orders and contractors claims

Variation orders should be assessed against the original design, the effect on cost and whether they were implemented correctly. Variation orders are almost always associated with claims.

5.4.9 Measurement and payment certificates

• Measurement and payment certificates should be compared with the tendered bills of quantities for confirmation of work done;
• It is essential to ensure that all of the specified layers are properly done as per contract specifications.
• Sample payment certificates should be checked and related to the supporting documentation;
• Calculations for delays and contract price adjustment should be in accordance with the conditions of contract. The rates used to calculate amounts must be either the tendered rates or agreed rates with supporting documentation;
• Payments for extensions of time and unforeseen conditions must agree with the approval given by the Engineer;
- Payments for day works should be according to the certificates signed by the contractor and the resident Engineer. The need for day-works can also be evaluated;
- All quantities should be measured in accordance with the pay items.
- Each certificate should be cross-referenced with the Engineer’s and the contractor’s measurements;
- Dimensions of works from typical plans should be checked;
- Where a current certificate is evaluated, the materials on site should be verified. Spot measurement checks may also be required.

5.4.10 Project management problems and issues

The application of good project management principles can be assessed in a number of areas. The contractor's program is a key project management tool. The quality and detail of the program, and progress according to the program should be assessed. Consistency between planned activities and those actually undertaken should be noted as well as resources and time spent. The on-site labor force and plant resources should be pertinent to current activities and adequate for meeting project deadlines. Any excessive delays due to adverse weather should be noted and queried.

Conformance with the requirements of the general conditions of contract as to submission and response dates, certificates of insurance, compliance with statutory submissions for labor, etc. should be reviewed and compliance verified.

Both the contractor and the Engineer should have suitably qualified site personnel to ensure that the project is properly managed.

5.5. Final audit

The final audit carried out when construction is nearing completion makes use of all the information collected during the earlier phases to justify and identify the need for additional investigations. Problems identified and rectified during the initial and intermediate audits should minimize problems likely to be revealed in the final audit.

In addition to the information already available from the earlier audits, it is necessary that the following also be evaluated:

- Consultant’s construction/completion report;
- Performance of the road to date;
- Deflection and riding quality.

The completion report is usually not available immediately after completion of construction. Attempts should, however, be made to have it submitted as soon as possible.

5.5.1 Construction/ completion report

It is essential that the Engineer submits a full completion report as soon as possible after construction has been completed, certainly within 6 months. This should contain all the relevant information regarding progress of the project including all quality control records and test results. This document must be very carefully evaluated. There should be a particular focus on the frequency of testing and completeness of test results, i.e. no areas with missing data.
5.5.2 Performance of the road to date

The performance of the road in the first few months following its opening to traffic can be a crucial indicator of the quality of construction. Usually, parts of the project will have been opened some time prior to completion and the performance of these sections should be assessed. However, good early performance may not necessarily indicate continuing good performance. The road could perform well, for instance, if it is opened to traffic during the dry season but problems resulting from poor materials or construction could manifest as soon as the wet season starts or later during periods of higher than average rainfall.

Aspects to be considered during assessment of the initial performance of the road include:

- The number of areas requiring patching or reconstruction;
- The overall riding quality of the road and evidence of functional distress, e.g. bleeding, raveling;
- Early evidence of structural distress, e.g. deterioration of riding quality, rutting, fatigue cracking, shear failures, potholes, etc.;
- The overall finish of the road a neat, well-finished project is usually, but not always, indicative of a well-executed project;
- Erosion of side slopes and drainage works.

Similar inspection of concrete structures should be carried out to ensure that the concrete quality is (at least visually) acceptable.

5.5.3 Deflection and riding quality surveys

It is standard practice, to carry out deflection and riding quality surveys on all roads as part of the road management system. These are generally carried out at about 2/3 year intervals. It is recommended that these surveys be conducted on all new projects within 6 months of construction (subject to the season as discussed below) by an independent party, in order to assist with the technical audit. The deflection and riding quality surveys shall be carried out as directed by the client.

Deflection surveys should always be carried out at or towards the end of the wet season when the pavement is at its weakest, at intervals of about 100 meters. Although it is not recommended that the information obtained be used to analyse the structural or functional capacity of the project, it can be cost-effectively used in identifying those areas of the project with high variability or that differ significantly from the norm for the road, and may require more detailed investigation.

The deflection and riding quality information would also form the baseline data for most performance service index parameters.

