BASIC DESIGN STUDY REPORT
ON
THE PROJECT ON STRENGTHENING
OF WATER EXAMINATION SYSTEM
IN
THE PEOPLE'S REPUBLIC OF BANGLADESH

JULY 2004

JAPAN INTERNATIONAL COOPERATION AGENCY〔JICA〕

KOKUSAI KOGYO CO., LTD.

PREFACE

In response to a request from the Government of the People's Republic of Bangladesh, the Government of Japan decided to conduct a basic design study on the Project on Strengthening of Water Examination System and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh study teams from February 29 to March 17 and from April 6 to 30, 2004.

The team held discussions with the officials concerned of the Government of Bangladesh, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Bangladesh in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the People's Republic of Bangladesh for their close cooperation extended to the team.

July 2004

Yasuo Matsui
Vice-President
Japan International Cooperation Agency

July, 2004

LETTER OF TRANSMITTAL

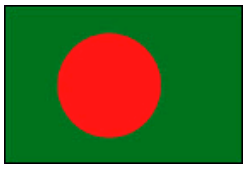
We are pleased to submit to you the basic design study report on the Project on Strengthening of Water Examination System in the People's Republic of Bangladesh.

This study was conducted by Kokusai Kogyo Co., Ltd., under a contract to JICA, during the period from February to July, 2004. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Bangladesh and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

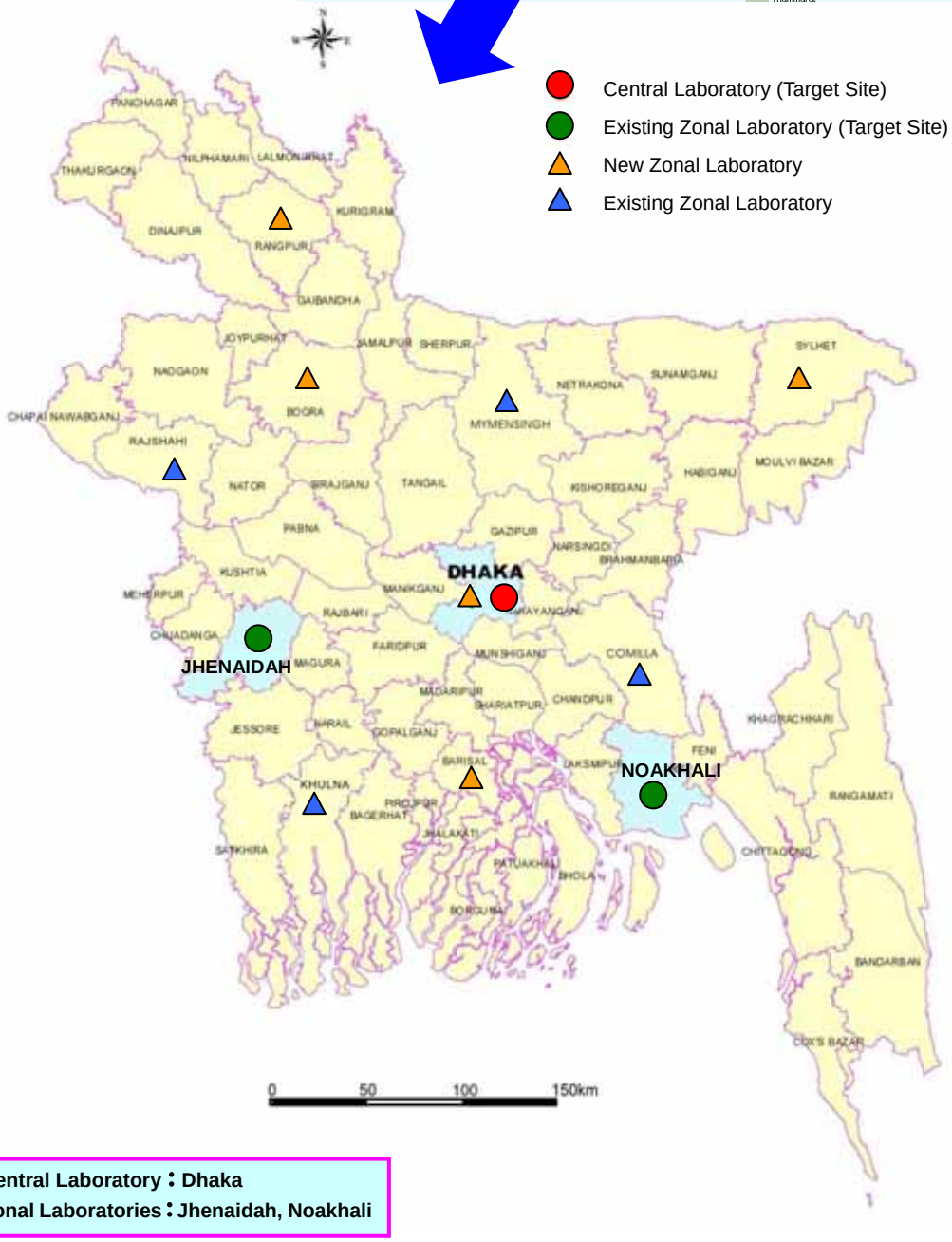
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Toshiyuki Matsumoto
Project manager,
Basic design study team on the Project on Strengthening of Water Examination System
Kokusai Kogyo Co., Ltd.



People's Republic of Bangladesh



Central Laboratory : Dhaka
Zonal Laboratories : Jhenaidah, Noakhali

Location Map of

Basic Design Study on the Project for Strengthening of the Water Examination System in Bangladesh

Perspective of Central Laboratory (Dhaka)

List of Figures

List of Tables

Abbreviations

AEC	:	Atomic Energy Center
A/P	:	Authorization to Pay
APSU	:	Arsenic Policy Support Unit
AusAID	:	Australian Agency for International Development
B/A	:	Banking Arrangement
BAMWSP	:	Bangladesh Arsenic Mitigation and Water Supply Project
BCSIR	:	Bangladesh Council of Scientific & Industrial Research
BNBC	:	Bangladesh National Building Code
BRAC	:	Bangladesh Rehabilitation Assistance Committee (NGO)
BUET	:	Bangladesh University of Engineering & Technology
CIDA	:	Canadian International Development Agency
Dhaka WASA	:	Dhaka Water Supply and Sewerage Authority
DANIDA	:	Danish International Development Agency
DfID	:	Department for International Development
DOE	:	Department of Environment
DPHE	:	Department of Public Health Engineering
E/N	:	Exchange of Notes
FAO	:	Food and Agriculture Organization of the United Nations
ICDDR,B	:	International Center for Diarrhoeal Disease Research, Bangladesh
ITN-BUET	:	International Training Network, Bangladesh University of Engineering and Technology
JICA	:	Japan International Cooperation Agency
JICWELS	:	Japan International Corporation of Welfare Services
LGD	:	Local Government Division
LIMS	:	Laboratory Information Management Systems
LLDC	:	Least among Less Developed Countries
MLGRD&C	:	Ministry of Local Government, Rural Development & Cooperatives
NAMIC	:	National Arsenic Mitigation Information Centre
NPAM	:	National Policy for Arsenic Mitigation 2003
OCETA	:	Ontario Centre for Environmental Technology Advancement

PCP	:	Project Concept Paper
PRSP	:	Poverty Reduction Strategy Paper
PSF	:	Pond Sand Filter
QC	:	Quality Control
SDC	:	Swiss Agency for Development and Cooperation
SPT	:	Standard Penetration Test
TK	:	Bangladesh Taka
UNDP	:	United Nations Development Programme
UNICEF	:	United Nations Children's Fund
USD	:	US Dollars
WHO	:	World Health Organization
WQMSC	:	Water Quality Monitoring & Surveillance Circle

Summary

The People's Republic of Bangladesh (hereinafter referred to as Bangladesh) has a population of about 129 million (2001), which is the largest population of the 50 (January, 2004) Least among Less Developed Countries (LLDC) throughout the world. The GDP per capita is 389 US dollars (2002) and about 50% of the people live below the absolute poverty line. (Based on the Direct Calorie Intake method, the poverty rate is 47.5 %.) Regardless of economic growth due to economic structural reforms, the situation has not improved (JICA's country-by-country project evaluation, June 2000).

In 1983, the first patients were diagnosed with arsenic poisoning from contaminated groundwater in the neighboring Indian state of West Bengal. Since then, arsenic contaminated wells were confirmed in the western region of Bangladesh in 1993 and the first patients suffering from arsenic poisoning were discovered in the same region in 1994. The results of nationwide investigations revealed that arsenic contamination was prevalent throughout the country. By the end of 1999, arsenic contaminated groundwater was detected in 59 of the 64 districts in the country, excluding the mountain and hilly region. At present, approximately 25% of the estimated 10 million wells have arsenic concentrations exceeding the national standard (0.05mg/L; the WHO guideline value is 0.01mg/L), supplying drinking water to more than 30 million people. There are over 10,000 patients suffering from arsenic-related diseases (official announced in 2001) and at least 20 million people are at risk of arsenic poisoning.

