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Technical Assistance for Implementation of Institutional Reforms in the Road Sector of Uttar Pradesh

ESTABLISHING QUALITY MANAGEMENT FRAMEWORK AND DEDICATED HQ UNIT AND RESOURCES (FINAL)

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Glossary

ADB	Asian Development Bank
ADT	Average Daily Traffic
AE	Assistant Engineer
BOOT	Build Own Operate Transfer
BOT	Build Operate Transfer
CBR	California Bearing Ratio
CC	Cement Concrete
CE	Chief Engineer
CEO	Chief Executive Officer
CRF	Central Road Fund
CRRI	Central Road Research Institute
CSR	Civil Service Reforms
DAO	Divisional Account Officer
DBC	Dense Bitumen Concrete
EE	Executive Engineer
E-in-C	Engineer in Chief
GNP	Gross National Product
GO	Government Order
GOI	Government of India
GoUP	Government of Uttar Pradesh
GSDP	Gross State Domestic Product
HDM	Highway Design Model
HGV	Heavy Goods Vehicle
HO	Head Office
HQ	Head Quarter
HR	Human Resource
HRD	Human Resource Development
IBRD	International Bank for Reconstruction and Development
IDS	Institutional Development Strategy
IDSP	Institutional Development And Strengthening Plan
IRC	Indian Road Congress
IT	Information Technology
ISAP	Institutional Strengthening Action Plan
ISO	International Organisation for Standardisation
JE	Junior Engineer
MDR	Major District Roads
MLA	Member of Legislative Assembly
MIS	Management Information System
MOST	Ministry of Surface Transport
MoSRTH	Ministry of Shipping, Road Transport & Highways
MoRTH	Ministry of Road Transport and Highways
MSS	Mixed Seal Surface
NABARD	National Bank of Agricultural and Rural Development
NITHE	National Institute for Training of Highway Engineers
NH	National Highway
NHAI	National Highways Authority of India
ODR	Other District Road
OMC	Optimum Moisture Content
PCC	Project Coordinating Consultant
PCI	Pavement Condition Index
PCU	Passenger Car – equivalent Unit
PMS	Pavement Management System
PMGSY	Pradhan Mantri Gram Sadak Yojana
PRI	Panchayat Raj Institution
PWD	Publics Works Department
QA	Quality Assurance
QC	Quality Control
QM	Quality Management
RES	Rural Engineering Services
RIDF	Rural Infrastructure Development Fund
RMMS	Road Maintenance Management System
RSPEU	Road Safety Planning and Engineering Unit
RSC	Road Safety Cell
SDBC	Semi Denise Bitumen Carpet
SE	Superintending Engineer
SH	State Highway
SRF	State Road Fund
SRP-II	State Road Project-II
SRB	State Road Safety Board
SRSF	State Road Safety Fund
TA	Technical Assistance
ToR	Terms of Reference
TNA	Training Needs Assessment
UP	Uttar Pradesh
UPRNN	Uttar Pradesh Rajkiya Nirman Nigam
UPSBCC	Uttar Pradesh State Bridge Construction Corporation
UPSRTC	Uttar Pradesh State Road Transport Corporation
UPSRP	Uttar Pradesh State Road Project
UPSHA	Uttar Pradesh State Highway Authority
UNDP	United Nations Development Programme
VOC	Vehicle Operating Cost
VR	Village Roads
WB	World Bank
WBM	Water Bound Macadam

1. BACKGROUND

Delivery of quality road infrastructure has been accorded high priority by the UPPWD. As part of the endorsed Policy and Institutional Development Study, 2002, Quality Management finds an important to position in the working of PWD. In fact, establishing Quality Management framework and establishment of a dedicated unit in Head Quarters of PWD was agreed by the Government of UP. This report focusses on it.

2. CONCEPT OF QUALITY MANAGEMENT

2.1 BACKGROUND

The basic mandate of PWD is to provide a safe, comfortable, efficient and economical transportation infrastructure system for the public to use. In order to achieve the objective and to ensure that the required level of quality of product (i.e., roads), is in fact offered to the public, a number of events, elements, organisation, personnel, policies, processes, procedures and documents which have to be in place which will guaranty that the PWD continues to provide satisfactory roads for the public to use. These " coordinated activities to direct and control an organisation (i.e., PWD) with regard to quality" is called Quality Management. Quality Management includes all the activities that managers carry out in an effort to implement their quality policy. These activities include :

- Quality Planning
- Quality Control
- Quality Assurance
- Quality Audit, and
- Quality Improvement.

The technical definitions of the above terms and their meanings are as given below:

2.2 QUALITY PLANNING

"Part of Quality Management focussed on setting quality objectives and specifying necessary operational processes and related resources to fulfil the quality objectives." In other words, it is defined as a set of activities whose purpose is to define quality system policies, objectives and requirements, and to explain how these policies will be applied, how these objectives will be achieved and how these requirements will be met. It is always future oriented.

2.3 QUALITY CONTROL (QC)

"The operational techniques and the activities used to fulfil requirements of quality". Alternatively, it is a set of activities or techniques whose purpose is to ensure that all quality requirements are being met. In order to achieve this purpose, processes are monitored and performance problems are solved.

2.4 QUALITY ASSURANCE (QA)

"All those planned or systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality." It is a set of activities whose purpose is to demonstrate that an entity meets all quality requirements. Quality Assurance activities are carried out in order to inspire confidence of both managers and users, confidence that all quality requirements are being met.

2.5 QUALITY AUDIT

"A systematic and independent examination to determine whether quality activities and results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives. " It is also known as Quality Assessment or Conformity Assessment. It essentially examines the elements of a quality management system to evaluate how well these elements comply with quality system requirements.

2.6 QUALITY IMPROVEMENT

"Part of Quality Management focussed on increasing the ability to fulfil quality requirements." Quality Improvement refers to anything that enhances an organization's ability to meet quality requirements.

2.7 RELEVANCE TO PWD

For example, in the context of PWD, let us take the case of a construction contract. First a need for some work is identified and defined. This is done in accordance with a laid out policy supported by survey and other data. Then, to satisfy the need, the code of engineering practice comes into force, which stipulates the materials to be used in construction, including various tests of acceptance; then there are design guidelines to arrive at the optimum design, and finally the code deals with the specifics of construction to ensure that the finished product meets the intended requirement and quality, and continues to perform satisfactorily for a stipulated period in the future. At each step, there is a management approved policy, called Quality Policy, in existence. Then the work is carried out in accordance with well established or laid out principles or plan, which ensures a quality product or design. This is called Quality Plan. Then there is an independent audit, called Quality Audit, to review the whole or part of the system. The entire process is called Quality System.

2.8 QUALITY CONTROL VS QUALITY ASSURANCE

By the 1970s, the statistically based specifications had been incorporated into QA programmes with a strong dependence on statistical analysis. With the development of these programmes came the recognition of a need for separate quality (process) control and acceptance functions. Part of this recognition was the realisation by the specifying agency that the contractor, or producer, was in the best position to conduct the process control function, because it depended on the contractor's personnel and equipment. The acceptance function was agreed to be an agency function to ensure that satisfactory quality control has been exercised and that the proper degree of compliance to the specifications has been attained. These definitions of the parts of a QA system have been formalised and widely adopted.

The evolution has continued to where performance related specifications (PRS) are now being developed; that not only describe the desired levels of selected quality characteristics, but also employ quantified relationships containing these characteristics to predict subsequent pavement performance.

One of the important element associated with QA performance has been differing interpretation of the terms used in QA programmes. In order to clarify, any misunderstanding in this regard, the key terms are defined below. These definitions are now standardised and are now almost universally accepted.

Quality:

- The degree of excellence of a product or service
- The degree to which a product or service satisfies the needs of a specific customer
- The degree to which a product or service conforms with a given requirement

Quality Control (QC)

Also called process control. These QA actions and considerations necessary to assess and adjust production and construction processes so as to control the level of quality being produced in the end product.

Acceptance

Sampling and testing, or inspection, to determine the degree of compliance with contract requirements.

Quality Assurance (QA)

All those planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service. [QA addresses the overall problem of obtaining the quality of a service, product, or facility in the most efficient, economical and satisfactory manner possible. Within this broad context, QA involves continued evaluation of the activities of planning, design, development of plans and specifications, advertising and maintenance, and the interactions of these activities.]

By these definitions, therefore, QA is a combination of QC and acceptance.

The table below assists to clarify the difference between quality control (QC) quality assurance (QA).

QC	QA
Making the quality of a product what it should be	Making sure the quality of a product is what it should be
Doing things right	Doing the right things
A producer/contractor responsibility	A highway agency responsibility
A part of QA	Includes QC
Motivated by QA and acceptance producers	Motivates good QC practices

The above is an idealised/generalised description of the concept of QC/QA. There are innumerable ways as to how highway agencies actually use it in practice. For example, many agencies use contractor's testing data for acceptance, while others do not. Therefore, it is important that the system to be designed is responsive to local needs and conditions, be fair and practical, and still meet the requirements of acceptance and quality assurance.

3. APPRECIATION OF ISO 9000

3.1 BACKGROUND

In order to best fulfil customer or user needs, requirements, and expectations, effective organisations create and utilize quality systems. Within a quality management system, the necessary ingredients exist to enable the organisation to identify, design, develop, produce, deliver, and support products or services, that the customer or user wants. Effective quality management systems are dynamic, able to adapt and change to meet the needs, requirements, and expectations of their customers or users. Effective organizations use standards such as ISO 9000 to provide guidance for establishing their quality management system's structure, maintaining records, and using quality techniques to improve processes and systems.

ISO 9000 series of international standards began in 1979 to facilitate the multinational exchange of products and services by providing a clear set of quality system requirements. In 2000, the ISO 9000 standards were revised significantly, so that their structure more closely resembled the way organizations are managed. The wording of the standard was made more generic so that it is applicable to a wider variety of business sectors, including government services, business enterprises, e-business, manufacturing and service industries.

3.2 PRINCIPLES OF ISO 9000

There are eight key principles that have been included in the ISO 9000:2000 standards. These are:

- Customer-focussed organization
- Leadership
- Involvement of people
- Process approach
- Systems approach to management
- Continual improvement
- Factual approach to decision making
- Mutually beneficial supplier relationship

3.3 APPROACH OF ISO 9000 / 9001

ISO 9001:2000 takes a process-oriented approach. The standard focusses on quality management systems and requires the identification of quality management processes as well as their sequence and their interactions with key processes. A quality management system describes the organizational structure, procedures, and resources necessary to manage quality. The ISO 9000 requirements describe what an organization must accomplish in order to meet customer or user expectations. However, how these goods are accomplished is left up to the particular organization.