5.5.4 Information required

A checklist of the information required to ensure a successful technical audit is provided in appendix- A. Both the availability and quality of the documentation and information should be evaluated in terms of poor, medium or high for later use during the audit. The quality and quantity of information available has a direct bearing on the extent of the post construction audit. This is covered in detail in section 4 and table 6.1. The total quality of the project work shall be assessed in terms of quality index has been shown in appendix-D. This is measured by multi-criteria analysis (MCA) method and the procedure of quality index assessment has been described in appendix-E and the method of quality index rating has been described in appendix-F.
PART C: ANALYTICAL ASPECTS
6. ASSESSMENT OF AUDIT RESULTS

6.1. Contractual implications

In assessing a project the auditor will be working within the framework of two contracts—one between the client and the Engineer and another between the client and the contractor. Both contracts should be in the possession of the auditor. The contract between the client and the Engineer for professional services requires the contract administration to be done with due care and diligence. The contract between the client and the contractor is more clearly defined in the general and special conditions of contract.

Where the audit leads to the conclusion that either the Engineer or the contractor has been in breach of their respective contracts and that this will lead to under performance of the final product then the audit report should refer to the contracts and where possible the specific terms and clauses. The client will then be guided by the result of the audit in his decision as to whether or not to take appropriate action in terms of the contracts.

6.2. Design compliances

The Engineer’s intentions for the construction of the project are conveyed to the contractor by way of the design drawings. It is important to confirm that all amendments to the design have been approved by the client and that a complete set of signed drawings is or was available to the contractor at all times.

Assessment of compliance by the contractor should, in the first instance, come from a review of the Engineer’s inspection and measurement records including dimension measurements of the roadway, drainage, services, layers and structures. The degree of verification checks that are deemed necessary will depend on the completeness and reliability of the records.

6.3. Material compliances

Material compliance will be evaluated using a statistical technique. Although the strength/stiffness and durability are the primary requirements for pavement materials, a number of other properties are typically specified in the standard specifications and contract documentation. Some of these, e.g. plasticity index, have been developed over time as proxies for other parameters such as strength. Despite this, they are still specified and the contractor undertakes to comply with those specifications.

Statistical acceptance schemes have been developed to take into account the natural variability of construction materials in such a way that the contractor’s risk of material being wrongly rejected is maintained at a low value, whilst at the same time ensuring that the client’s risk of accepting poor quality workmanship is maintained at a similarly low level. These schemes have not yet been generally used for material control during construction and absolute limits are still applicable. This is probably the result of the large degree of natural and testing variability generally associated with rock and soil materials. The technical auditor should bear this in mind during the audit but use some discretion with occasional results that are slightly out of specification for the project.
Graphic plotting of test results is a useful technique for identifying trends along the road. Simple spreadsheets should be used and statistical parameters such as mean, median, standard deviation and coefficient of variation should be determined. Changes in material source or uniform sections can be used to develop subsets of the data and allow more detailed assessment of trends.

6.4. Construction compliances

Statistical methods of quality control are in use for construction and standards for construction tolerances are in the standard specifications. The contractor has thus a definite target to work towards and this should be considered during any technical audit.

Properties such as density, layer thickness and percentage compaction should be plotted and analyzed statistically, as discussed above, for material properties to assess trends and variations.

6.5. Consequences and implications

The consequences of construction tolerances or material specifications not being met can be severe. Instead of the road carrying the traffic it was designed for, a poorly constructed road will require premature maintenance or rehabilitation/strengthening.

The most appropriate method of evaluating the consequences of poor construction or materials is to estimate the remaining structural capacity of the road using deflection measurements and to compare this with the design traffic. If the total cumulative traffic (that already carried plus the remaining structural capacity) is less than the design traffic loading the contractual implications will require careful assessment.

7. REPORTING

7.1. General

All aspects of the technical audit should be carefully and fully reported. In many cases the results of the technical audit could be the most important document affecting the outcome of arbitration or legal proceedings.

In general, technical audit reports tend to contain large quantities of information but should not repeat contract data. To ensure that they are optimally utilised, they should be carefully structured. It is suggested that as much background and supporting information as possible is included in appendices or referred as separate documentation and that the audit reports themselves concentrate only on the critical issues and their implications.

All reports should be comprehensive without being excessively lengthy. It is important that well considered to the point executive summaries are included with all reports.

It is essential that audit reports are submitted as soon as possible in order for the client to institute corrective action. All audit reports should be submitted within 3 weeks of completion of the respective audits.
7.2 **Familiarization phase**

A written report is required from the familiarization phase of the project bringing out clearly deficiencies in design, tendering or other documentation. It is also recommended that the technical auditor prepares notes to assist him with assessment and audits as the project progresses.