Although water quality analysis to determine the safeness of water supplies is being done with field test kits, an adequate implementation system for water quality examination has not been established. In light of the current situation, the National Policy for Arsenic Mitigation 2003 (NPAM, approved by the cabinet in 2004) places emphasis on strengthening the water quality examination system as part of the water supply policy to combat arsenic contamination.

The issues concerning the current water quality examination system in Bangladesh include lack of an implementation system and lack of a regulatory and fund system. As there is no central instruction in the implementation system, it is not possible to adequately carry out equipment maintenance and the procurement of chemicals, etc. or accuracy control, management of water quality data, and reflection of research results in policy. Under such circumstances, the Government of Bangladesh made a request to the Government of Japan for Grant Aid for the establishment and strengthening of a water quality examination system.

The contents of the request submitted by the Government of Bangladesh in January 2003 are as follows:

- Construction of 2-story central laboratory (total floor space: 1,500m^2)
- Renovation of four existing zonal laboratories (Khulna, Rajshahi, Mymensingh, Comilla)

- ♦ Procurement of analytical equipment and materials, glassware, and support vehicles for the central laboratory and above-mentioned zonal laboratories
- ♦ Technical support for handling of equipment

The Project Concept Paper (PCP) prepared by Local Government Division (LGD) and Department of Public Health Engineering (DPHE) in July 2003 was generally in accordance with the request. However, the PCP was revised in October 2003.

Based on this request, the Japanese Government decided to conduct a basic design study and in response, the Japan International Cooperation Agency (JICA) dispatched a study team from February 28 to March 18, 2004 to investigate the appropriateness and effect of the project (1st Field Study).

As a result, in the first Field Study discussions were held with Ministry of Local Government, Rural Development & Cooperatives (MLGRD&C)/LGD and DPHE, the responsible agencies and the implementing agency in the counterpart country. The following contents were confirmed as a revised request from the Government of Bangladesh:

- ♦ Construction of central laboratory (1 building) and procurement of equipment
- ♦ Procurement of equipment for two existing zonal laboratories (Jhenaidah, Noakhali) (interior renovation of the two laboratories if necessary, not including construction of new buildings)
- ♦ Technical support for operation and maintenance of equipment

Based on these results, a study team was dispatched from April 5 to May 1, 2004 (2nd field study) to formulate an optimal basic design. After analysis and examination in Japan, a draft of the basic design was prepared and a team was sent to Bangladesh to explain and discuss the draft from June 11 to 19, 2004.

The primary objective of the overall project plan (including independent efforts by the Government of Bangladesh, and the Grant Aid and Technical Cooperation projects) is to provide a safe drinking water supply, free from arsenic contamination, and the project goal is “to strengthen the water quality examination system”. This Grant Aid project, by equipping infrastructure of the water quality examination system, will contribute to achieving the primary objective together with “promoting arsenic mitigation measures and water supply projects” being implemented separately.

The functions and roles of the central laboratory were determined based on discussions with the Government of Bangladesh. They include:

- ■ Coordination and management of all zonal laboratories
- ■ Training and development of human resources for the zonal laboratories

- Management of the zonal laboratories in terms of quality control
- Provision of technical support to zonal laboratories for maintenance of equipment
- Analysis of water samples that the zonal laboratories cannot cover
- Management of water quality analysis data at the national level
- Conducting of research to support water quality policies and measures

Based on these functions, roles and the water quality standards for 55 parameters (excluding the two radiation-related parameters) and standard analysis methods in Bangladesh, the basic design was carried out considering ease of operation and maintenance, the impact on the environment, the technical competence, and so on.

The contents of the original request and the basic design (optimal plan) are shown in Table 1.

Table 1 Comparison of Original Request and Basic Design

	Contents of Original Request	Basic Design
Facility	• Construction of 2-story central laboratory (total floor area: 1,500m^2) • Renovation of four existing zonal laboratories (Khulna, Rajshahi, Mymensingh, Comilla)	• Construction of 3-story central laboratory (total floor area: 1,464m^2) • Renovation of two existing zonal laboratories (Jhenaidah, Noakhali)
Equipment	• Procurement of analytical equipment, glassware, chemicals and support vehicles for the central laboratory and four existing zonal laboratories	• Procurement of analytical equipment, glassware, chemicals and support vehicles for the central laboratory and two existing zonal laboratories
Technical Support	• Technical support for operation and maintenance of equipment	• Technical guidance for technical staff of two existing zonal laboratories • Guidance for operation of the central laboratory, operation and maintenance of equipment, and data management

A summary of facility construction and the main equipment to be procured in the basic design are shown in Table 2 and Table 3.

Table 2 Summary of Facility Construction

Type of Facility	Quantity	Remarks
Construction plan for the central laboratory	1	Dhaka, Mohakhali area
• Total floor space	1,255.8m^2	
• Ground floor: Director's room, Logistic division, Administration, Financial & HRD, Meeting room, etc.	414.2m^2	
• 1st floor: Analysis rooms, Analytical Division, Waste Water Treatment, etc.	425.6m^2	
• 2nd floor: Data management, Training room, Dormitory, etc.	416m^2	
• Generator house	21m^2	
• Water supply and sewerage	1 set	
• Ventilation	1 set	
Renovation plan for zonal laboratory (1)	1	Jhenaidah Laboratory
• Window	11	
• Door	2	
• Wall tiles	300m^2	
• Coating for wall and ceiling	600m^2	
• Partition panel	12m^2	
• Electricity	1 set	
• Water supply and sewerage	1 set	
• Ventilation	1 set	
Renovation plan for zonal laboratory (2)	1	Noakhali laboratory
• Window	1	
• Removal of wall (thickness=0.3m)	9.75m^2	
• Coating for wall and ceiling	300m^2	
• Partition panel	15.45m^2	
• Electricity	1 set	
• Water supply and sewerage	1 set	
• Ventilation	1 set	

Table 3 Summary of Equipment Procurement

No.	Item	Unit	Quantity				Specification
			Dakha	Jhenaidah	Noakhali	Total	
Equipment and material for analysis laboratories							
*	Atomic absorption spectrophotometer	unit	1			1	As, Se
*	Atomic absorption spectrophotometer	unit	1			1	Heavy metal
*	Atomic absorption spectrophotometer	unit	1			1	Al, Ba
*	Atomic absorption spectrophotometer	unit			1	1	All elements
*	Murcury analyzer	unit	1			1	
*	Ion chromatograph	unit	1			1	Anion
*	Ion chromatograph for Chromium	unit	1			1	Sexivalent chrome
*	Gas chromatograph	unit	1			1	Solvent extraction
*	Gas chromatograph (w/ purge & trap)	unit	1			1	With verge & trap
*	Flow injection analyzer	unit	1			1	Total P & total N
*	UV-VIS spectrophotometer	unit	2		1	3	
*	Water quality meters (desk top type)	unit	1	1	1	3	pH, ORP, Ion, DO, Turbidity
*	TOC analyzer	unit	1			1	
*	Microwave digestion apparatus	unit	1			1	
*	Pure water apparatus	unit	1	1	1	3	40L/day, 80L/day
*	Draft chamber (perchloric acid)	unit	1			1	With acidic gas emission
*	Draft chamber (w/ gas adsorber)	unit	1			1	With solvent sdsorption device
*	Draft chamber	unit unit		1		1	Without acid gas emission & solvent absorption device
*	Clean bench	unit	1			1	Fixed type
*	Waste water treatment device	unit	1			1	
Glassware		unit	1	1	1	3	Beaker, flask, test tube etc.
Reagent for initial operation		unit	1			1	Reagent for 6 months
Supporting vehicle							
*	4WD vehicle	unit	2			2	For management of zonal Lab.
*	Microbus	unit	1			1	For training
*	Pick-up truck	unit	1			1	To transport samples and material
Training equipment		unit	1			1	Projector, screen etc.
*	Photocopy machine	unit	1			1	
Equipment for water quality database management		unit unit	1			1	PC for server, scanner etc.

The project is to be implemented by Grant Aid in one fiscal year, at an estimated project cost of 535 million yen (495 million yen covered by Grant Aid, 40 million yen by the Bangladeshi side). The required term for completion is expected to be 3 months for implementation design, 11 months for facility construction, 3.5 months for equipment procurement, and 3 months for technical support, respectively.