3.4 ELEMENTS OF ISO 9000 / 9001

ISO 9001:2000 consists of four main sections:

1. Management Responsibility

- Management commitment
- Customer/user focus
- Quality policy
- Planning
- Responsibility, authority and communication
- Management review

2. Resource Management

- Provision of resources
- Human resources
- Infrastructure
- Work environment

3. Product and/or Service Realization

- Planning of product realization
- Customer/user-related processes
- Design and development
- Purchasing
- Product and service provision
- Control of monitoring or measuring devices

4. Measurement, Analysis and Improvement

- General
- Monitoring and measurement
- Control of non-conforming product
- Analysis of data
- Improvement

ISO 9001 focuses on 20 key requirements: To illustrate the scope of the requirements, consider the first one, Management Responsibility. To meet this standard an organization must

- establish, document, and publicize its policy, objectives, and commitment to quality;
- designate a representative with authority and responsibility for implementing and maintaining the requirements of the standard;
- provide adequate resources for managing, performing work, and verifying activities including internal quality audits;
- conduct in-house verification and review of the quality system. These reviews should consider the results of internal quality audits, management effectiveness, defects and irregularities, solutions to quality problems, implementation of past salutations, handling of nonconforming product, results of statistical score-keeping tools, and the impact of quality methods on actual results.

A brief summary of the basic requirements for the remaining 19 elements of ISO 9001 are summarized below:

- Quality system: The organization must write and maintain a quality manual that meets the criteria of the applicable standard and defines conformance to requirements. The company must effectively implement the quality system and its documented procedures and prepare quality plants for determining how requirements will be met.
- Contract review: The organization must review contracts to assess whether requirements are adequately defined and whether the capability exists to meet requirements.
- Design control: The organization must verify product design to ensure that requirements are being met and that procedures are in place for design planning and design changes. This includes documenting plans for each design and development activity, defining organizational and technical interfaces, validating outputs against design input requirements, and describing design verification and validation procedures.
- Document and data control: The organization must establish and maintain procedures for controlling documentation and data through approval, distribution, change, and modification.
- Purchasing: The organization must have procedures to ensure that purchased products conform to requirements. This includes evaluating subcontractors preparing clearly written purchasing documents, and verifying purchased products.
- Control of customer-supplied products: Procedures to verify, store, and maintain items supplied by customers must be established.
- Product identification and traceability: The organization must identify and trace products during all stages of production, delivery, and installation.
- Process control: The organization must carry out production processes under controlled conditions. The processes must be documented and monitored, and workers must use approved equipment and have specified criteria for workmanship.
- Inspection and testing: The organization must maintain records of inspection and testing at all stages to verify that requirements are met. This includes receiving, in-process, and final inspection and testing.
- Control of inspection, measuring, and testing equipment: The organization must establish procedures to control, calibrate, and maintain equipment used to demonstrate conformance to requirements.
- Control of non-conforming product: Procedures should ensure that the company avoids inadvertent use of non-conforming product. This includes how non-conforming product is reviewed and how repaired or reworked product is re-inspected.

- Corrective and preventing action: The organization should investigate cause of non-conformance and take action both to correct the problems and to prevent them in the future. Corrective action includes handling customer complaints, investigating causes of non-conformities, and applying appropriate controls. Preventive action includes detecting, analyzing, and eliminating potential causes of non-conformities and initiating preventive actions.
- Handling, storage, packaging, preservation, and delivery: The organization should develop procedures for properly handling, storing, packaging, preserving, and delivering products.
- Control of quality records: The organization should identify, collect, index, file, and store all records relating to the quality system.
- Quality audits: The organization must establish a system of audits to verify whether its activities comply with requirements and to evaluate the effectiveness of the quality system.
- Training: The organization must establish procedures for identifying training needs and provide for training of all employees who perform activities that affect quality.
- Servicing: The organization must develop procedures to ensure that service is performed as required by its contracts with customers.
- Statistical techniques: Procedures should identify statistical techniques used to control processes, products, and services and how they are implemented.

4. APPRECIATION OF PREVIOUS STUDIES - QUALITY MANAGEMENT

4.1 INTRODUCTION

Control of quality is an important and crucial activity of any construction project. Lack of it will have serious adverse on the project, resulting in enormous waste of public money and unnecessary and avoidable inconvenience to the public. Advanced countries have designed and implemented elaborate quality systems and infrastructure to implement it. Good quality is rewarded and the contractor is penalized for poor quality. Thus, there is a monetary incentive as reward for good quality. These, however, are advanced systems which have developed over a number of years, and may not find application in India because of the lack of necessary specification and infrastructure to support these. Development of infrastructure and facilities is a long term proposition and needs the support and investment by the Government, construction industry and third parties. However, system can be developed which carries out quality control / quality assurance in an organized and well laid out manner so that quality is not compromised.

4.2 MANDATE AND ITS BACKGROUND

The Strategic Options Study conducted by Consulting Engineering Services, followed by Policy and Institutional Development Study (IDS) conducted by TCE Consulting Engineers Ltd in 2002 recommended that:

"Construction process to be strengthened by introducing new technologies, systematic construction supervision and independent quality audits and controls", and that a separate unit under a Chief Engineer be established for this purpose.

The Government of Uttar Pradesh endorsed the above IDS recommendation, and decided to include the following in the present Institution Development and Strengthening Plan (IDSP) and the Uttar Pradesh State Roads Project (UPSRP):

1. Establish Quality Management framework and dedicated HQ Unit and resources
2. Implement (in conjunction with new Training / HRD Cell) ongoing PWD-wide project Quality Management Training

4.3 IDS REPORT – AN APPRECIATION ON QM AND QM UNIT

There were certain recommendations made in the final report of IDS with respect to QA activity in the PWD structure. It was suggested that in the organisation of PWD an office of Chief Engineer dealing with Quality Assurance and standards be set up. The objective of the office is to ensure quality in project delivery and network performance by setting up quality policy and guidelines. The Chief Engineer will also be responsible for continuously evaluating and revising the relevant standards and technical procedures to be adopted by the PWD. He will also undertake quality improvement programmes to train internal staff in quality systems.

In addition the IDS recommended creating the position of EE (QA) under the zonal Chief Engineer and the position of AE (QA) under the SE in each district.

Further recommendations envisaged; that:

The Quality Unit in the department should also audit the quality of works during construction.

A quality awareness programme to educate contractors and their technical staff. Attendance at such a programme would be a pre-requisite for bidding purposes and certificate of attendance would be issued upon its completion.

'From the first recommendation it appears that the proposed Quality Unit will have dual function i.e. Quality Assurance as well as the Quality Audit, that means self-audit which is defeating the very purpose of audit, not a desirable situation at all. If there is to be an audit unit, at should be independent of the Quality Unit.

In respect of Quality Control of maintenance works, the periodic assessment of the effectiveness of the maintenance activities (performing quality audit) be introduced. This evaluation would be done by the Quality Unit. This, however, is not feasible, because the contracts do not have performance-related specifications in it.

An important omission in the IDS report is that it has not carried out any analysis of financial and human resources requirements of its recommendations. Without a firm and dedicated financial and human resources commitment, any system is bound to fail.

5. PRESENT PRACTICES AND PROCESSES

5.1 POLICY DIRECTIVE

In the Uttar Pradesh Road Development Policy 1998, one of the objective mentioned is "to keep the roads free of potholes and patches all the time by continuously maintaining and repairing them", and anther one is "to ensure quality in construction and maintenance of roads." One of the salient features of the Policy is, "latest techniques will be used for construction of roads and bridges." An examination, however, reveals that these objectives are far from being realized, and it appears that in many instances the necessary policy/procedures are lacking and even where they do exist, their implementation is lacking.

5.2 CURRENT STATE OF PRACTICE IN PWD

It appears that UPPWD has not been introduced to the modern concept of a formal, organized quality management system encompassing all activities of the department. The only mention that with construction and maintenance quality finds in the Department's activities is in connection.

The major part of the activity of UPPWD is construction and maintenance of roads. The only mention that 'quality' finds in the department's activities is in connection with construction and maintenance. In the field, as per UP Government Notification, it is mandatory to perform in full the prescribed quality control testing on total quantity of materials used in work and in accordance with prescribed norms.

It is worth mentioning that the Detailed Specifications for UPPWD were last revised in 1974, and the Maintenance Manual was prepared in 1984. The Schedule of Rates dates back to even older era, i.e., 1969. It appears that these documents are neither in force nor withdrawn.

To add to the confusion, Engineer-in-Chief had issued a Circular No. 1527 – Ni/87-Niyojan/98 dated July 2, 1998, decreeing that the Indian Roads Congress's Specifications for Road and Bridge Works shall, henceforth, be adopted for construction of roads by UPPWD. The above Circular, however, stands rescinded with effect from April 01, 2005 through another Circular No. 7507 M.T./60 M.T./99 dated October 14, 2005.

In the 1980s, UPPWD did have an organised, Department-wide quality control and testing programme in place. The Research Institute at Lucknow was equipped to carry out all soils, aggregate, hot mix asphalt and concrete testing. Each zonal headquarter had a testing laboratory, headed by Research Officer. The zonal laboratory carried out testing of samples referred to it from works being carried out in the districts within the zone. If the workload warranted, then additional field laboratories were set up at specific job sites, on instructions from the Director of Research or the Zonal Chief Engineer. These were manned by Assistant

Research Officer or Junior Engineer from Research Institute. The funding for the equipment was provided from the pooled budget for this purpose or by the Executive Engineer himself. These zonal and field laboratories were equipped to carry out basic soils, aggregate and bituminous material tests. Concrete strength testing was available only at Meerut and Varanasi in addition to Lucknow. Marshall mix design testing of Job Mix Formulae was done at Lucknow only. A provision of 1 percent for quality control was made on every construction project to defray the costs associated with this activity.

Presently, quality control in UP PWD is carried out essentially by the district laboratories in each district and a zonal laboratory at Meerut. District laboratories are under the administrative control of the Zonal Chief Engineers, whereas, the regional laboratory at Meerut is under the administrative control of Director of Research Institute, who in addition to research activities is also responsible for quality promotion activities in UPPWD. These laboratories carry out tests on materials and also function as extension centres for technology dissemination.

Day-to-day routine inspection and testing for quality control is carried out by Junior Engineer with the assistance of a Mate. The test equipment at the site is minimal and in poor condition. Frequency of tests, norms and acceptance criteria used are in accordance with IRC Standards and Specifications for Road and Bridge Works. Formats for recording observations, test results and other quality records also conform to the recommendation contained in the IRC Standards and Specifications.

As per UP Government Notification, it is mandatory to perform in full the prescribed quality control testing on total quantity of materials used in work and in accordance with prescribed norms. It is also necessary to include a detailed cost estimate of quality control tests before technical sanction is granted. The Executive Engineer in charge of construction supervision, in addition, collects two samples of each construction and sends it to the regional or central laboratory for testing. The results, however, are kept confidential.

Testing equipment currently in use in district, zonal and central laboratories is old and outdated. Because of budgetary constraints no new equipment has been purchased for years. The morale of junior staff is low due to stagnation, resulting in hostility and indiscipline. Hasty completion of work, dilution of standards due to lack of funds, untrained contractor staff, inadequate facilities, shortage of available funds all lead to poor quality of testing and ultimately that of quality of works.

There is only one zonal laboratory at Meerut. Out of the seventy districts, forty eight supposedly have district laboratories. These are reported to be abysmally equipped to reasonably well equipped, depending upon the divisional officers' initiative, because there is no dedicated funding made available for quality control or laboratory. One of the better district laboratory visited by the TA Consultant had the capability to carry out the following testing:

- Sieve analysis (75 μm to 125mm)
- Sand replacement density
- Proctor density
- Plasticity Index
- Aggregate impact value
- Bitumen content

The laboratory was manned by a technician and an assistant, who performed tests at the request of JE or AE in the field. The laboratory itself was confined to one small room which was functioning as storage with no space for testing.