7.3. **Preliminary audit**

The report at the end of the preliminary audit should include details of any critical issue that the auditor considers could have a possible influence on the successful completion of the project. The suggested actions of the roads department must be clearly highlighted and prioritized, with summaries of the possible implications of the issue not being rectified. It should be noted that many of the concerns identified at this stage would have a serious impact on successful completion of the project.

7.4. **Intermediate audit**

The report presented after the intermediate audit should be handled in the same manner as the previous report. In this case, however, emphasis should be placed on the material and construction techniques and whether all the issues identified in the earlier phases of the project have been addressed.

7.5. **Final audit**

The report on the final audit will summaries the total project and make recommendations on any further investigation (post construction audit) deemed necessary by the auditors.
PART D: APPENDICES
## APPENDIX A

### Audit plan Stage 1 Audit field level

<table>
<thead>
<tr>
<th>Type of audit/ Standard/ Date of issue:</th>
<th>Quality system audit</th>
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<td>Audit period on site:</td>
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<tr>
<td>Company</td>
<td>Client:</td>
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<tr>
<td>Name of highway</td>
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<td>Section km…… to ……km.</td>
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<tr>
<td>Auditor responsible:</td>
<td>Team leader</td>
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<tr>
<td>Lead auditor/ auditor:</td>
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<td>Audit language(s):</td>
<td>English</td>
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**Audit plan released:** Date __________ Signature Lead Auditor __________

**Audit plan changed:** Date __________ Signature Lead Auditor __________

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Event</th>
<th>Needed documents or documents to be created</th>
<th>Persons/ Departments</th>
</tr>
</thead>
</table>
| 1st day |  | Audit start-Introduction, opening meeting | - Management guidelines.  
- Project quality assurance plan.  
- Project super vision  
Consultant agreement.  
- Contractor quality assurance plan.  
- RHD Organization with authority and responsibilities.  
- Client correspondence  
- Environmental management plan  
- Approved method statements.  
- Approved QC plan.  
- Approved ITP's (inspection and test plan in construction).  
- Consultant review reports.  
- Internal audit reports.  
- NCR's details.  
- Corrective Actions record.  
- Preventive action records. | SE/EE/RE office |
| | | Verification of the system of the organization regarding:  
- Project review  
- Processes and interactions  
- Plant and equipment  
- On site activities inspection  
- Performance data | | |
| | | Break | | |
| | | Verification of the system of the organization regarding:  
- Project review  
- Processes and interactions  
- Plant and equipment  
- On site activities inspection  
- Performance data | - Contractor quality assurance plan.  
- Approved method statements.  
- Calibration reports  
- Site order book  
- Approved  
- Approved QC plan.  
- Approved ITP's.  
- Test reports & MTC's (mill test certificate)  
- Equipment break down reports  
- Equipment ideal time reports  
- Test reports & MTC's (mill test certificate.) | SE/EE/RE office |
<p>| | | Return and end of Day 1 | | |</p>
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<th>Needed documents or documents to be created</th>
<th>Persons/Departments</th>
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</table>
| 2nd day | Verification of the system of the organization regarding: Management system documentation project review processes and interactions objectives of the organization internal audits performance data | - Management guidelines.  
- Project quality assurance plan.  
- Project supervision  
Consultant agreement.  
Contractor quality Assurance plan.  
RHDorganization with authority and responsibilities.  
Client correspondence  
Environmental management plan  
Approved method statements.  
Approved QC plan.  
Approved ITP’s.  
Consultant review reports.  
Internal audit reports.  
NCR’s details.  
Corrective actions record.  
Preventive action records. | SE/EE/RE office |
| | Verification of the system of the organization regarding: Project review processes and interactions plant and equipment on site activities inspection performance data | - Approved method statements.  
- Calibration reports  
- Site order book  
- Approved QC plan.  
- Approved ITP’s.  
- Test reports & MTC’s.  
- Equipment break down reports  
- Equipment ideal time reports  
- Test report & MTC’s. | SE/EE/RE office |
| | Verification of the system of the organization regarding: Management system documentation project review processes and interactions objectives of the organization internal audits performance data | - Contractor quality assurance plan.  
- Approved method statements.  
- Approved QC plan.  
- Approved ITP’s.  
- Consultant review reports.  
- Site order register  
- Test reports & MTC’s. | SE/EE/RE office |
<p>| | Return and end of Day 2 | | | |</p>
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<th>Time</th>
<th>Event</th>
<th>Needed documents or documents to be created</th>
<th>Persons/ Departments</th>
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</table>
| 3rd day  |      | Verification of the system of the organization regarding: Management system documentation project review processes and interactions objectives of the organization internal audits performance data | - Management guidelines.  
- Project quality assurance plan.  
- Project supervision  
Consultant agreement.  
- Contractor quality assurance plan.  
- PSC organization with authority and responsibilities.  
- Client correspondence  
- Environmental management plan  
- Approved method statements.  
- Approved QC plan.  
- Approved ITP’s.  
- Consultant review reports.  
- Internal audit reports.  
- NCR’s details.  
- Corrective actions record.  
- Preventive action records. | SE/EE/RE office                                |
|          |      | Break                                                               | - Contractor quality assurance plan.  
- Approved method statements.  
- Approved QC plan.  
- Approved ITP’s.  
- Consultant review reports.  
- Site order register  
- Test reports & MTC’s. |                                               |
|          |      | Return and end of Day 3                                             |                                                                                                              |                             |
| 4th day  |      | Verification of the system of the organization regarding: Management system documentation project review processes and interactions objectives of the organization internal audits performance data | - Project quality assurance plan.  
- Project supervision guidelines  
Consultant agreement.  
- Contractor quality assurance plan.  
- RHD organization with authority and responsibilities.  
- Client correspondence  
- Environmental management plan  
- Approved method statements.  
- Approved QC plan.  
- Approved ITP’s.  
- Consultant review reports.  
- Internal audit reports.  
- NCR’s details.  
- Corrective actions record.  
- Preventive action records. | SE/EE/RE office                                |
|          |      | Return and end of Day 4                                             |                                                                                                              |                             |
|          |      | Auditors discussions and finalization of NCR’s                      |                                                                                                              |                             |
|          |      | Closing Meeting at Project Director Office                         |                                                                                                              |                             |
|          |      | The company has to put a room at the audit team disposal for their vote. |                                                                                                              |                             |
## List of audit participants