Under the Grant Aid, a water quality analysis laboratory will be constructed and analytical equipment procured, and basic technology will be transferred to the counterpart staff to ensure the smooth start up of the laboratory. As a result, a responsible organization for water quality examination in Bangladesh will be established and the number of water quality samples to be analyzed will increase. Moreover, through support for arsenic mitigation policy by a long-term expert and the realization of the technical cooperation project currently under consideration, DPHE staff's capacity for planning water quality programs and for water quality analysis will be improved through training,

etc. It is expected that the water quality examination system in Bangladesh will be strengthened from an institutional aspect and in terms of human resources.

Strengthening of the water quality examination system in Bangladesh will contribute to achieving the primary objective to supply safe drinking water, along with the promotion of arsenic mitigation measures being carried out separately.

To ensure the sustainability of the overall project, LGD and DPHE must address the following three main issues:

- Establishment of a laboratory management system and staff assignment
- Establishment of a drinking water quality examination system
- Establishment of a revolving fund system for laboratory management

  The annual cost for operation and maintenance of the central laboratory and 11 zonal laboratories is assumed to be roughly 92 million yen, which accounts for a relatively large portion of the annual budget of DPHE (about 11% of the current budget). If budgetary arrangements remain the same, allocation of the amount is feasible. However, effort by the Government of Bangladesh to take budgetary steps such as to set up the revolving fund system for laboratory management is indispensable.

Although part of the existing problems will be solved through implementation of technical support under the Grant Aid project, coordination with long-term experts (currently dispatched) and the technical cooperation project (under consideration) is vital to ensure sustainability of the project. At the same time, smooth shift from the Grant Aid to technical cooperation through the provision of basic technical support under the project is essential.

Table of Contents

Chapter 1 Background of the Project

Chapter 1. Background of the Project

(1) Background of the Request

In 1998, the Japanese Government dispatched three short-term experts to Department of Public Health Engineering (DPHE) to examine the current situation and measures on arsenic contamination in the People's Republic of Bangladesh (hereinafter referred to as "Bangladesh"). As a result, to extend Japanese cooperation with targeting three districts (Jessore, Jhenaidah, and Chuadanga) in the western region of Bangladesh, where arsenic contamination was found to be particularly serious besides difficulty of securing alternative water resources such as surface water, was examined. Based on the above background, the Government of Bangladesh submitted a request for cooperation for the "Study on Groundwater Development in Arsenic Contaminated Regions in Bangladesh", which was implemented during the period from March 2000 to January 2003. In the study, an arsenic mitigation master plan was formulated, priority projects were proposed and a pre-feasibility study was conducted, targeting the same three districts in the western region, based on findings concerning the current situation of arsenic contamination, the development potential of deep groundwater, arsenic mitigation measures, and the arsenic contamination mechanism.

The framework of the Master Plan consists of (1) studies, (2) measures for rural areas, (3) measures for urban areas, and (4) research and development (R&D) and monitoring. The short-term and mid-term goals for R&D and monitoring include renovation and use of DPHE's existing laboratories, training of technical staff, and so on. In addition, from October 2000, an expert was dispatched to DPHE and the Local Government Division (LGD) as an advisor on arsenic mitigation measures to provide technical guidance on the arsenic mitigation sector program and make recommendations on alternative water resources. Consequently, it was pointed out that the water quality examination system in Bangladesh was weak and the construction of a central laboratory was necessary.

Issues concerning the current water quality examination system in Bangladesh include lack of an implementation system and lack of a regulatory and fund system. As there is no central instruction in the implementation system, it is not possible to adequately carry out equipment maintenance and the procurement of chemicals, etc. or accuracy control, management of water quality data, and reflection of research results in policy. Under such circumstances, the Government of Bangladesh made a request to the Government of Japan for Grant Aid for the establishment and strengthening of a water quality examination system.

The contents of the request submitted by the Government of Bangladesh in January 2003 are as follows:

- ♦ Construction of 2-story central laboratory (total floor space: 1,500m^2)
- ♦ Renovation of four existing zonal laboratories (Khulna,, Rajshahi, Mymensingh, Comilla)
- ♦ Procurement of analytical equipment and materials, glassware, and support vehicles for the central laboratory and above-mentioned zonal laboratories
- ♦ Technical support for handling of equipment

The Project Concept Paper (PCP) prepared by LGD and DPHE in July 2003 was generally in accordance with the request. However, the PCP revised in October 2003 has the following changes.

- ♦ No reference to the upgrading of equipment at the existing zonal laboratories
- ♦ Construction of central laboratory (4-story) and dormitory (6-story)

In the 1st Field Study in March 2004, discussions were held with Ministry of Local Government, Rural Development & Cooperatives (MLGRD&C)/LGD and DPHE, the responsible agencies and the implementing agency in the counterpart country and the following contents were confirmed as a revised request from the Government of Bangladesh.

- ♦ Construction of central laboratory (1 building) and procurement of equipment
- ♦ Procurement of equipment for two existing zonal laboratories (Jhenaidah, Noakhali) (interior renovation of the two laboratories if necessary, not including construction of new buildings)
- ♦ Technical support for operation and maintenance of equipment

Overview of the Request

The contents of the original request and the basic design (optimal plan) are shown in Table 1-1.

Table 1-1 Comparison of Original Request and Basic Design

	Contents of Original Request	Basic Design
Facility	• Construction of 2-story central laboratory (total floor area: 1,500m^2) • Renovation of four existing zonal laboratories (Khulna, Rajshahi, Mymensingh, Comilla)	• Construction of 3-story central laboratory (total floor area: 1,464m^2) • Renovation of two existing zonal laboratories (Jhenaidah, Noakhali)
Equipment	• Procurement of analytical equipment, glassware, chemicals and support vehicles for the central laboratory and four existing zonal laboratories	• Procurement of analytical equipment, glassware, chemicals and support vehicles for the central laboratory and two existing zonal laboratories

	Contents of Original Request	Basic Design
Technical Support	• Technical support for operation and maintenance of equipment	• Technical guidance for technical staff of two existing zonal laboratories • Guidance for operation of the central laboratory, operation and maintenance of equipment, and data management

A summary of facility construction and the main equipment to be procured in the basic design are shown in Table 1-2 and Table 1-3.

Table 1-2 Summary of Facility Construction

Type of Facility	Quantity	Remarks
Construction plan for the central laboratory	1	Dhaka, Mohakhali area
• Total floor space	1,255.8m^2	
• Ground floor: Director's room, Logistic division, Administration, Financial & HRD, Meeting room, etc.	414.2m^2	
• 1st floor: Analysis rooms, Analytical Division, Waste Water Treatment, etc.	425.6m^2	
• 2nd floor: Data management, Training room, Dormitory, etc.	416m^2	
• Generator house	21m^2	
• Water supply and sewerage	1 set	
• Ventilation	1 set	
Renovation plan for zonal laboratory (1)	1	Jhenaidah Laboratory
• Window	11	
• Door	2	
• Wall tiles	300m^2	
• Coating for wall and ceiling	600m^2	
• Partition panel	12m^2	
• Electricity	1 set	
• Water supply and sewerage	1 set	
• Ventilation	1 set	
Renovation plan for zonal laboratory (2)	1	Noakhali laboratory
• Window	1	
• Removal of wall (thickness=0.3m)	9.75m^2	
• Coating for wall and ceiling	300m^2	
• Partition panel	15.45m^2	
• Electricity	1 set	
• Water supply and sewerage	1 set	
• Ventilation	1 set	

Table 1-3 Summary of Equipment Procurement

No.	Item	Unit	Quantity				Specification
			Dakha	Jhenaidah	Noakhali	Total	
Equipment and material for analysis laboratories							
*	Atomic absorption spectrophotometer	unit	1			1	As, Se
*	Atomic absorption spectrophotometer	unit	1			1	Heavy metal
*	Atomic absorption spectrophotometer	unit	1			1	Al, Ba
*	Atomic absorption spectrophotometer	unit			1	1	All elements
*	Murcury analyzer	unit	1			1	
*	Ion chromatograph	unit	1			1	Anion
*	Ion chromatograph for Chromium	unit	1			1	Sexivalent chrome
*	Gas chromatograph	unit	1			1	Solvent extraction
*	Gas chromatograph (w/ purge & trap)	unit	1			1	With verge & trap
*	Flow injection analyzer	unit	1			1	Total P & total N
*	UV-VIS spectrophotometer	unit	2		1	3	
*	Water quality meters (desk top type)	unit	1	1	1	3	pH, ORP, Ion, DO, Turbidity
*	TOC analyzer	unit	1			1	
*	Microwave digestion apparatus	unit	1			1	
*	Pure water apparatus	unit	1	1	1	3	40L/day, 80L/day
*	Draft chamber (perchloric acid)	unit	1			1	With acidic gas emission
*	Draft chamber (w/ gas adsorber)	unit	1			1	With solvent sdsorption device
*	Draft chamber	unit unit		1		1	Without acid gas emission & solvent absorption device
*	Clean bench	unit	1			1	Fixed type
*	Waste water treatment device	unit	1			1	
Glassware		unit	1	1	1	3	Beaker, flask, test tube etc.
Reagent for initial operation		unit	1			1	Reagent for 6 months
Supporting vehicle							
*	4WD vehicle	unit	2			2	For management of zonal Lab.
*	Microbus	unit	1			1	For training
*	Pick-up truck	unit	1			1	To transport samples and material
Training equipment		unit	1			1	Projector, screen etc.
*	Photocopy machine	unit	1			1	
Equipment for water quality database management		unit unit	1			1	PC for server, scanner etc.