The information gathered by the TA Consultant revealed that:

- contractors fail to carry out any testing
- only the Department conducts whatever testing is done
- there do not appear to be any establish norms, but the amount of testing done is minimal

There is no formal quality control/quality assurance processes in place for the execution of state contracts. Yet on the World Bank aided projects being executed by UPPWD, quality control by the contractor and quality assurance by the supervision consultant is the norm. Similarly, it is understood that on PMGSY project, the contractors do set up a laboratory and adhere to the norms stipulated in the contract specifications.

It was also found that even very simple and basic procedures which would greatly assist in ensuring quality are not followed. For example, adulteration of bitumen is a well-known problem, yet to date a simple act of sealing the tanker with a tamper-proof seal at the refinery has not been undertaken. The result is that contents of each tanker have to be tested for adulteration, that too for away from the job site and the testing takes too long. This has serious adverse impact upon the quality and progress of work, but the simple act of sealing could not be implemented. This shows a lacuna in the system so far as quality is concerned.

In 1982, at the insistence of the Government of India, a Quality Promotion Cell was created within UPPWD. The Director of Research was entrusted with its responsibility. The Cell does exit today, but its effectiveness is questionable.

5.3 DESIGN, STANDARDS AND QUALITY ASSURANCE

5.3.1. Introduction

The Strategic Options Study conducted by Consulting Engineering Services, followed by the Policy and Institutional Development Study (IDS) recommended that:

"Construction process to be strengthened by introducing new technologies, systematic construction supervision and independent quality audits and control".

The Government of Uttar Pradesh endorsed the above IDS recommendation, and decided to include the following in the present Institution Development and Strengthening Plan (IDSP) and the Uttar Pradesh State Roads Project (UPSRP):

1. Establish quality management framework and dedicated HQ unit and resources
2. Implement (in conjunction with new Training/HRD Cell) ongoing PWD-wide project quality management training

The basic mandate of PWD is to provide a safe, comfortable, efficient and economical transportation infrastructure system for the public to use. In order to achieve the objective and to ensure that the required level of quality of product (i.e., roads), is in fact offered to the public, certain organisation, personnel, policies, processes, procedures and documents have to be in place, which will guaranty that the PWD continues to provide satisfactory roads for the public use. These "coordinated activities to direct and control an organisation (i.e., PWD) with regard to quality" is called quality management. The most widely used international standards for quality management are ISO 9000, which involve elaborate process-oriented approach requiring detailed documentation of procedures, inspection, testing, record keeping and audits of every facet of the function of the agency, ultimately leading to certification upon successful completion. Quality management includes all the activities that managers carry out in an effort to implement their policy. These activities include:

Quality Assurance to demonstrate to managers and users that all quality requirements are being, through quality planning, control, audit and management.

Quality Planning to define quality system policies, objectives and requirements, and to explain how these policies will be applied, how these objectives will be achieved and how these requirements will be met.

Quality Control to ensure that all quality requirements are being met. For this, processes are monitored.

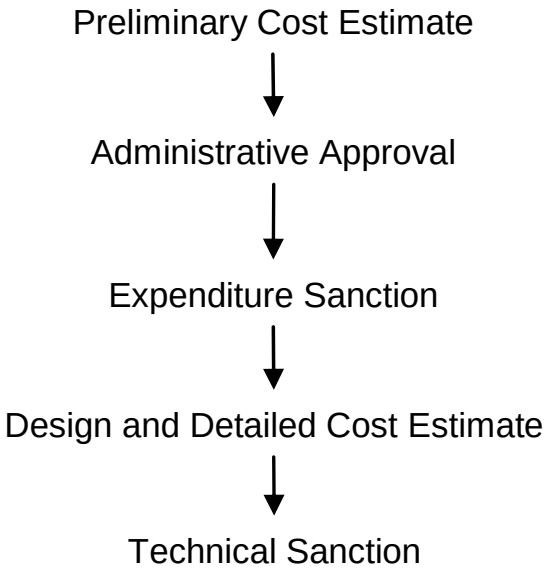
Quality Audit to examine and evaluate how well the elements of quality management system comply with the system requirements.

It should be noted that the concept of quality management encompasses all activities of the department ranging from planning, programming, design and execution to maintenance.

5.3.2. Current Status of PWD

(a) Design

The process leading to design of works in the PWD involves the following steps:



A formal process requiring the above sequence of events does exist, though it is often flouted. The competent authorities for the above approvals depend upon the size of the project. For example, Executive Engineer is authorised to grant Technical Sanction for projects costing upto Rs. 40 lakh. Most of the design work carried out in the PWD relates to maintenance and rehabilitation of roads and bridges. Design of structures more than 30m in length is entrusted to UP Bridge Corporation.

In order to put a project on the program, there is a directive which describes how often the renewal/rehabilitation of the road should be carried out, depending upon its functional classification and surface type. For example, for village roads the renewal cycle is eight years. These norms, however, are more often ignored than followed, because of the external compulsions and financial constraints.

There is no pavement rating system in place, nor any criteria, which would trigger a project and indicate what is the appropriate course of action to be undertaken. The last Maintenance Manual was issued in 1984 and is irrelevant today. This is a glaring and serious shortcoming. In fact, long time ago there was a system, which categorized the roads in class A,B,C or D, depending upon their state of disrepair; but even that has been lost and few are even aware of its existence, not that it would be applicable now.

Normally, a project is initiated at the divisional level and the executive engineer-in-charge is responsible for preparing the design and cost estimate. The trigger for the project is either the guidelines for periodic renewal and/or subjective judgement of the engineer, and often external influences. All design work is carried out in-house at the divisional office. There are no standard

drawings, design manuals or guidelines for this purpose. Designs are carried out according to basic engineering principles and the engineer is free to choose any methodology he wishes. The division has to conduct all necessary investigations and surveys from its own internal resources. There is no further check or review of the design for its appropriateness or quality. Moreover, even the competence of the designer may be in question, since designing requires certain specialized knowledge, and without proper training not everyone is equipped to do so. There is neither a policy, nor specialized staff, nor program, nor oversight system for design.

Design for maintenance and rehabilitation activities is carried out in the respective divisional offices. Apparently, there is a design cell at HQ, but its involvement is limited to checking the design. Design of structures more than 30m in length is carried out by the Bridge Corporation. Design of major works, such as new links and upgrading is carried out by external consultants.

(b) Standards

As mentioned earlier there are no standard drawings, design manuals or guidelines in UPPWD. The Detailed specifications for UPPWD were last revised in 1974, and the Maintenance Manual was prepared in 1984. The Schedule of Rates dates back to even older era, i.e., 1969. These documents officially exist and are, therefore, in force, but are obsolete. Ostensibly, from time to time directives have been issued that, in lieu, Indian Roads Congress norms should be adopted for PWD works. But, even there, the situation is far from clear and confusion prevails. For example, Engineer-in-Chief had issued a Circular No.1527-Ni/87-Niyojan/98, dated July 2, 1998, decreeing that the Indian Roads Congress' Specifications for Road and Bridge Works shall, henceforth, be adopted for construction of roads and bridges by UPPWD. The above Circular, however, stands rescinded with effect from April 01, 2005 through another Circular No. 7507 M.T./60 M.T./99, dated October 14, 2005, leaving the engineer in a state of uncertainty.

Thus, there is a woeful lack of standards at every stage, be it planning, programming, design, construction or maintenance.

(c) Quality Control/Quality Assurance

There is no formal quality control/quality assurance processes in place for the execution of state contracts. Yet, on the World Bank aided projects executed by UPPWD, quality control by the contractor and quality assurance by the supervision consultant seems to be the norm. Similarly, it is understood that on PMGSY projects, contractors do set up laboratories and adhere to the conditions stipulated in the contract specifications, and the quality control requirements. This, however, needs to be verified.

Because there is no structured organization and no well defined duties, responsibilities and authority, nor an established system for quality control/quality assurance, other agencies or public representatives feel free to interfere in the execution and quality of works.

The lack of attention to the quality is evident from the fact that despite wide-spread practice of adulteration of bitumen, a simple act to prevent it by sealing the tanker with a tamper-proof seal at the refinery could not be implemented.

Similarly, some directives to check upon the quality of works are impractical and self-defeating. For example, every chief engineer is required to have at least eight night halts in a month and inspect all works in his zone at least once a year as part of quality control system of the PWD.

In an attempt to increase the awareness of quality in PWD, a Quality Promotion Cell was created in 1982. The funding was provided by the Government of India, and the Director of Research was entrusted with its responsibility. The Cell is apparently still in existence, but its effectiveness is highly questionable.

6. TECHNICAL ASSISTANCE FOCUS

6.1 ESTABLISH QUALITY MANAGEMENT FRAMEWORK AND DEDICATED HQ UNIT AND RESOURCES

The technical assistance will introduce the concept of quality management into the workings of UPPWD and outline what would be needed for its implementation. The following aspects related to quality management and a dedicated Unit will be considered and presented for discussion:

- Expound the concept of quality management, its components and its applicability and benefits to the PWD
- Define the role and responsibility of Quality Unit at HQ
- Define the role and responsibility of agencies and staff undertaking quality control and quality assurance in planning, design, construction and maintenance.
- Identify cadre and human resources for performing quality control and quality assurance activities
- Identify material and equipment requirements
- Identify physical facilities requirements
- Estimate the financial resources required for quality systems
- Review the norms and the frequency of quality control tests for their practicality and appropriateness
- Introduce norms for quality assurance plan and frequency of quality assurance tests
- Produce final report for quality management system
- Organize quality management training. This would be the subject of Report No. 30

6.2 DETERMINE POLICY FOR AND IMPLEMENT PWD MAINSTREAM USE OF INDEPENDENT QUALITY AUDIT

- Decide the location of a separate, independent Quality Audit Unit for inspection of works.
- Define the role and responsibility of the agency and the staff performing quality audit and its relationship with other agencies.
- Identify cadre and human resources for Quality Audit Unit
- Estimate the need of financial resources for the Unit
- Formulate the process and procedures to be followed in quality audit
- Establish guidelines for inspection by Quality Audit Unit
- Standardize reporting system for inspection by the Unit
- Devise standards for follow up action to be taken resulting from the inspection
- Devise a methodology to report the status and findings from the inspections by the Quality Audit Unit.
- Identify and direct the designer to use other existing design manuals, guidelines or text so that a standardized approach and methodology is used.

Sufficient staff should be identified and trained in design, so that there is adequate oversight capability in each zone to ensure adequacy and quality of designs.

The subject of mainstream use of independent quality audit would be covered in Report No. 12.