### Opening meeting

#### Audit cycle no.

<table>
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Closing meeting
Audit cycle no.

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## List of inspected documents

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<tbody>
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<td>1.</td>
<td>Consultant contract agreement.</td>
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<td>Quality assurance plan</td>
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<td>3.</td>
<td>Construction supervision guidelines</td>
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<tr>
<td>4.</td>
<td>Manpower deployment records.</td>
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<tr>
<td>5.</td>
<td>Correspondence between consultant and RHD</td>
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<tr>
<td>6.</td>
<td>Correspondence between consultant and contractor</td>
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<td>7.</td>
<td>(Request for Information) RFI's records</td>
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<td>8.</td>
<td>Monthly progress reports</td>
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<td>9.</td>
<td>Quarterly progress report</td>
</tr>
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<td>10.</td>
<td>Input materials records.</td>
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<td>11.</td>
<td>Manufacturer test reports of purchased products.</td>
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<td>12.</td>
<td>Contractor's Lab records(QA/QC) (a) Test Reports (b) Calibration reports (c) Mix design reports.</td>
</tr>
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<td>13.</td>
<td>Plants &amp; equipments records.</td>
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<td>14.</td>
<td>Site instruction records.</td>
</tr>
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<td>15.</td>
<td>Design &amp; drawing review records.</td>
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<td>16.</td>
<td>Setting out records</td>
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<td>Environmental management plan.</td>
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<td>Statutory approvals</td>
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<td>20.</td>
<td>Minutes of monthly meeting on safety and environmental reviews</td>
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<td>21.</td>
<td>Minutes of monthly meeting on progress review</td>
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</table>
### APPENDIX  B

On site audit report
Action list

#### A) Non-Conformities

A root cause analysis and the implementation of corrective actions for all non-conformities must be completed and verified by the auditor latest 45 days.

For non-conformities, which will be verified and checked for effective implementation during the next audit, corrective actions must be submitted from the company to the auditor latest 30 days after the last audit day.

<table>
<thead>
<tr>
<th>Chapter (Audit checklist)</th>
<th>Process Evaluation</th>
<th>Description of non-conformity</th>
<th>Root cause analysis of the company</th>
<th>Corrective action of the company</th>
<th>Responsible /Date</th>
<th>Corrective action</th>
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On site audit report

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Company name:  
Audit period:  

Verific. Effect.
### On site audit report

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Non-conformity:  
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On site audit report
Action list

Company name:                      Audit period:

### Information about the handling of corrective action - Criteria that must be fulfilled for auditors to accept corrective action

1. **Is immediate action required to prevent recurrence and / or delivery of non conforming parts?**
   - In what instances has the system failed, allowing this non-conformity to occur?