Chapter 2 Contents of the Project

Chapter 2. Contents of the Project

2-1 Basic Concept of the Project

(1) Primary Objective and Goal

In Bangladesh, the problem of arsenic contamination was first discovered in 1993. Since then, the government has formulated the National Water Policy 1998, the National Policy for Safe Water Supply and Sanitation 1998, and the Draft National Water Management Plan 2001, with the aim of managing water resources in order to provide safe water supply and sanitation services. However, based on the need to supplement the existing policy in order to combat the spread of arsenic contamination, the National Policy for Arsenic Mitigation 2004 (NPAM) was approved by the Cabinet in March 2004. This new policy states the following four items as the focus of water policy in respect to arsenic contamination.

- Public awareness
- Alternative arsenic safe water supply
- Diagnosis and management of patients
- Capacity building

The NPAM places a high priority on the need for water quality analysis (not only for arsenic) and states that capacity building to strengthen the water quality examination system shall include the following:

- Upgrading of the capacity for water quality monitoring and surveillance of existing safe tube wells and proposed interventions (arsenic removal devices and other alternative technical options for water supply, etc)
- Establishment of a network of well-equipped laboratories with arsenic measurement capacities at appropriate levels

In respect to research and development (R&D), the policy states that a reference laboratory shall be designated for analytical validation of arsenic related laboratory activities. The proposed central laboratory will be a reference laboratory of DPHE.

The Implementation Plan for Arsenic Mitigation in Bangladesh was prepared as the implementation plan for NAMP. As the Institutional Arrangement, the plan states that DPHE, being the mandated government organization for rural water supply and having a countrywide network of personnel, shall be made responsible for coordinating the overall emergency water supply program at

the central level. Regarding the development of laboratory facilities, the plan also states that laboratory facilities must be set up in health centers at the Upazila level in the future and must be linked to the existing DPHE laboratories. The DPHE laboratories must also be equipped with the necessary instruments, chemicals, and trained personnel.

Based on these national policies, the primary objective of the Project is to provide "safe water supply" through arsenic mitigation, and the goal of the Project is "to strengthen water quality examination system". This project, together with separate efforts to promote arsenic mitigation and water supply services, will contribute to achieving the primary objective.

(2) Basic Concept of the Project

The overall project goal is to strengthen water quality examination system supported by establishment of central laboratory and zonal laboratories, and to establish a regulatory and fund system (refer to Figure 2.1). The aim of the Grant Aid requested for the project is as follows:

- ♦ Construction of a central laboratory (one building in Mohakhali, Dhaka) and procurement of equipment
- ♦ Procurement of equipment for two existing zonal laboratories (Jhenaidah, Noakhali) and internal renovation of existing facilities (not including reconstruction)
- ♦ Provision of technical support for the operation and maintenance of laboratories and equipment and data management (soft component)

Technical cooperation project focusing on human resource development for water quality examination is under consideration by both Bangladeshi and Japanese side to achieve the overall project goal as stated above.

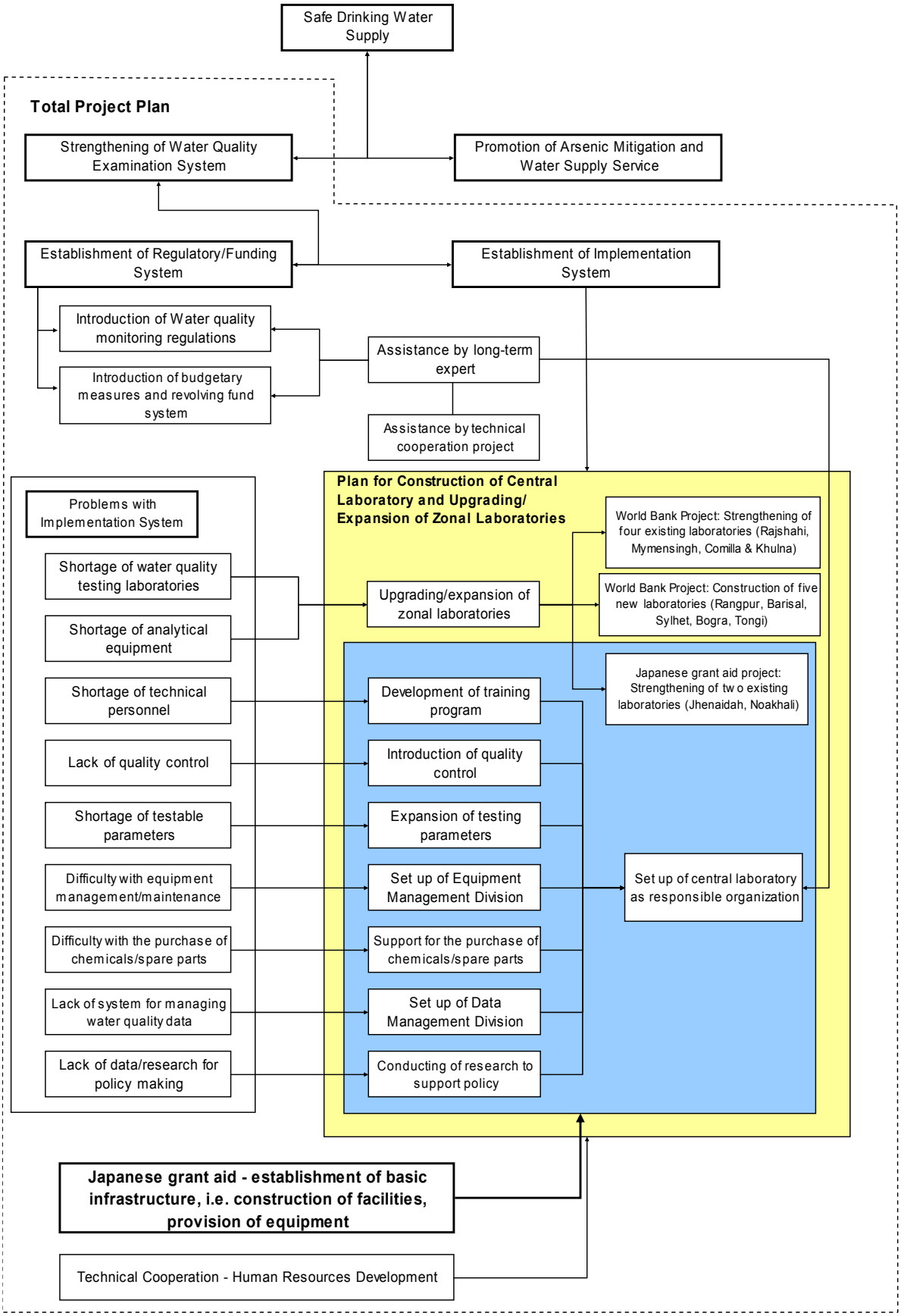


Figure 2-1 Project Overview and Requested Japanese Grant Aid

2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy

The main issues concerning the water quality examination system in Bangladesh are the "establishment of an implementation system" and "establishment of regulatory and funding arrangements". These issues are summarized in Figure 2.2.