7. SOME THOUGHTS QM UNIT – AN APPROACH

The establishment of Quality Management framework and dedicated Unit and resources shall focus and materialise considering the following:

- Review the existing organizational set-up with respect to Quality Management
- Review the existing standards, processes and procedures in place at HQ, zonal and district offices as they relate to design, standards and quality assurance.
- Review actual compliance, in practice, with the standards and processes
- Identify deficiencies in the existing system, and the reason thereof
- Review Quality Management system of 1 or 2 other states
- Generate possible solutions to eliminate the deficiencies and to improve the quality of project delivery

- Select the best and most effective solution and discuss with PWD Engineers and the World Bank, and present to PSC,
- Evolve a comprehensive Quality Management system encompassing the following key issues:

Some issues concerning the above are:

- Directive exists for resurfacing cycle depending upon the category of road and surface. More often not followed.
- Once a rating system existed, classifying the roads as A, B, C or D depending upon the condition. Now not used
- No maintenance manual per se
- No pavement rating system
- No system for monitoring of the network
- Division does all survey, investigation and design
- No check on the designs
- Anybody inspects the works and asks for quality checks
- No systematic training

8. QUALITY MANAGEMENT UNIT - OPTIONS

The gamut of variation in the type of quality assurance programmes could run from:

agency controlling the quality and performing acceptance

to

Contractor controlling quality and agency performing acceptance

to

Contractor controlling quality and contractor results used in the acceptance decision

The last option is most undesirable, and underlines the importance of having a proper testing facility and capability.

The first option shifts the responsibility of QC from the contractor to the agency, putting unnecessary burden on the agency. Moreover, if the agency controls the contractor's processes, it implicitly accepts responsibility for the product and must accept it. Secondly, it should be borne in mind that it is the contractor's production equipment and staff that are used to produce the material and construction, therefore, the best entity to control these items is the contractor.

Similarly, there are variations in quality measures used in acceptance which range from individual values in the case of soils and embankments to percent within limits and moving averages.

Thus, there is no single solution that fits all situations. However, all material and construction specifications must have all three elements, i.e., QC, QA and acceptance comprising quality assurance, in one form or another, so that the final product is produced and accepted in the form intended.

Whatever the case, for the system to be successful and useful must be simple, easy, practical, workable and fair to the contractor and the agency.

In the 1980s, UP PWD did have an organised, Department-wide quality control and testing programme in place. The Research Institute at Lucknow was equipped to carry out all soils, aggregate, hot mix asphalt and concrete testing. Each zonal headquarter had a testing laboratory, headed by Research Officer. The zonal laboratory carried out testing of samples referred to it from works being carried out in the districts within the zone. If the workload warranted, then additional field laboratories were set up at specific job sites, on instructions from the Director of Research or the Zonal Chief Engineer. These were manned by Assistant Research Officer or Junior Engineer from Research Institute. The funding for the equipment was provided from the pooled budget for this purpose or by the Executive Engineer himself. These zonal and field laboratories were equipped to carry out basic soils, aggregate and bituminous material tests. Concrete strength testing was available only at Meerut and Varanasi in addition to Lucknow. Marshall mix design testing of Job Mix Formulae was done at Lucknow only. A provision of 1 percent for quality control was made on every construction project to defray the costs associated with this activity. There should be a minimum of two junior engineers and two laboratory technicians in each laboratory.

9. FUNCTION OF QUALITY MANAGEMENT UNIT

The prime responsibility and function of the Quality Management Unit will be quality assurance of works being constructed by U.P.P.W.D. The quality of a road is, however, affected by a number of activities which begin at the stage of project preparation, and continue through preparation of design, drawing and contract documents, organizing and management of suppliers/contractors, procurement of material and services and production of items of construction. Therefore, the Quality Management Unit should ensure that:

(i) during project preparation the data collection (including sway and material investigation) is adequate and accurate and that it is properly documented and reviewed before finalisation.

(ii) detailed design and drawings are based on appropriate engineering report and documentation; all alternatives are considered and evaluated and the chosen alternative is constructable and proof checked.

(iii) the standardised general conditions of contract and the detailed technical specifications are current and applicable to the contract. Update the specifications and test procedures and criteria, wherever required.

(iv) There is a Management's 'Quality Policy'

(v) there is a Quality Assurance Manual, if not, then prepare one

(vi) there is provision and availability of required facilities and equipment both on and off site for quality assurance

(vii) there is qualified and experienced technical work force and trained supervisors,

(viii) there is a training programme for the personnel engaged in quality management

(ix) there is a quality assurance plan defining documentation and traceability for the projects under construction

(x) the Department's quality policy is adhered to' the stipulated testing is carried out and is properly document, including action taken, wherever necessary

(xi) there is a provision for quality audit

10. QUALITY MANAGEMENT UNIT – STRUCTURE

The Policy Support and Institutional Development Study carried out by TCE Consulting Engineers Limited in the Final Report of June 2002 recommended to 11 restructure the department under the twin dimensions of 'Principal objective of the function (i.e. Development Works, Network Maintenance and Quality Management functions) and 'Nature of the function' (Strategic, Managerial or Operational)'. The recommendation of the consultant was accepted by GOUP.

The recommendation envisaged to;

1. Establish Quality Management framework and dedicated HQ unit and resources

2. Implement (in conjunction with new Training/HRD Cell) ongoing PWD-wide project Quality Management training

3. Determine policy for mainstream use of independent quality audit

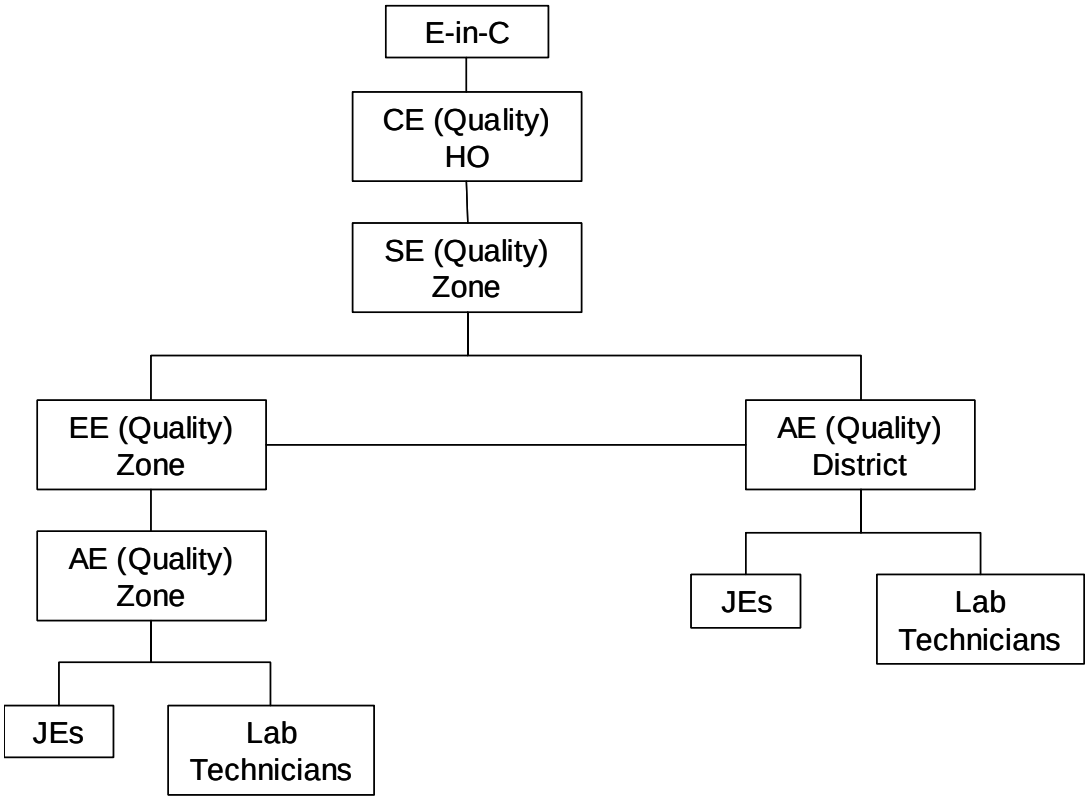
This Report # 19 concerns the first recommendation. Recommendation 2 is the subject of Report # 33, and Recommendation 3 will be addressed in Report # 30.

As part of the recommendation a separate Unit under a Chief Engineer is to be set up "to ensure quality in project delivery and network performance. This function will introduce owner-supplier situation wherein a two-different-party set-up is considered to enhance accountability in the delivery system.

This unit shall be responsible for setting up quality policy and guidelines for Works and Network operations. It shall further delineate the responsibilities of PWD staff at various levels with respect to quality and develop a quality manual."

At the Focus Group meeting on April 4, 2007 an organisation as shown on the following page, was suggested for the proposed Quality Management Unit. There was full agreement on the suggested organisation. It was suggested, that if necessary, the Chief Engineer (Quality Management) under the Engineer-in-Chief may also handle other areas such as road safety, traffic, and environmental and socials issues.

Figure 1 : SUGGESTED ORGANIZATIONAL STRUCTURE FOR QUALITY MANAGEMENT



11. RESPONSIBILITIES OF QUALITY MANAGEMENT PERSONNEL

11.1 RESPONSIBILITIES OF CHIEF ENGINEER (QUALITY)

Direction, administration and management of Quality Unit in the PWD

Ensure that adequate resources are available at HQ and field offices

Framing of quality policy & quality system, including criteria, procedures and documentation,

Monitoring implementation of quality policy and system,

Constant review of quality assurance and quality control criteria,

Appraisal of quality of works executed

Quality surveillance of designs and construction and Technical Audit of works,

Maintenance of QA/QC training of PWD staff,

Advise the Government and organisation staff on all technical matters relating to quality in construction and design of works in PWD,

Carry out the instructions/directions of Government regarding quality policy matter, quality assurance, work audit,

Investigations the issues referred to in respect of quality of works,

In order to perform the responsibilities stated above the CE (Quality) will:

Keep in touch with the latest developments on use of latest quality assurance tools, new materials, quality control methods and R&D activities in the state and elsewhere.

The CE (Quality) shall ensure that periodic independent quality audit is conducted of the work executed by the contractor.

The CE (Quality) will advise on issues pertaining to development of QC/QA specifications for all items/activities involved in road construction with emphasis on quality control/quality assurance.

Develop QC, QA and TA training programmes; arrange seminars, quality control workshops, training programmes and assist in nomination of the PWD staff for training in India and aboard. He shall frame and organise the training programmes for new entrants and in service staff of PWD.

Regularly coordinate and interact with the Chief Engineers of other Wings of PWD with an objective to ensure high-class quality in works executed through PWD and to identify the gray areas where improvement is necessary.

Keep in close touch with UP PWD Research Institute to keep him abreast with research activities in the state regarding construction materials and QC testing.

Verify the implementation and maintenance of PWD's quality policy and detailed quality procedures.

Review all quality activities and provide assistance to CE (Execution/Construction) in the development of quality plans of major projects of PWD.

Initiate suitable measures for prevention and resolution of problems related to quality.

Prepare new manuals or update the old ones for quality assurance, quality system, maintenance, construction practices etc

Prepares new specifications or update the old ones wherever required

For discharging the above-mentioned responsibilities the CE (Quality) shall be assisted by the SE in the zonal offices.