2. **Have the root causes under lying problem occurrence been identified? Has this been done using an adequate method?**
   - If further external customers or projects maybe concerned, have measures been taken to limit or correct the problems and protect these parties or projects?

3. **Is the problem system-related?**
   - A specific incidence is not a system-related problem.

4. **Have measures to limit the problems involved in the specific incidences been taken?**
   - Changes in the system, unspecified employees, procedures etc?
   - And the identified under lying causes?

5. **Does corrective action defined by the organization also take the following in to account?**
   - Changes in the system, unspecified employees, procedures etc?
   - The root cause must be determined within the 30-day period and corrective action implemented and verified by the auditor by then. In cases involving long-term solutions (Programming, new machinery, investments, etc.) proof of initiation may be furnished.
   - Documented evidence, e.g. action catalogue, instructions, records, to furnish proof that the non-conformity has been corrected, including the names of the persons responsible, or direct on-site verification within 30 days.
   - In the follow-up-audit these measures must be followed up and verified and the non conformity closed.
## Corrective action report

Comments / Compliance on site audit report

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description of non-conformity</th>
<th>Standard</th>
<th>Root cause analysis</th>
<th>Corrective action</th>
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## APPENDIX D

### Quality index

**Work site safety management**

Individual component/ Aspect marking scale

### 1. Traffic management

<table>
<thead>
<tr>
<th>Mark/s</th>
<th>Sub-component</th>
<th>Marks obtained</th>
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<tbody>
<tr>
<td>3</td>
<td>Preparation (Adequacy) and timely submission of traffic management / control plan (addressing specific site requirement)</td>
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<td>3</td>
<td>Execution of traffic management / control arrangements vis-a-vis the approved plan.</td>
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<td>6</td>
<td>Total</td>
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### 2. Traffic safety measures in work zones.

Include signage (including advance warning signage), portable and permanent barricading devices, delineators, cones, flagmen and sandbags.

<table>
<thead>
<tr>
<th>Mark/s</th>
<th>Sub-component</th>
<th>Marks obtained</th>
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<tbody>
<tr>
<td>1</td>
<td>Provision of traffic safety measures in the highway work zones (as defined in IRC SP:55)</td>
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<tr>
<td>1</td>
<td>Provision of traffic safety measures at diversions</td>
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<tr>
<td>1</td>
<td>Provision of traffic safety measures at structure construction sites (fly-over, ROB, Bridge, Underpass and Culvert construction sites).</td>
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<tr>
<td>1</td>
<td>Safety provisions near / at deep excavations</td>
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<tr>
<td>1</td>
<td>Night-time safety measures</td>
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<tr>
<td>1</td>
<td>Regular maintenance/ cleaning of barricading, signage and other safety devices</td>
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### 3. Dust control.

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<tbody>
<tr>
<td>1</td>
<td>Availability of sufficient number of water tankers for sprinkling water</td>
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<tr>
<td>1</td>
<td>Dust control in / along works on the highway</td>
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<tr>
<td>1</td>
<td>Availability and use of sprinkling system/s at crusher sites</td>
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<tr>
<td>1</td>
<td>Dust control in plant sites (stack yard, circulation area)</td>
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<tr>
<td>1</td>
<td>Dust control on haul roads</td>
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<tr>
<td>1</td>
<td>Regular cleaning of the road surface (lane/s where there is traffic movement)</td>
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### 4. Road maintenance

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<td>2</td>
<td>Maintenance of main carriageway</td>
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<tr>
<td>2</td>
<td>Maintenance of shoulders</td>
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<tr>
<td>2</td>
<td>Maintenance of haul roads</td>
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### 5. Transportation and storage of materials

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<tr>
<td>1</td>
<td>Cover on materials during transportation</td>
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<tr>
<td>1</td>
<td>Proper stacking of fine material such as stone, dust, sand, cement, etc.</td>
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<td>1</td>
<td>Proper storage of hazardous and toxic materials</td>
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<td>1</td>
<td>Proper storage of inflammable materials, chemicals &amp; explosives (at crushers)</td>
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<tr>
<td>1</td>
<td>Safety measures during loading and unloading operations</td>
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<tr>
<td>1</td>
<td>Over-all housekeeping in the camp and plant site.</td>
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6. **Fire safety practices**
Includes identification and demarcation of ‘no smoking zones’ and provision of appropriate firefighting equipment.