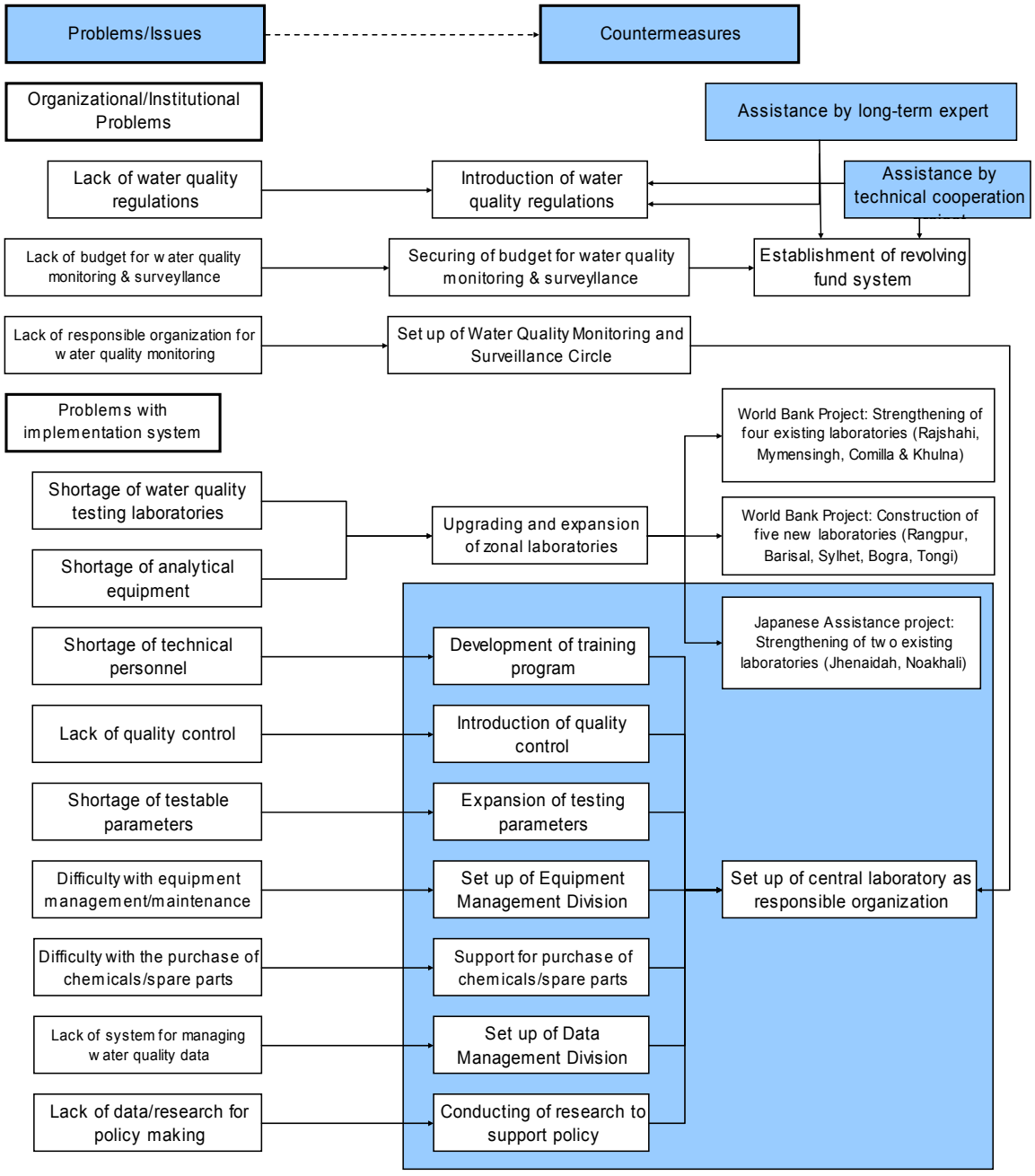
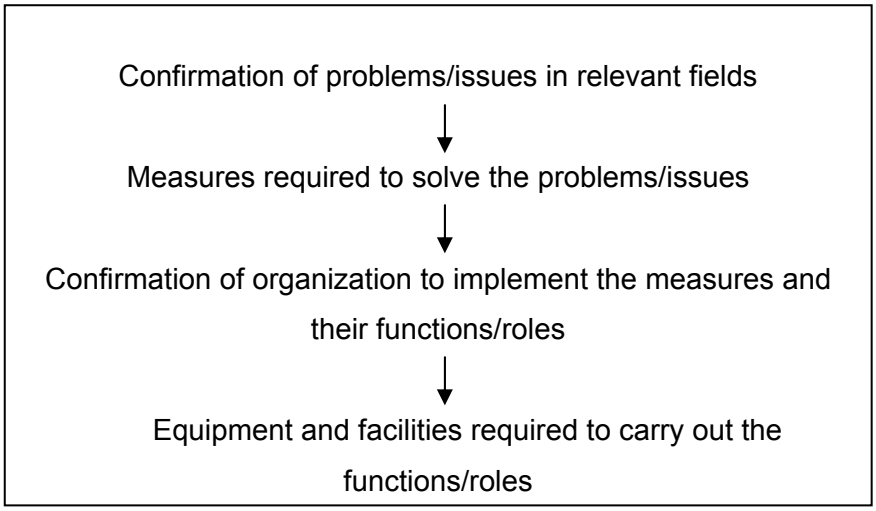


Figure 2-2 Problems concerning water quality examination system and countermeasures

The Japan's Grant Aid will contribute to solving the above-mentioned issues through the provision of funds to establish the physical infrastructure. Based on this policy, the basic design will be carried out according to the following process:



① Functions and roles of the central laboratory

The functions and roles of the central laboratory were determined based on discussions with the Government of Bangladesh as follows:

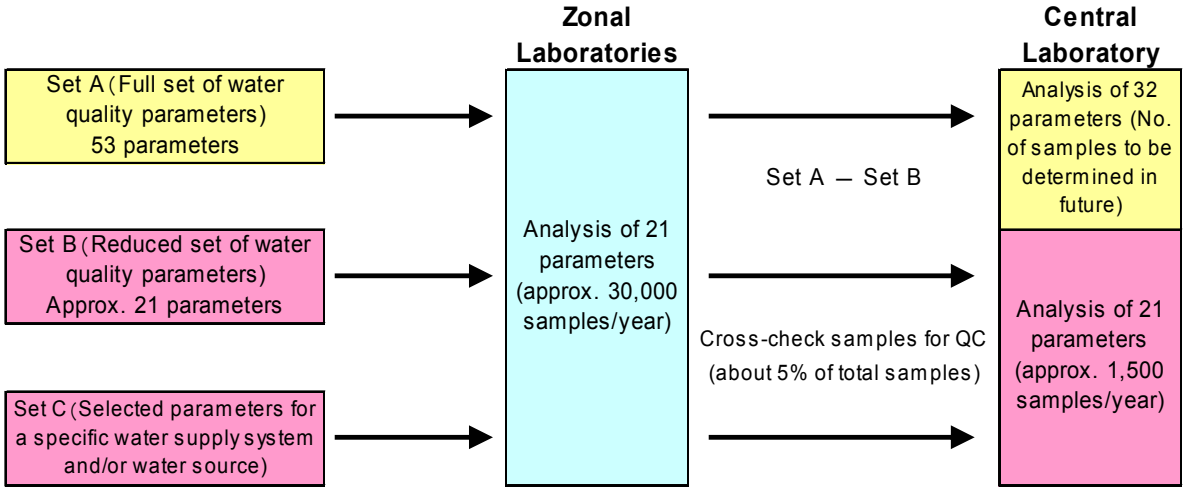
- To coordinate and manage all zonal laboratories
- To train and develop human resources for the zonal laboratories
- To manage the zonal laboratories in terms of quality control
- To provide technical support to the zonal laboratories for maintenance of equipment
- To analyze water samples that the zonal laboratories cannot cover
- To manage water quality analysis data at the national level
- To conduct research to support the development of water quality policies and measures

Management and Coordination of All Zonal Laboratories: The central laboratory will be responsible for assessing the situation of the zonal laboratories and developing, in collaboration with the zonal laboratories, the annual water quality monitoring and surveillance program. It shall also coordinate and manage the zonal laboratories to overcome existing problems and issues concerning the laboratories, which is the most important function of the central laboratory.

Training and Development of Human Resources: Training for technical staff of the zonal laboratories will be provided at the central laboratory. This training is to be long-term, mainly On-the-job training basis. Training will also be provided to engineers and well technicians

working at DPHE's regional offices in sampling and field measurements so that they are able to support water monitoring activities. This training is to be short-term, consisting of several workshops and practical guidance.

Quality Control/Analysis of Water Samples: In Bangladesh, water quality standards have been set for 55 parameters. It was discussed with DPHE that the two parameters that need to be analyzed by radioactivity measurement should be entrusted to the AEC (Atomic Energy Center). Analysis of the remaining 53 parameters will be conducted at the central laboratory in accordance with the "Standard Methods of Water and Wastewater Examination (20th edition)" (Published by the American Public Health Association, et. al., hereinafter referred to as "Standard Methods"), which is applied in Bangladesh. The zonal laboratories shall analyze around 21 of the 53 parameters. The parameters to be analyzed are based on the draft protocol by BAMWSP (Bangladesh Arsenic Mitigation Water Supply Project) funded by the World Bank. BAMWSP has divided parameters to be analyzed into three sets, Set A (full set of water quality parameters), Set B (reduced set of water quality parameters), and Set C (selected parameters for a specific water supply system and/or water source), according to the type of water source, size of supplied population and time of water quality analysis (when starting operation of water supply, during operation) (Refer to the figure below). BAMWSP is currently finalizing decisions for application of Set A～C.