11.2 RESPONSIBILITIES OF SUPERINTENDING ENGINEER (QUALITY)

Provide direction, administration management and technical guidance to the Quality Unit in the zone

Ensure that adequate human, material and transportation are made available at zonal and district Quality Units Ensure that the quality policy of the PWD is adhered to in the zone

Take corrective action in case of non-compliance of policy

Conduct quality assurance review of designs for works in the zone

Review quality plans of major projects in the zone

Provide expert advice to the Zonal Chief Engineer and other staff in all matters relating to quality in design and construction in order to maintain high standards

Investigate quality-related issues referred to and furnish a definite resolution including any rectification or action required

Monitor quality assurance activities in the zone to ensure that it complies with all norms including frequency of testing and documentation

Suggest improvements to quality assurance procedures to make it more streamlined and effective

Ensure that the staff in the Quality Unit is properly Trained and arrange for such training

Ensure that periodic independent audit of works is carried out

Prepare periodic review reports for the HQ documenting the compliance with the policies, procedures and criteria.

11.3 RESPONSIBILITIES OF EXECUTIVE ENGINEER (QUALITY)

Ensure that the quality policy of the PWD is followed in the district

Review contractor's quality plans of works/projects in the district; approve/disapprove or suggest changes to the contractor and inform the SE

Review and assess the adequacy and suitability of contractor's construction equipment

Review the suitability of contractor's key personnel related to construction and quality control

Review the adequacy of contractor's laboratory facilities and personnel

Review the contractor's construction methodology supervise and organise sampling and testing for quality assurance and acceptance

Review the results and make decisions regarding acceptance/non-acceptance and any follow up action required. Executive Engineer shall be the final authority for interpretation of test results

Verify that the follow up action is carried out in the field

Carry out random inspections for sampling and testing

Ensure that the zonal and district laboratories are adequately supplied and manned

Ensure that the calibration of equipment is carried out as per norms

Ensure that working conditions for the subordinate staff are safe and they have appropriate safety equipment

Ensure that there is emergency medical aid kit available in all laboratories

11.4 RESPONSIBILITIES OF ASSISTANT ENGINEER (QUALITY)

Organise sampling and testing of works under his jurisdiction

Ensure that sampling conforms to norms

Ensure that testing is carried out as per the procedures contained in the Lab Manual

Ensure that sampling and testing is carried out in a timely manner with no delay. This is particularly important in the case of testing of bitumen supplied.

Review and interpret the test results; make recommendations of findings and forward to the Executive Engineer (Quality)

Carry out regular inspections for sampling and testing

11.5 RESPONSIBILITIES OF JUNIOR ENGINEER (QUALITY) AND LABORATORY TECHNICIAN

Carry out sampling as directed or as required

Carry out laboratory tests in accordance with procedures in the Lab Manual

Complete laboratory report including calculations and plots wherever required and submit to the Assistant Engineer

Ensure that all laboratory and field equipment is n working order; report any problems to the Assistant Engineer

Ensure that the laboratory is clear of obstructions and clutter

12. TESTING FACILITIES

12.1 EXISTING DISTRICT LABORATORIES

As mentioned earlier in Section 5.2 out of seventy districts, forty eight districts supposedly have laboratories. The quality of these laboratories is reported to be very uneven. One of the better district laboratory visited by the TA Consultants was equipped to carry out the following tests:

Sieve analysis (125 mm to 75 micron)

Liquid limit

Plastic limit

Sand replacement density

Proctor density

Aggregate impact value

Bitumen content

The laboratory itself was housed in a small room which was used for showing the equipment rather than carrying out the tests. There was no facility to test for the bitumen being delivered to the site. This testing was done at the Central Laboratory in Lucknow and took at least six week, thus negating the whole purpose of testing.

12.2 EXISTING ZONAL LABORATORY

There is only one zonal laboratory at Meerut. A visit by the TA Consultants to the laboratory indicated that it carries out the following tests on advance payment basis:

A. Chemical Analysis

1. Cement: sand ratio in mortar
2. Cement: sand: aggregate ratio in concrete
3. Quick test of cement and sand in mortar
4. Full ordinary chemical analysis of portland and pozzolona cement/ full analysis of cement
5. Determination of percent cement in adulterated cement
6. Full chemical analysis of soil/harmful salts

B. Coarse Aggregate

1. Sieve analysis
2. Flakiness index
3. Water absorption
4. Determine the Aggregate Impact Value

C. Fine Aggregate

1. Sieve analysis/Fineness modulus
2. Determination of finer than 75 micron
3. Determination of clay, fine silt and fine dust/sedimentation method

D. Brick Testing

1. Compressive strength
2. Water absorption
3. Efflorescence test/salt migration
4. Testing of dimensions of the brick

E. Physical Testing of Soil

1. Plasticity Index test
2. Sieve analysis/classification test
3. Dry bulk density field testing
4. Optimum moisture content (OMC) Proctor test
5. Moisture content
6. CBR test including OMC
7. Bearing capacity of soil for widening
8. Bearing capacity of soil for strengthening

F. Compressive strength of C.C. Cubes

G. Bitumen Testing

1. Binder content of bitumen
2. Softening point test
3. Penetration test

In order to carry out the above tests the zonal laboratory was equipped as follows:

1. Sieve set 450 mm diameter
2. Sieve set 200 mm diameter
3. Sieve shaker
4. Platform balance
5. Triple beam balance
6. Pan balance
7. Weight box
8. Flakiness and elongation gauges
9. Specific gravity pycnometer
10. Aggregate Impact Value tester
11. Dry bulk density apparatus
12. Proctor moulds
13. Metal rammer
14. CBR apparatus
15. CBR moulds
16. Bitumen extractor
17. Bitumen penetrometer
18. Softening point (Ring and Ball) apparatus
19. Oven
20. LeChatelier apparatus
21. Compression testing machine, capacity 100 t, hand operated
22. Compression testing machine, capacity 200 t, electrically operated

23. Vernier calliper
24. Distillation apparatus
25. Heating plate
26. Muffle furnace
27. Water bath (6 and 12 holes)
28. Acids and bases for chemical analysis
29. Chemical balance
30. p^H meter

12.3 PROPOSED LAYOUTS FOR LABORATORIES

A review of the equipment in the district and zonal laboratories revealed that the existing facilities are far from adequate. It was felt that there should be uniformity in the testing facilities across the state. Therefore the TA Consultants have prepared a standard layout of laboratories both in the zonal office and the district office. These layouts are shown on the following pages.

Figure 2: LAY OUT OF LABORATORY SET UP AT ZONAL HEAD QUARTER

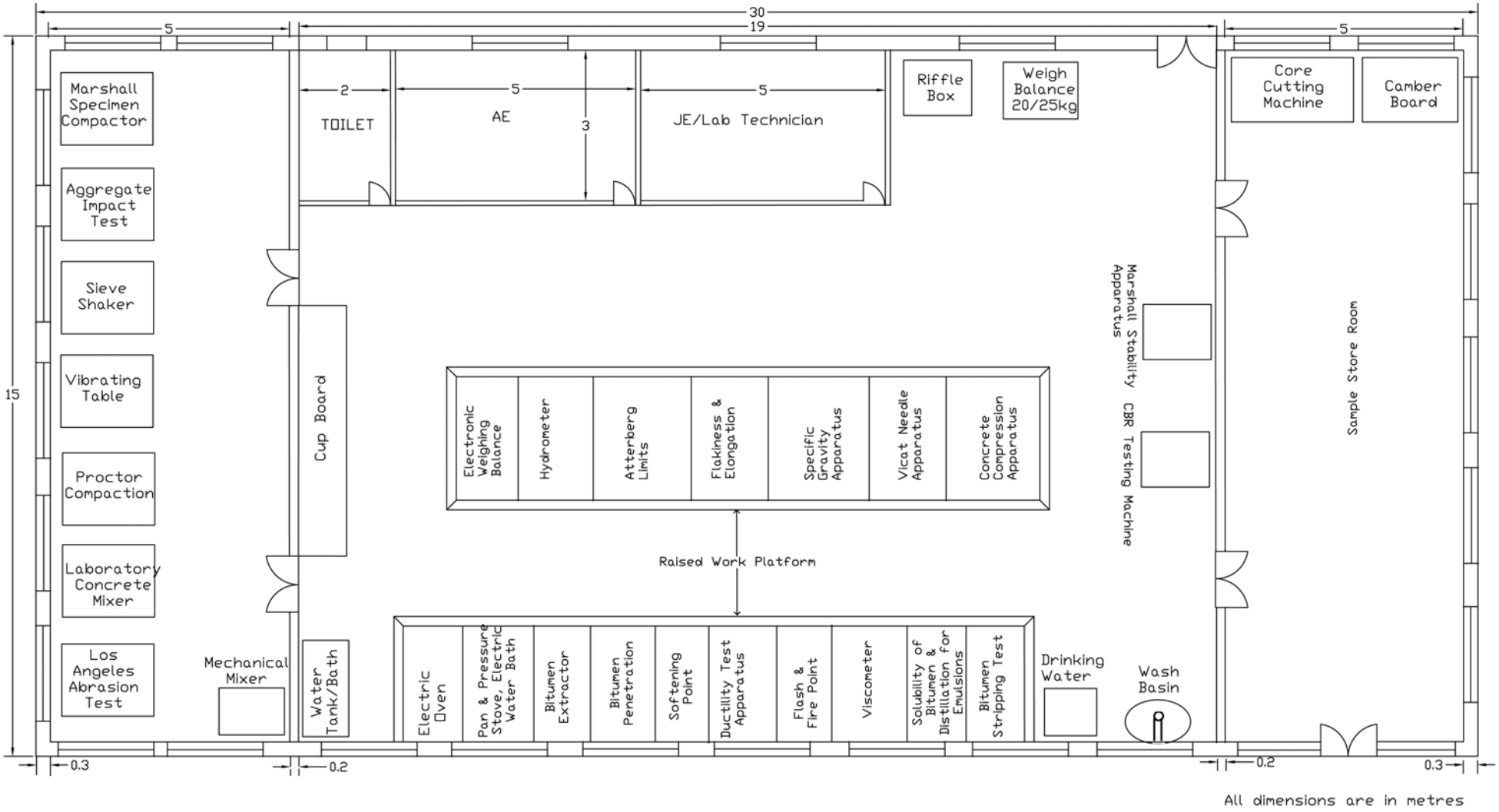
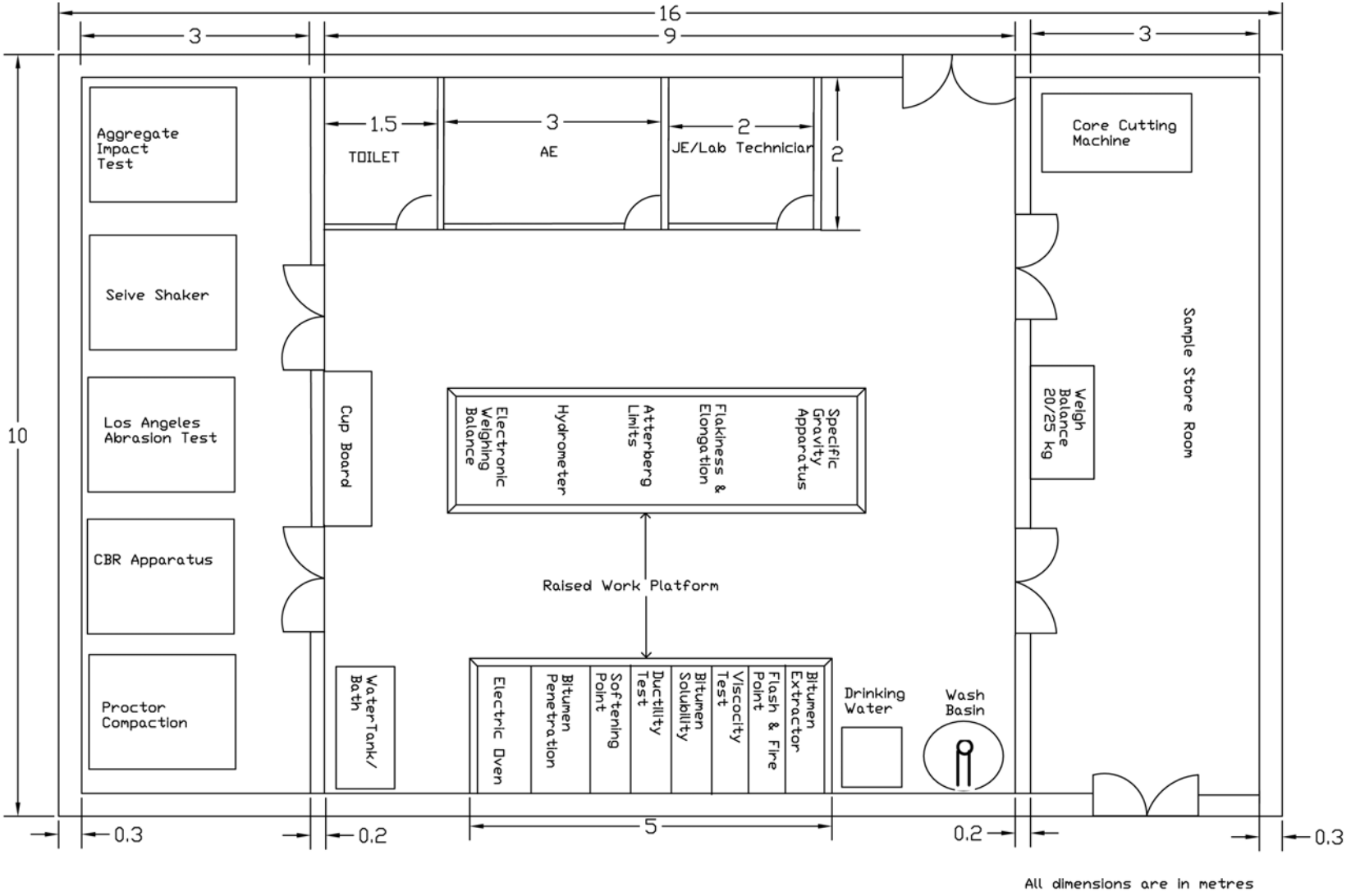