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<tr>
<td>1</td>
<td>Fire safety practices in the camp office and staff/workers accommodation area</td>
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<td>1</td>
<td>Fire safety practices at plant site (Hot Mi Plant, Batching plant, Crusher, WMM plant)</td>
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<tr>
<td>1</td>
<td>Fire safety practices at diesel pump</td>
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<td>1</td>
<td>Fire safety practices in the workshop and storage area of lubricants, chemicals and other inflammable materials</td>
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<td>1</td>
<td>Fire safety training to workers and staff (such as awareness about different types of fire extinguishers and their use)</td>
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<td>System for regular inspections/ checks of fire safety equipments.</td>
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7. **Electrical safety practices**
Includes provision of appropriate installations / devices; protection from exposure to water, use of proper cables/ wires and provision of proper installation, ear thing, circuit breakers.

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<td>Electrical safety practices at camp office and staff accommodation area</td>
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<td>1</td>
<td>Electrical safety practices at plant sites (Hot mix plant, Batching plant, Crusher, WMM plant)</td>
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<td>Electrical safety practices at structure construction sites-(Fly-over, ROB, Bridge, Underpass and Culvert construction sites)</td>
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<td>Electrical safety practices in the workers living area/labour-camp</td>
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<td>Electrical safety practices in the workshop/s and storage areas of lubricants, diesel and other inflammable materials</td>
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<td>System for regular inspections/ checks of electrical equipment / installation</td>
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8. **Mechanical safety practices**
(Includes plants, Heavy machinery/ Equipment, Vehicles) Electrical safety practices

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<td>2</td>
<td>Mechanical safety provisions at plants sites (Hot mix plant, batching plant, Crusher, WMM plant)</td>
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<tr>
<td>1</td>
<td>Use of vehicles / equipments with tall boards (in tippers), reflective triangles, backlights 9in working order)a and safety rod (at the back of the vehicle)</td>
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<td>1</td>
<td>Use of vehicles / equipments with reverse home</td>
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<td>Safety practices – cranes/ lifting machines/ hoists</td>
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<td>System for regular inspections / checks for vehicles/ equipment/machinery.</td>
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### 9. Worker's safety

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<td>Identification of activity based PPE requirement (It is important to understand the type of PPE required for different activities which depends upon the particular risk associated with it)</td>
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<tr>
<td>1</td>
<td>Identification and demarcation of 'hard hat areas' also called helmet zone</td>
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<tr>
<td>1</td>
<td>Provision and enforcement of PPE during various road works (including surveys, marking on the road and various activities in the main carriageway and service road)</td>
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<tr>
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<td>Provision and enforcement of PPE at plant sites (Hot mix plant, WMM plant Batching plant crusher)</td>
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<tr>
<td>1</td>
<td>Provision and enforcement of PPE at structure construction sites (Fly-over, ROB, Bridge Underpass and Culvert construction sites)</td>
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<tr>
<td>1</td>
<td>Provision of training or awareness generation among workers and other staff about the need and correct use of PPE.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
</tr>
</tbody>
</table>

### 10. First aid & emergency response arrangements

<table>
<thead>
<tr>
<th>Mark/s</th>
<th>Sub-component</th>
<th>Marks obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Provision of proper first-aid box in the camp/s, plants and structure construction sites</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Availability of doctor/paramedical staff</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Medical check-up for workers</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Preparation of an emergency response plan</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Implementation of the emergency response plan (includes assembly points. warning devices like hooter/alarms, display of emergency numbers at various locations. emergency response equipment, basic training for response during emergency situations and provis</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Maintenance of accident records on the required format</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX E

Quality Index

1.0. Introduction:

For each important item of work, certain attributes are listed which contribute or affect quality of that item. Individual scores are then assigned to each of the attributes on a scale of 0 to 5 depending on observations and scrutiny of that attribute of that site. The sum total of the scores of all attributes for particular item divided by maximum score achievable is termed as quality index of that item.

Considering the agreement condition, statutory requirements and the documentation requirements 20 attributes are listed which contributes or affect the quality system.

These 20 attributes are sub-divided into 3 categories with certain weightage Attributes category;
A – with 50% weightage
B – with 30% weightage
C - with 20% weightage

Each attributes under category 'A' carries a weightage of ‘10’
Each attributes under category 'B' carries a weightage of ‘6’
Each attributes under category 'C' carries a weightage of ‘2’

> Individual source are assigned to each of these attributes on a points scale of 0 to 5 depending on performance standards as per quality system requirements.
> Total score of an individual attribute is the product of weight age of that attribute and the point score allotted against the respective attribute.
> Maximum score achieved will be product of total weight age i.e. ‘100’ and maximum points for each attribute i.e. ‘5’. This shall be equal to '500'.
> The ratio of sum total of the all attributes for the particular audit cycle over maximum score and appropriately converted to a scale of 0-10 is termed as quality index for that audit cycle.