The central laboratory will analyze samples that cannot be covered by the zonal laboratories (Set A － Set B). The number of samples will be determined after the national plan for water quality examination is formulated. In addition, to manage the zonal laboratories in terms of quality control (QC), the central laboratory will crosscheck about 5% (approximately 1,500 samples) of the samples analyzed at the zonal laboratories. In the protocol for water quality examination, Set C comprises parameters that are selected to monitor specific trends or impacts based on the analysis results of the full set of parameters (53 parameters) and will be analyzed at

the zonal laboratories. However, as the parameters of Set C cannot be confirmed until after analysis of the full set of parameters, they cannot be selected at present. As with the other sets of parameters, the central laboratory will crosscheck samples for Set C parameters analyzed at the zonal laboratories for quality control. Regarding water quality analysis, technical support under the Grant Aid project will be conducted for instrument analysis.

Technical support for Equipment Maintenance: The central laboratory will provide support to all zonal laboratories in the country in maintaining equipment and purchasing chemicals and spare parts. The central laboratory will have an equipment management division with skilled technical staff to carry out maintenance work on equipment. All chemicals and spare parts will be managed by the central laboratory and a stock will be kept to ensure that supplies can be delivered promptly when needed. Such a management system will make it possible to maintain the quality of the chemicals and equipment at a fixed level.

Data Management: As analysis activities get activated in the zonal laboratories, large amounts of data will be sent to the central laboratory on a regular basis. Therefore, the central laboratory must have the capacity to manage this data. The management of water quality data is essential for formulating appropriate water policy based on actual conditions. Development of an integrated system (LIMS: Laboratory Information Management System) for managing all water quality data using GIS is envisioned in the future.

Research to Support the Development of Policies/Measures: The subject for research should be considered based on water quality data to be collected. For example, research related to the mitigation of arsenic contamination can be carried out and the findings can be used to develop policies and measures. The central laboratory to be constructed is designed to enable this kind of research.

② Site Selection

The site of the central laboratory shall be Mohakhali, Dhaka (DPHE owned property) as proposed in the original request. In the process of discussions, Tejgaon, Dhaka (also DPHE owned property) was proposed as a new candidate site. However, after site visits and discussion, the Bangladeshi side concluded that Mohakhali was more suitable. Considering the functions of the central laboratory, i.e. support for equipment maintenance, training, etc., the site is favorably located in central Dhaka.

③ Equipment Selection

The selection of the equipment and material in the project was decided according to the policy shown in Figure 2-3.

④ Facility Design

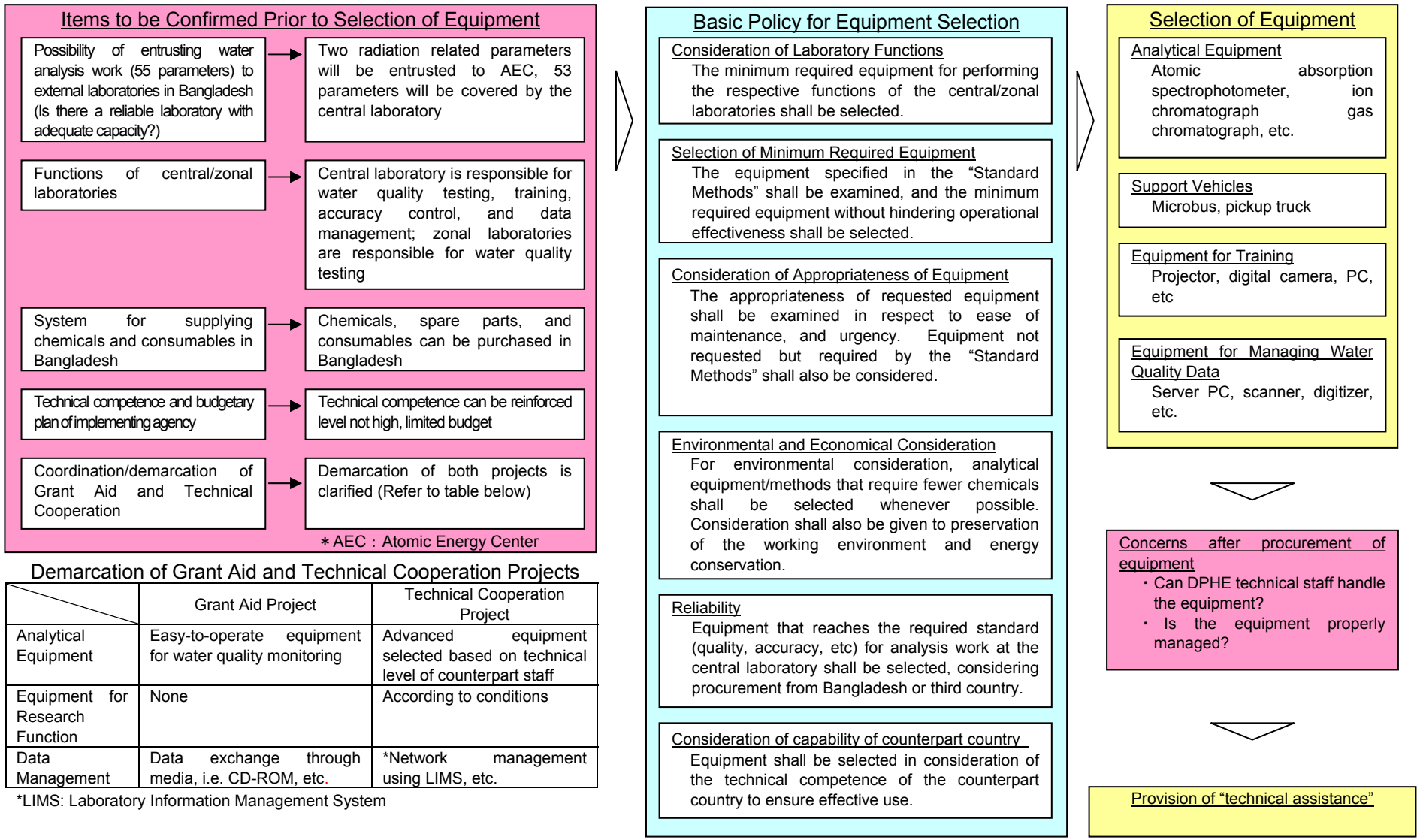
The overall size of the central laboratory was determined based on its roles and functions (required laboratory space, administrative space, training space, etc.) and on the Bangladesh Government's standards for calculating office space. The following regulations were applied to the building design and layout. The existing zonal laboratories thus far are in compliance with these standards.

- Bangladesh National Building Code 1993
- Rules of Building Construction 1996 Capital Development Authority

As many chemicals will be handled at the central laboratory, fire protection equipment and safety measures are needed to be planned. The policy for facility design is shown in Figure 2-4.

⑤ Technical Support

Technical support will be provided to ensure sustainability of the Project by facilitating smooth operation in the start up phase. There shall be a clear demarcation between technical support under Grant Aid and the technical cooperation project currently under consideration. Furthermore, in view of the schedule for completion of facility construction and equipment installation and expiration of the Exchange of Notes, the need to conduct guidance and practical training on equipment use in a short period will be taken into account.



Demarcation of Grant Aid and Technical Cooperation Projects

	Grant Aid Project	Technical Cooperation Project
Analytical Equipment	Easy-to-operate equipment for water quality monitoring	Advanced equipment selected based on technical level of counterpart staff
Equipment for Research Function	None	According to conditions
Data Management	Data exchange through media, i.e. CD-ROM, etc.	*Network management using LIMS, etc.