Figure 3: LAY OUT OF LABORATORY SET UP AT DISTRICT LEVEL (EXCLUDING ZONAL HQ)



12.4 PROPOSED EQUIPMENT FOR LABORATORIES

The zonal laboratories are equipped to carry out more sophisticated testing as compared to the district laboratories which conduct mostly routine testing. Consequently two lists have been prepared for the equipment that is required to carry out testing in the zonal and district laboratories. These lists are shown on the following pages.

Table 1: LIST OF EQUIPMENT FOR ZONAL LABORATORY

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
1	**Sieves 450 mm Diameter (2 sets)**	2	1100	2200
	125 mm	2	1100	2200
	106 mm	2	1100	2200
	90 mm	2	1100	2200
	75 mm	2	1100	2200
	63 mm	2	1100	2200
	53 mm	2	1100	2200
	45 mm	2	1100	2200
	37.5 mm	2	1100	2200
	26.5 mm	2	1100	2200
	22.4 mm	2	1100	2200
	19 mm	2	1100	2200
	13.2 mm	2	1100	2200
	11.2 mm	2	1100	2200
	9.5 mm	2	1100	2200
	6.7 mm	2	1100	2200
	5.6 mm	2	1100	2200
	4.75 mm	2	1100	2200
	Pan and Cover	2	1100	2200

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
2	**Sieves 200 mm Diameter (2 sets)**	2	850	1700
	4.75 mm	2	850	1700
	3.35 mm	2	850	1700
	2.80 mm	2	850	1700
	2.36 mm	2	850	1700
	2.00 mm	2	850	1700
	1.18 mm	2	850	1700
	1.00 mm	2	850	1700
	710 micron	2	850	1700
	600 micron	2	850	1700
	425 micron	2	850	1700
	300 micron	2	850	1700
	150 micron	2	850	1700
	90 micron	2	850	1700
	75 micron	2	850	1700
	Pan and Cover	2	850	1700
3	Sieve Shaker, Motorised with Built-in Digital Timer	1	44000	4400
4	Adaptor for 450 mm Dia Sieves	1	12000	12000
5	Platform Scale, Capacity 300 kg × 50 g	1	7895	7895
6	Two Balance; Capacity 25 kg × 2 kg	1	5000	5000
	Pan Balance; Capacity 5 kg × 0.5 g with Weights	1	2467	2467
7	Electronic Weigh Balance; Capacity 0.6 g × 0.01 g	1	40461	40461
8	Electronic Weigh Balance; Capacity 150 kg × 0.001 g	1	75000	75000

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
9	Electric Oven; Thermostatically Controlled; Size			
	(600 × 600 × 600) mm	1	41000	41000
	(450 × 450 × 450) mm	1	25170	25170
10	Glass Beakers			
	500 ml	2	100	200
	1000 ml	2	200	400
	2000 ml	2	400	800
11	Glass Measuring Cyclinders			
	100 ml	2	300	600
	500 ml	2	600	1200
	1000 ml	2	1000	2000
12	Plastic Measuring Cylinders			
	100 ml	2	100	200
	500 ml	2	200	400
	1000 ml	2	300	600
13	Glass Thermometer	2	100	200
14	First Aid Box	1	1000	1000
15	G.I. Tray			
	(300 × 250 × 50) mm	2	400	800
	(450 × 300 × 50) mm	2	500	1000
	(500 × 300 × 50) mm	2	600	1200
	(600 × 450 × 50) mm	2	700	1400
16	Pan & Pressure Stove	1	1000	1000
17	Electric Water Still	1	3000	3000
18	Porcelain Dishes 150mm Diameter	12	200	2400

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
19	Scoops (GI or Suitable)	4	50	200
20	Mallet	4	50	200
21	Sieve Brush	4	40	160
22	Riffle Sample Divider (13 mm, 20 mm, 25 mm, 40 mm) 1 each	4	5000	20000
23	Sampling Auger	3	1500	4500
24	Steel Scale (300 mm, 500 mm)	4	100	400
25	Measuring Tape (5 m, 20 m, 50 m)	6	200	1200
26	Liquid Limit Device with Casagrande & ASTM Grooving Tools & Gauge Block, Hand Operated with Counter	2	7250	14500
27	Plastic Limit Device with Glass Plate	2	4000	8000
28	Rapid Moisture Meter	2	8000	16000
29	Laboratory CBR Apparatus, Electrically Operated with Speed Control	1	82000	82000
30	CBR Moulds 150 mm Dia, 175 mm ht. Complete with Collar, Base Plate	24	1000	24000
31	Annular Metal Weight 2.5 kg	4	300	1200
32	Slotted Metal Weight 5.0 kg	4	500	2000
33	Circular Metal Spacer Disk, 148 mm Dia, 47.5 mm ht. with Detachable Handle	4	500	2000
34	Perforated Plate 148 mm Dia, with Adjustable Lock & Nut	4	700	2800
35	Dial Gauge 0.01 × 25 mm	4	2000	8000
36	Metal Tripod for Dial Gauge	4	250	1000
37	Sample Extractor			
	Hand Operated	1	500	500
	Hydraulic	1	12000	12000
38	Soaking Tank	1	7500	7500

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
39	Proving Ring			
	1000 kg	1	6000	6000
	2500 kg	1	7000	7000
	5000 kg	1	8000	8000
40	Circular Filter Papers	10	410	4100
41	Hydrometer Test Apparatus for Grain Size Analysis	1	1300	1300
42	Cone Penetrometer	1	1000	1000
43	Proctor Density Apparatus (Heavy Compaction) with Mould, Base Plate, Collar, Rammer etc	1	18000	18000
44	Proctor Density Apparatus (Light Compaction) with Mould, Base Plate, Collar, Rammer etc	1	10000	10000
45	Field Density Test Apparatus; Sand Replacement Method; Cylinder Large 150 mm Dia	2	10050	20100
46	10% Fines Value Test Apparatus with Sieve	1	4000	4000
47	Moisture Can (Containers)			
	(50 × 50) mm	24	30	720
	(75 × 50) mm	24	40	960
48	Hot Plate Electric	1	1500	1500
49	Flakiness & Elongation Gauges	2	800	1600
50	Aggregate Impact Value Apparatus with Blow Counter	1	13500	13500
51	Los Angeles Abrasion Test Apparatus	1	80000	80000
52	Specific Gravity Bottle	1	400	400
53	Core Cutting Machine with Diamond Bit (100 & 150 mm dia)	1	100000	100000
54	Straight Edge (Aluminium) 3 m with Sliding Wedge	2	1000	2000
55	Metallic and Digital Thermometer	2	1500	3000

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
56	Stop Watch Accuracy 1/5 second	2	1500	3000
57	Camber Board with Spirit Level	2	3000	6000
58	Bitumen Extractor Electrically Operated	1	34000	34000
59	Bitumen Penetrometer, Automatic	1	29700	29700
60	Softening Point Test Apparatus (Ring & Ball), Electric	1	10000	10000
61	Viscometer	1	6000	6000
62	Constant Temperature Water Bath, Eletrically, Operated & Thermostatic, Control.	1	7000	7000
63	Ductility Test Apparatus	1	65000	65000
64	Marshall Stability Apparatus	1	77000	77000
65	Thin Film Oven Apparatus for Loss on Heating	1	55000	55000
66	Thermometer Range			
	2^0 C to 80^0 C	2	500	1000
	30^0 C to 200^0 C	2	500	1000
67	Vicat Needle Apparatus	1	2630	2630
68	Moulds			
	(150 × 150 × 150) mm	50	800	40000
	(70.6 × 70.6 × 70.6) mm	50	500	25000
69	Compression Testing Machine 2000 KN (with 3 gauges)	1	280000	280000
70	Slump Test Apparatus	2	2600	5200
71	Vibrating Machine Electrically Operated	1	52000	52000
72	Vibrating Table Electrically Operated	1	62000	62000
73	Laboratory Concrete Mixer Electrically Operated	1	50000	50000
74	Flow Table Electrically Operated	1	28000	28000
75	LeChatelier Apparatus	1	3000	3000

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
76	Pycnometer	2	400	800
77	Schmidit Hammer	1	12000	12000