The quality index will be measured on the scale of 0-10. This scale measure will be up to two decimal points.

2.0. Quality Index:

Eased on the on-site quality system audit followed by follow up audit, the quality index for this audit cycle is worked out and the working of the quality index is attached as annexure-5.

The quality index obtained for this audit cycle on scale of 0-10 is 7.9
## APPENDIX F

### Quality Index

<table>
<thead>
<tr>
<th>Quality index rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audit cycle no.</td>
</tr>
<tr>
<td>Prevision consultant</td>
</tr>
<tr>
<td>Period of on-site audit</td>
</tr>
<tr>
<td>Period of follow-up audit</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No.</th>
<th>Attributes (A)</th>
<th>Performance standards</th>
<th>Weight age (50%)</th>
<th>Points on (0-5)</th>
<th>Score</th>
</tr>
</thead>
</table>
| 1   | Deployment of manpower as per agreement conditions | a) For TL -1.5 points.  
b) RE, BE and HE -1 Point each.  
c) Visit of Engineer designate - 0.5 Points. | | | |
| 2   | Issue and control of GFC drawings | a) Control & maintenance of design issue/receipt register-1 point.  
b) Review of adequacy prior to issue and approval-1 point.  
c) Review, up-date & re-approval system followed during changes-1 point.  
d) Identification of revision status and changes made is reflected on revised drawings-1 point.  
e) Steps taken to ensure that the unintentional use of obsolete drawings is prevented and that the latter are suitably identified-1 point. | | | |
| 3   | Implementation of EMP | a) Approved EMP available-1 point.  
b) All pollution control board consents obtained-1 point  
c) Environmental engineer regularly visited and report submitted-1 point.  
d) Regular monitoring of pollutants done as per consent requirements-1 Point.  
e) Implementation of EMP-1 point. | | | |
| 4   | Implementation of safety plan | a) Approved safety plan available-1 point.  
b) Implementation of safety for traffic by providing adequate safety sign boards and caution boards-1 points.  
c) Safety Engineer regularly visited and report submitted-1 point.  
d) Accident records are maintained, analysed and suitable precautions taken.-1 point.  
e) Implementation of safety for workers by providing adequate No. of Helmets, Safety shoes, safety belts etc.-1 point. | | | |
| 5   | Source approvals of input materials | a) Source approvals for all input materials are available-1 point.  
b) System of test witnessing/factory visit for evaluating the quality of production if followed-2 points.  
c) Intermediate testing of materials in third party lab conducted to ascertain consistency of quality-2 points. | | | |
No. | Attributes (B) | Performance standards | Weight age (50%) | Points on (0-5) | Score |
--- | --- | --- | --- | --- | --- |
6 | Control of records | a) All quality system records are legible, indexed and properly filed-2 points.  
   b) All records are properly identified and stored. Responsibility of the person for storage and retention defined-1 point.  
   c) All the records are stored till retention period and disposed properly after retention period-2 points. |  |  |  |
7 | Calibration of plant & equipment | a) All the Equipments, Batching plant, Hot mix plant, WMM plant were calibrated-2 points.  
   b) Calibration and adjustments done at regular intervals-1 point.  
   c) Master calibration reports available-1 point.  
   d) If the equipments is found not to conform to calibration requirements, previous measuring results are be re-assessed and documented-1 point |  |  |  |
8 | Number of major NCR’S raised during on-site quality system audit | a) No NCR’s raised-5 points OR  
   b) NCR’s raised between 1 to 5-4 OR  
   c) NCR’s raised between 6 to 10-3 points OR  
   d) NCR’s raised between 11 to 15-2 points OR  
   e) NCR’s raised between 16 to 20-1 points OR  
   f) NCR’s above 20-0 points |  |  |  |
9 | Time taken to close NCR’s | a) Corrective action reported within 30 days for all NCR’s-5 points OR  
   b) Corrective actions reported after 30 days for all NCR’s-4 points OR  
   c) Corrective actions reported within 30 days only for few and balance NCR’s are pending-3 points OR  
   d) Corrective actions reported after 30 days only for few and balance NCR’s are pending-2 points OR  
   e) Corrective actions reported after 60 days-0 points |  |  |  |
10 | Closure of NCR’s | a) All NCR’s closed-5 points, 75% closed-4 Points, 50% closed-3 points, 25% closed-2 points, Less that 25%-0 points. |  |  |  |
<table>
<thead>
<tr>
<th>No.</th>
<th>Attributes (C)</th>
<th>Performance Standards</th>
<th>Weightage (50%)</th>
<th>Points on (0-5)</th>
<th>Score</th>
</tr>
</thead>
</table>
| 11  | DPR review                                                                      | a) Complete review of DPR done and report available in complete-4 points OR  
   b) Review limited to BOQ items only-3 points OR  
   c) Review carried out on need basis-2 points OR  
   d) Review not done-0 Points  
   e) Value of comments (Value addition)-1 point |                                                                          |                 |                |       |