*LIMS: Laboratory Information Management System

Figure 2-3 Selection Process for Equipment

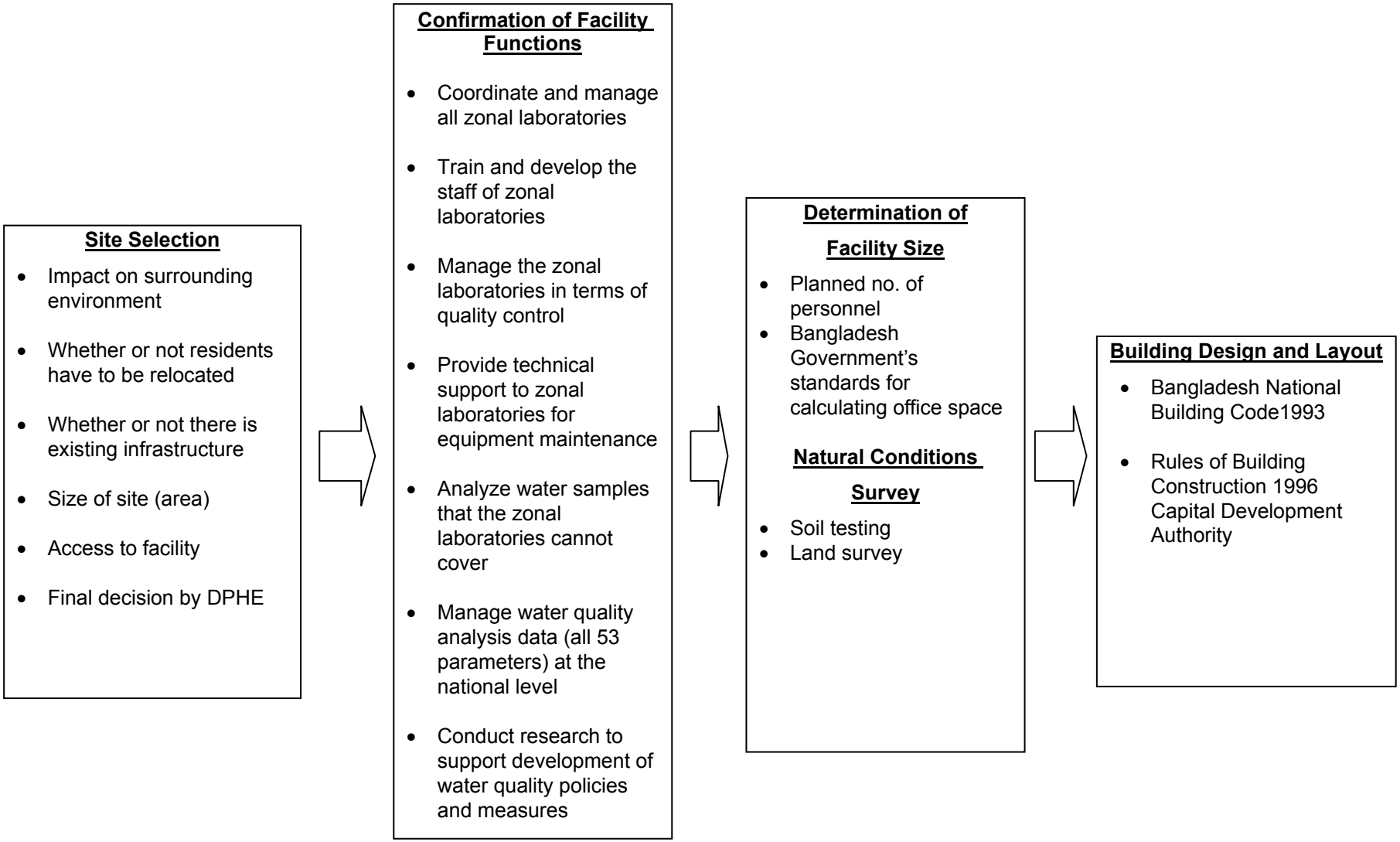


Figure 2-4 Facility Design Process

(2) Policy on Natural Conditions

The number of days with more than 10mm/day of rainfall is shown in the figure below. Implementation of the foundation work and waterproofing work during the rainy season shall be avoided.

Number of days with rainfall of more than 10mm/day

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	in a year
1998		0	2	6	6	5	15	10	10	4	3	0	61
1999	0	0	0	1	8	10	13	9	6	10	0	0	57
2000	1	1	2	9	10	7	7	4	5		0	0	46
2001	0	0	0	1	11	14	10	9	5	4	0	0	54
2002	1	0	3	5	6	13	11	8	4				51
2003		0	4										4
Average	0.50	0.17	1.83	4.40	8.20	9.80	11.20	8.00	6.00	6.00	0.75	0.00	4.74

Source: Bangladesh Meteorological Department (Banani Station)

Regarding flood damage, from interviews with residents in the surrounding area and experienced local consultants, it was found that Mohakhali becomes inundated by approximately 30cm of water once every several years. Therefore, the ground floor of the building shall be raised.

Since 1990, cyclones have hit twice a year, nearly every year. Therefore, as the design policy, the design wind speed shall be considered from the analysis results of the wind speed of past cyclones and the probable wind speed. In the BNBC, the design wind speed is 210km/hr in Dhaka, and that value shall be adopted.

The topography of Bangladesh is shown in Figure 2-5. The northern part of Dhaka is situated on an alluvial terrace and is of a slightly higher elevation than the surrounding area (the elevation of the site area in Dhaka is about 10m). As the topography was formed in an older geological era, the strength of soil is relatively higher than the surrounding area. Nevertheless, soft ground exists in some places along the river near the site, so soil tests were carried out to determine the strength of soil. The results were utilized in the facility design. A land survey was also conducted in and around the site area (DPHE grounds) to determine the difference in height between the site and its surroundings. The results were used in the facility design.

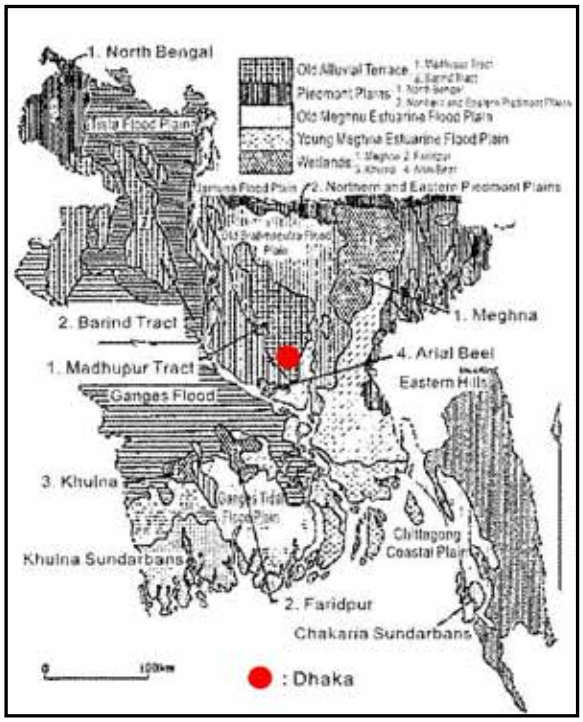


Figure 2-5 Topography of Bangladesh
(Source: H. Brammer, 1971 (modified))

Dhaka has never experienced heavy damage due to a direct earthquake in the past. However, tremors have been felt following earthquakes that have struck in surrounding regions. Therefore, based on the seismic zoning map adopted by BNBC, Dhaka is judged to lie in Zone 2, and the standard sheer coefficient of 0.15 was adopted.

(3) Policy on Socio-economic Conditions

Public holidays will be taken into consideration in determining the construction period. In Bangladesh, basic working days include all days except Fridays, the Muslim holy day, and national holidays. Although the dates of national holidays change each year according to the government, the number of national holidays stays the same (21 days). Therefore, the number of working day will be based on the number of national holidays and Fridays during that period.

(4) Policy on Construction/Procurement Situation

Based on Japan's Grant Aid system, equipment and materials are to be procured in Bangladesh and Japan in principle. However, procurement of equipment and materials from a third country will be considered if they satisfy the quality and specifications required and it is preferable in terms of cost and after care.

(5) Policy on Use of Local Subcontractors

In construction of the facility, local subcontractors cannot be the primary contractor under Japan's Grant Aid system. However, judging by the many high-rise buildings under construction throughout Dhaka, local construction companies are believed to have suitable experience and will be utilized for subcontracted works, in order to reduce construction costs.

(6) Policy on Operation and Management Capacity of Implementing Agency

A new circle (i.e. Water Quality Monitoring and Surveillance Circle, consisting of four divisions: Data Management Division, Logistic Division, Equipment Management Division, and Analytical Division) responsible for the monitoring and surveillance of water quality is to be set up within the implementing agency (DPHE). In order to secure budget for laboratory operation and maintenance, it is important to state the necessary budget clearly in the PCP (Project Concept Paper), and DPHE and LGD must secure permanent posts for laboratory staff on a revenue basis. Moreover, DPHE is currently in the final stages of developing a revolving fund system to use revenue from the collection of water quality analysis fees for laboratory operation. If the plan is approved, DPHE will be able to secure a self-sustaining budget for operation of the laboratory.

Bangladesh has an abundance of people with advanced degrees (university level and higher) in the fields of chemistry and biology. Therefore, the potential of the labor market is not expected to be a major concern. However, for laboratory management, the Bangladeshi side must secure sufficient staff

with necessary administrative qualifications. Regarding the recruiting method, Class 1 staff (senior staff of the central laboratory in addition to the Director) will be recruited through the government's Civil Service Commission, and lower level staff will be recruited based on final approval by the Chief Engineer of DPHE. Based on the technical level of recruited staff, the human resources development plan will be considered and technical support will be conducted. The central laboratory is responsible for overall water quality monitoring, and the recruitment of staff will be conducted considering its role not only as a center for water quality examination but also as a service provider involving the zonal laboratories and local residents.