Table 2: LIST OF EQUIPMENT FOR DISTRICT LABORATORY

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
1	**Sieves 450 mm Diameter (2 sets)**	1	1100	1100
	125 mm	1	1100	1100
	106 mm	1	1100	1100
	90 mm	1	1100	1100
	75 mm	1	1100	1100
	63 mm	1	1100	1100
	53 mm	1	1100	1100
	45 mm	1	1100	1100
	37.5 mm	1	1100	1100
	26.5 mm	1	1100	1100
	22.4 mm	1	1100	1100
	19 mm	1	1100	1100
	13.2 mm	1	1100	1100
	11.2 mm	1	1100	1100
	9.5 mm	1	1100	1100
	6.7 mm	1	1100	1100
	5.6 mm	1	1100	1100

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
	4.75 mm	1	1100	1100
	Pan and Cover	1	1100	1100
2	**Sieves 200 mm Diameter (2 sets)**	2	850	1700
	4.75 mm	2	850	1700
	3.35 mm	2	850	1700
	2.80 mm	2	850	1700
	2.36 mm	2	850	1700
	2.00 mm	2	850	1700
	1.18 mm	2	850	1700
	1.00 mm	2	850	1700
	710 micron	2	850	1700
	600 micron	2	850	1700
	425 micron	2	850	1700
	300 micron	2	850	1700
	150 micron	2	850	1700
	90 micron	2	850	1700
	75 micron	2	850	1700
	Pan and Cover	2	850	1700
3	Sieve Shaker, Motorised with Built-in Digital Timer	1	44000	4400
4	Adaptor for 450 mm Dia Sieves	1	12000	12000
5	Platform Scale, Capacity 300 kg × 50 g	1	7895	7895
6	Two Balance; Capacity 25 kg × 2 kg	1	5000	5000
	Pan Balance; Capacity 5 kg × 0.5 g with Weights	1	2467	2467
7	Electronic Weigh Balance; Capacity 0.6 g × 0.01 g	1	40461	40461

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
8	Electric Oven; Thermostatically Controlled; Size			
	(600 × 600 × 600) mm	1	41000	41000
9	Glass Beakers			
	500 ml	2	100	200
	1000 ml	2	200	400
	2000 ml	2	400	800
10	Glass Measuring Cyclinders			
	100 ml	2	300	600
	500 ml	2	600	1200
	1000 ml	2	1000	2000
11	Plastic Measuring Cylinders			
	100 ml	2	100	200
	500 ml	2	200	400
	1000 ml	2	300	600
12	Glass Thermometer	2	100	200
13	First Aid Box	1	1000	1000
14	G.I. Tray			
	(300 × 250 × 50) mm	1	400	400
	(450 × 300 × 50) mm	1	500	500
	(500 × 300 × 50) mm	1	600	600
	(600 × 450 × 50) mm	1	700	700
15	Pan & Pressure Stove	1	1000	1000
16	Electric Water Still	1	3000	3000
17	Porcelain Dishes 150mm Diameter	4	200	800

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
18	Scoops (GI or Suitable)	2	50	100
19	Mallet	2	50	100
20	Sieve Brush	2	40	80
21	Riffle Sample Divider (13 mm, 20 mm, 25 mm, 40 mm) 1 each	1	5000	5000
22	Sampling Auger	1	1500	1500
23	Steel Scale (300 mm, 500 mm)	2	100	200
24	Measuring Tape (5 m, 20 m, 50 m)	3	200	600
25	Liquid Limit Device with Casagrande & ASTM Grooving Tools & Gauge Block, Hand Operated with Counter	1	7250	7250
26	Plastic Limit Device with Glass Plate	1	4000	4000
27	Rapid Moisture Meter	1	8000	8000
28	Laboratory CBR Apparatus, Electrically Operated with Speed Control	1	82000	82000
29	CBR Moulds 150 mm Dia, 175 mm ht. Complete with Collar, Base Plate	24	1000	24000
30	Annular Metal Weight 2.5 kg	2	300	600
31	Slotted Metal Weight 5.0 kg	2	500	1000
32	Circular Metal Spacer Disk, 148 mm Dia, 47.5 mm ht. with Detachable Handle	2	500	1000
33	Perforated Plate 148 mm Dia, with Adjustable Lock & Nut	2	700	1400
34	Dial Gauge 0.01 × 25 mm	2	2000	4000
35	Metal Tripod for Dial Gauge	2	250	500
36	Sample Extractor			
	Hand Operated	1	500	500
	Hydraulic	1	12000	12000
37	Soaking Tank	1	7500	7500

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
38	Proving Ring			
	1000 kg	1	6000	6000
	2500 kg	1	7000	7000
	5000 kg	1	8000	8000
39	Circular Filter Papers	10	410	4100
40	Hydrometer Test Apparatus for Grain Size Analysis	1	1300	1300
41	Cone Penetrometer	1	1000	1000
42	Proctor Density Apparatus (Heavy Compaction) with Mould, Base Plate, Collar, Rammer etc	1	18000	18000
43	Proctor Density Apparatus (Light Compaction) with Mould, Base Plate, Collar, Rammer etc	1	10000	10000
44	Field Density Test Apparatus; Sand Replacement Method; Cylinder Large 150 mm Dia	2	10050	20100
45	Moisture Can (Containers)			
	(50 × 50) mm	12	30	360
	(75 × 50) mm	12	40	480
46	Hot Plate Electric	1	1500	1500
47	Flakiness & Elongation Gauges	1	800	800
48	Aggregate Impact Value Apparatus with Blow Counter	1	13500	13500
59	Specific Gravity Bottle	1	400	400
50	Straight Edge (Aluminium) 3 m with Sliding Wedge	2	1000	2000
51	Metallic and Digital Thermometer	2	1500	3000
52	Stop Watch Accuracy 1/5 second	2	1500	3000
53	Camber Board with Spirit Level	2	3000	6000
54	Bitumen Extractor Electrically Operated	1	34000	34000
55	Bitumen Penetrometer, Automatic	1	29700	29700

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
56	Softening Point Test Apparatus (Ring & Ball), Electric	1	10000	10000
57	Viscometer	1	6000	6000
58	Constant Temperature Water Bath, Eletrically, Operated & Thermostatic, Control.	1	7000	7000
59	Thermometer Range			
	2^0 C to 80^0 C	2	500	1000
	30^0 C to 200^0 C	2	500	1000
60	Slump Test Apparatus	1	2600	2600

All zonal laboratories will be new except for the one at Meerut. In the districts, twenty two laboratories will be new. Wherever there is a zonal laboratory at the zonal head quarter, it will function both as the zonal laboratory and the district laboratory for that district. Thus, there will be twelve (12) zonal laboratories and fifty eight (58) district laboratories to cover the entire state. The existing forty eight laboratories in the districts will need to be upgraded to bring these to the stipulated standards. The estimated cost of individual equipment is also included in the lists. Some of these costs were obtained from a supplier while the others were estimated. Therefore, these costs should be treated only as a guide.

It is of utmost importance that the staff involved in quality management should be fully familiar with testing and reporting procedures. Therefore, the TA Consultants have compiled a comprehensive Test Procedures Manual, which contains the details of all the tests that may be carried out. The Manual is included as a separate document for ready reference. Though the preparation of the Manual was not included in the Terms-of-Reference, but the Consultants strongly felt the need of such as Manual and took the initiative to prepare one or their own at no additional cost to the Client. Each test describes the scope, apparatus and material required, preparation of specimen, procedure for testing, calculations, reportings, and a precision statement. Forms for recording data and reporting the results of the test are included at the end of the Manual, others are already included in the test procedure itself.

It is imperative that adequate transportation facilities should be made available to the staff to enable them to inspect the works, take samples and carry out tests in the field. It is recommended that two Jeep type vehicles should be kept exclusively for the Quality Management personnel at each laboratory.

13. ACTION PLAN

Sl. No.	Description of Activities	Months (0 – 6 – 12)
1	Create Unit at HQ and the position of CE (Quality Management)	
2	Create positions of SE and EE (Quality Management) in the zonal offices and recruit	
3	Undertake a survey of equipment and personnel in the district laboratories and obtain financial sanction for upgrading	
4	Establish/construct laboratory facilities in the zonal HQs and districts	
5	Purchase the necessary equipment for the laboratories and install it	
6	Create necessary positions of AE, JE and Lab Technicians (Quality Management) and recruit staff	
7	Organise training for SEs & EEs	
8	Organise training for AEs, JEs & Lab Technicians	
9	Formulate the Management's 'Quality Policy'	
10	Prepare Quality Assurance Manual	
11	Review and revise standards, specifications, methodology etc., wherever necessary	
12	Review and revise or prepare new manuals re : maintenance and construction	

14. PRESENTATION TO PROJECT STEERING COMMITTEE

Report No. 19: Establishing Quality Management Unit

PWD Focus Group - I

D.V.S. Sarawat	Chief Engineer, U.P.R.N.N. Lucknow
Surendra Kumar	Jt. M.D., U.P. State Bridge Corporation, Lucknow
Arun Kumar	EE, CD-1, Aligarh
Rajan Mittal	EE, PD, Saharanpur
Anurag Asthana	AE, UPRRDA, Lucknow
Navin Kumar	AE, TY. DCU (NH), Lucknow
Anay Kumar Srivastava	AE, IDS Cell, Lucknow
Sandeep Saxena	AE, IDS Cell, Lucknow
LEA International Ltd. & LEA Associates South Asia Pvt. Ltd.	
Anand Prakash	Deputy Team Leader

Report No. 19: Establishing Quality Management Unit

Current State of Practice

1. No dedicated unit in place
2. No formal, uniform policy and procedure re: quality management
3. Existing testing facilities:
   - Research Institute, Lucknow
   - Zonal Laboratory, Meerut
   - 48 District Laboratories
4. Laboratories poorly equipped, inadequate
5. Very little testing done, that too haphazardly
6. J.E. responsible for testing
7. No training in quality assurance / testing
8. No quality assurance in other areas, e.g. design, standards etc.

Report No. 19: Establishing Quality Management Unit

Strategic Options Study conducted by CES in 1996, and Policy Development and Institutional Development Study (IDS) conducted by TCS in 2002 recommended that :

“Construction Processes be strengthened by introducing new technologies, systematic construction supervision and independent quality audits and controls.”