| 12  | Review and approval of contractor work program with respect to work program     | a) Work program/Revised WP reviewed, approved and progress monitoring is as per approved work program-5 points OR  
   b) Work program/Revised WP reviewed, approved but progress monitoring is not as per approved work program-3 points OR  
   c) No approved work program-0 points |                                                                          |                 |                |       |
| 13  | Supervision guidelines                                                          | a) Guidelines prepared but not up to the mark-2 points OR  
   b) Guidelines not prepared-0 points  
   periodic review of supervision guidelines for improvement-1 point |                                                                          |                 |                |       |
| 14  | Quality assurance guidelines                                                    | a) QAM is adequate enough and is being followed-5 points  
   OR contractor submitted QAM and consultant has reviewed & approved but QAM is not up to the mark vis-à-vis RHD's quality assurance manual-3 points OR  
   c) QAM prepared (whether adequate/non adequate) but not being followed-0 points |                                                                          |                 |                |       |
| 15  | Disposal of RFI's                                                               | a) Numbering system of RFI's is followed-1 point  
   b) Approved RFI's are invariably carrying signature of contractor and consultant's representative for authentication-2 points  
   c) New RFI is raised against previously rejected RFI's and properly sequenced and system for its traceability followed-1 point  
   d) RFI's are disposed in time and instances of work suffered not noticed during audit because of delay in disposal of RFI-1 point |                                                                          |                 |                |       |
| 16  | Coordinating review meetings with contractor & RHD                              | a) Regular coordinating meetings are conducted-2 points  
   b) Coordinating meeting minutes documented-2 points  
   c) Review of previous meeting points done before new agenda taken-1 points |                                                                          |                 |                |       |
| 17  | Approved method statements                                                      | a) Method statements are submitted in full, activity wise and approved before start of activity-5 points OR  
   b) Method statements submitted in piece-meal manner for individual activity but before start of activity-3 points OR  
   c) Method statements not available-0 points |                                                                          |                 |                |       |
| 18  | Establishment of independent Laboratory (If not applicable total points to be considered) | a) Established and tests conducted and records available-5 points OR  
   b) Established but record of tests conducted at regular intervals not available-3 points OR  
   c) Not established-0 points |                                                                          |                 |                |       |
| 19  | Implementation of check list                                                    | a) Check lists of all activities available and used correctly-5 points OR  
   b) Check list available for few activities and used correctly-3 points OR  
   c) Check lists not available-0 points |                                                                          |                 |                |       |
<table>
<thead>
<tr>
<th>No.</th>
<th>Attributes (C)</th>
<th>Performance Standards</th>
<th>Weight age (50%)</th>
<th>Points on (0-5)</th>
<th>Score</th>
</tr>
</thead>
</table>
| 20  | Approval of mix design | a) Mix design reviewed and approved before activity started (also applicable for revised approval of mix design in case of change of source)-5 points OR  
|     |                     | b) Mix design reviewed but only provisional approval given-4 points OR  
|     |                     | c) Mix designs not approved/approval given after commencement of work-0 points OR     |                  |                |       |

**Total Score Obtained**

Quality index over a scale of 1 to 10

*Note: this Quality index is arrived based on the facts and figures verified during the period of onsite and follow-up audit. This cannot be treated as overall performance of the consultant and cannot be used as for any other purpose*
APPENDIX G

ABBREVIATIONS

CBR - California Bearing Ratio
DCP - Dynamic Cone Penetrometer
DFID - Department for International Development
10% Fines - Ten Percent Fines Value
ACV - Aggregate Crushing Value
LA - Loss angels’ abrasion Value
TRL - Transport Research Laboratory, UK
UCS - Unconfined Compressive Strength
PI/PL - Plasticity Index/Plastic limit
OMC - Optimum Moisture content
MDD - Maximum day density
LL - Liquid limit
QC - Quality control
QA - Quality Assurance