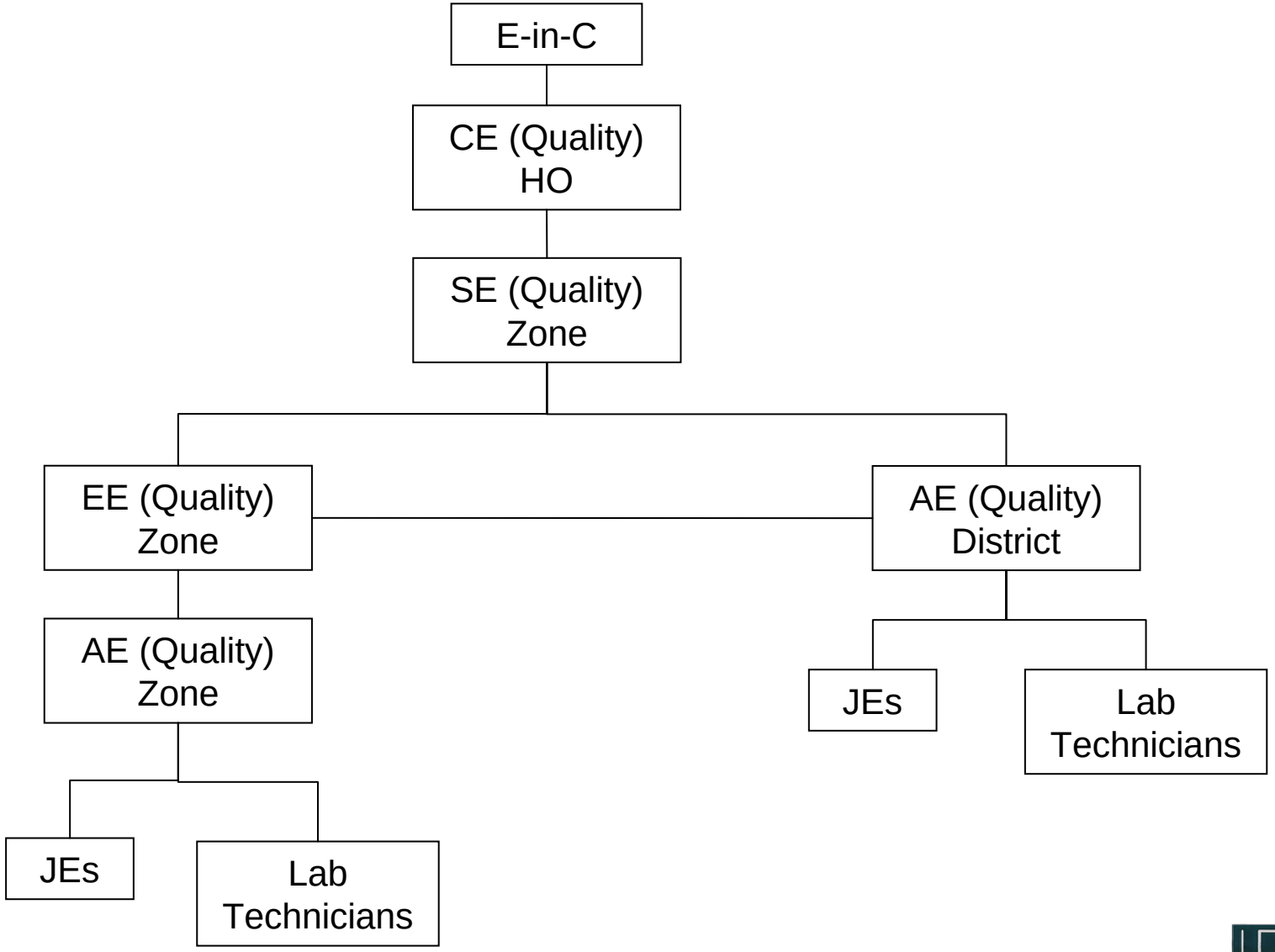
The GOUP enclosed the above IDS recommendation and decided to include the following in the present project :

1. Establishing Quality Management framework and dedicated HQ Unit and resources.

2. Implement (in conjunction with new Training /HRD Cell) ongoing PWD-wide project Quality Management Training.

Report No. 19: Establishing Quality Management Unit

Proposed Structure of QM Unit



Report No. 19: Establishing Quality Management Unit

FUNCTION OF QM UNIT

Ensure that :

- Project Preparation and data collected is adequate and reviewed
- Detailed designs and drawings have evaluated all alternatives and reflect the best option
- Contract conditions and specifications are updated and current
- There is a ‘ Quality Policy’
- The Departments’ QA policy is followed
- There is a Quality Assurance Manual
- There is QA plan and documentation for project
- There is facility and equipment
- There is qualified and experienced work force
- Prescribed testing is carried out
- There is a training program

Report No. 19: Establishing Quality Management Unit

RESPONSIBILITIES OF CHIEF ENGINEER (QUALITY)

- Management
- Policy
- Resources

RESPONSIBILITIES OF SUPPERINTENDING ENGINEER (QUALITY)

- Design review
- Expert advice
- Action for non-compliance
- Training

RESOPNSIBILITIES OF EXECUTIVE ENGINEER (QUALITY)

- Review contractors' quality plans, personnel and equipment
- Review final test results for acceptance
- Carryout random inspections

RESPONSIBILITIES OF ASSISTANT ENGINEER (QUALITY)

- Organise sampling and testing
- Review and interpret test results
- Carry out inspection for sampling and testing

RESPONSIBILITIES OF JUNIOR ENGINEER (QUALITY) AND LABORATORY TECHNICIAN

- Carry out sampling and testing

Report No. 19: Establishing Quality Management Unit

CURRENT TESTING FACILITIES

48 Districts out of 70 have laboratories.

Poorly equipped, inadequate facility

1 Zonal lab at Meerut

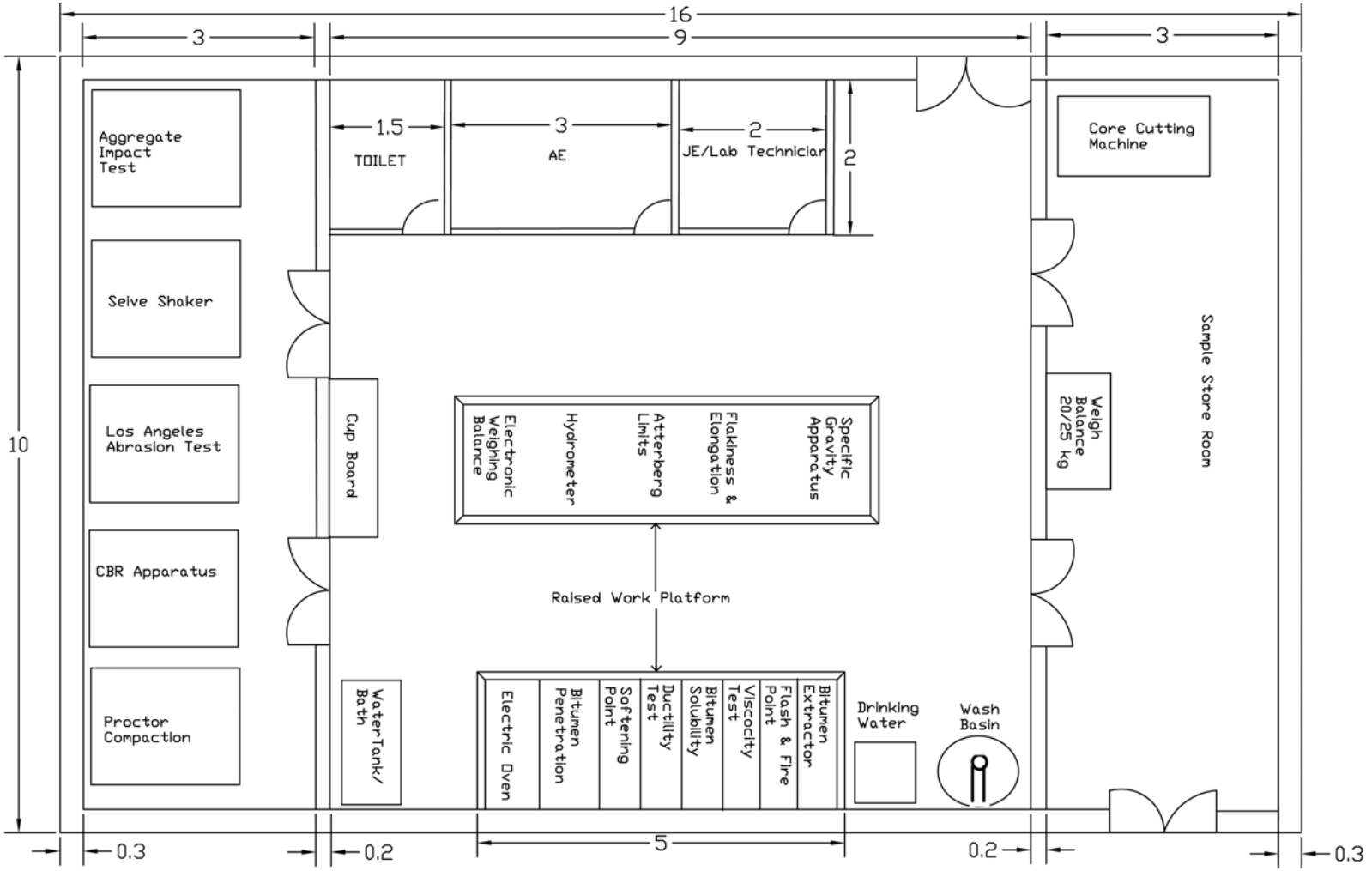
Bare minimum testing facility, inadequate

PROPOSED LAYOUTS FOR LABORATORIES

1. District laboratory (58)
2. Zonal Laboratory (12)

Report No. 19: Establishing Quality Management Unit

PROPOSED LAYOUT FOR DISTRICT LABORATORY



All dimensions are in metres

Report No. 19: Establishing Quality Management Unit

LIST OF EQUIPMENT & COST

1.	District laboratory	60 pieces
2.	Zonal Laboratory (12)	77 pieces

Report No. 19: Establishing Quality Management Unit

LIST OF EQUIPMENT & COST - EXAMPLE

Sl. No.	Description	No.	Unit Price (Rs.)	Cost (Rs.)
39	Proving Ring			
	1000 kg	1	6000	6000
	2500 kg	1	7000	7000
	5000 kg	1	8000	8000
40	Circular Filter Papers	10	410	4100
41	Hydrometer Test Apparatus for Grain Size Analysis	1	1300	1300
42	Cone Penetrometer	1	1000	1000
43	Proctor Density Apparatus (Heavy Compaction) with Mould, Base Plate, Collar, Rammer etc	1	18000	18000
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45	Field Density Test Apparatus; Sand Replacement Method; Cylinder Large 150 mm Dia	2	10050	20100

Report No. 19: Establishing Quality Management Unit

TEST PROCEDURES MANUAL

400 pages of Indian, British and U.S. standard test procedures in one place.

Report No. 19: Establishing Quality Management Unit

IMMEDIATE ACTION PLAN

Establish a Quality Unit at HQ with a core staff, who will be responsible to expand it to PWD–wide organisation

Report No. 19: Establishing Quality Management Unit

ACTION PLAN

Sl. No.	Description of Activities	Months (0 – 6 – 12)
1	Create Unit at HQ and the position of CE (Quality Management)	
2	Create positions of SE and EE (Quality Management) in the zonal offices and recruit	
3	Undertake a survey of equipment and personnel in the district laboratories and obtain financial sanction for upgrading	
4	Establish/construct laboratory facilities in the zonal HQs and districts	
5	Purchase the necessary equipment for the laboratories and install it	
6	Create necessary positions of AE, JE and Lab Technicians (Quality Management) and recruit staff	
7	Organise training for SEs & EEs	
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9	Formulate the Management's 'Quality Policy'	
10	Prepare Quality Assurance Manual	
11	Review and revise standards, specifications, methodology etc., wherever necessary	
12	Review and revise or prepare new manuals re : maintenance and construction	