DPHE, which does not have its own training program for water quality analysis, has high hopes for technical cooperation from Japan for human resource development. The details of the technical cooperation are under examination.

(7) Policy on Setting the Grade of Facilities/Equipment

① Facility

a. Central laboratory

The central laboratory will be constructed using locally available materials, according to the structure and construction method of normal grade buildings. In Dhaka, the interior and exterior of many buildings have deteriorated due to the moisture in the rainy season and car emissions. The central laboratory to be constructed in the project shall be of average quality, while taking account of measures to reduce the effects of humidity and exhaust gas.

b. Zonal laboratories

Regarding renovation of the zonal laboratories in Noakhali and Jhenaidah, the existing facilities shall be used as effectively as possible by securing a storage room for required equipment and instruments. In particular, the walls of the Noakhali laboratory are peeling due to the humidity. Therefore, the materials and construction method to be adopted in the renovation work shall be in accordance with average grade buildings in Bangladesh, taking humidity into consideration.

② Equipment

The equipment shall be of necessary and sufficient required grade, taking the functions and special features of the newly constructed central laboratory and upgraded zonal laboratories into consideration.

(8) Policy on Cost Reduction, Construction Method, and Construction Period

① Cost reduction

Consideration will be given to reducing costs by using locally available construction materials and sub local contractors.

② Method and period for construction of central laboratory

The central laboratory shall be a three-story, reinforced concrete building with a footing foundation. The required period for construction is approximately 11 months. Construction of the foundation during the rainy season should be avoided. The construction period of the central laboratory and implementation period of the technical support, which can be done only after construction, shall be adjusted.

③ Period for renovation of zonal laboratories

The estimated period for renovation of the Noakhali laboratory is approximately two months, and Jhenaidah laboratory three months.

2-2-2 Basic Plan (Construction Plan / Equipment Plan)

(1) Changes in Requested Components

The original request from Bangladesh, which was made July 2002, consisted of expansion of four existing DPHE laboratories (Khulna, Rajshahi, Mymensingh and Comilla) and construction of a two-story central laboratory. The Project Concept Paper (PCP) prepared by LGD and DPHE in July 2003 included almost the same contents as those in the original request although there was a change in the number of stories of the central laboratory building. The PCP was then revised in October, which did not include upgrading/expansion of the four existing laboratories but the construction of the central laboratory with four stories and a six-story dormitory nearby. After the discussion with the Bangladesh officials concerned during the study in Bangladesh, their request was finalized as follows.

Supervisory agency:	MLGRD&C/LGD (Ministry of Local Government Rural Development & Cooperatives Local Government Division)
Implementing agency:	DPHE
Request:	1. Construction of a central laboratory and equipment procurement 2. Equipment procurement for two existing zonal laboratories (Jhenaidah and Noakhali) and necessary interior renovation for the two laboratories (no construction of new buildings) 3. Technical support for equipment operation and maintenance

(2) Facility Plan

Facilities were designed based on the basic policies mentioned in Figure 2-4

① Compound and facility layout plan

a. Central laboratory

The compound for the central laboratory is outlined as follows.

- Owner: DPHE
- Lot size: 1,000m^2 area in the south-eastern part of DPHE-owned property (3,300m^2)
- Present use: DPHE storage and staff residences. Three families with 38 people will have to move out after execution of the project. DPHE is responsible for relocation arrangements.
- Nearby environment: The north and west parts of the compound border on the DPHE property and the east and south parts on the public road. As it is a commercial area, there are buildings with more than five stories adjoining.
- Future plan for the surrounding area: There is no major development plan in the area. A residence for the chief engineer and residential buildings for other DPHE staff are

planned to be constructed.

- Available public services: Box culvert for sewage (eastern and southern road), waterworks 200mm in diameter (southern road), high-voltage electric power (eastern and southern road)
- Soil condition: 5m thick silt with clay (N-value more than 10) was observed. Groundwater level about 2.5m.
- Flood (once several years, water level less than 30cm)

The planned facilities are as follows.

- Central laboratory: 1 building (building area: 455.8m^2, total floor space: 1,255.8m^2)
- Janitor's room: 1 house (building area 4m^2)
- Generator house: 1 house
- Parking area: For 7 vehicles

b. Zonal laboratories

The present situation and renovation plan are as follows.

• Noakhali Laboratory

The capacity of the laboratory is relatively small and there is not enough analytical equipment such as atomic absorption spectrophotometer. In addition, most of existing equipment is out of order. This project includes equipment procurement such as an atomic absorption spectrophotometer and setup of a room for the atomic absorption spectrophotometer through renovation of a part of the laboratory. Moreover, although the ceiling and walls inside of the laboratory is covered with a sheet, mold is propagated in between the sheet and the ceiling and considerable amount of mold comes out from the gaps, which shall not be accepted as a laboratory for water quality analysis. Therefore, the internal walls and ceiling are to be renovated in the project.

• Jhenaidah Laboratory

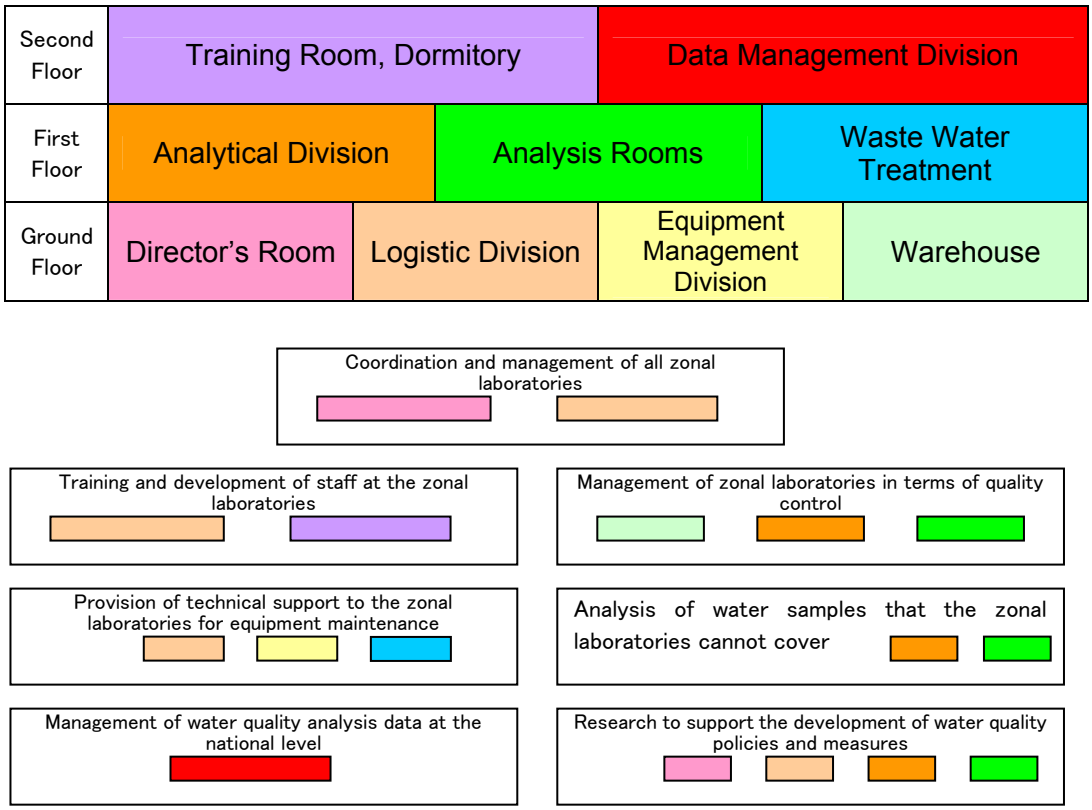
The capacity of the laboratory is small and it specializes in the analysis of arsenic by the use of an atomic absorption spectrophotometer. This project plans to develop the capacity of the laboratory in terms of equipment and facilities and also relocate the laboratory, which is now located in an office building, to rooms on the first floor of the next building.

② Construction and renovation plan

a. Construction plan for the central laboratory

The room assignment and size of the central laboratory were decided considering its

functions and roles. The room assignment and the functions and roles each room supports are shown in the following figure.



Each room and its planned area are described below.

Director's room (Ground floor): 49.0m^2

In addition to a Director (equivalent to superintending engineer) to manage the central laboratory and the zonal laboratories in the whole country, three staff members such as a secretary and chore person will be stationed in this room. The area of the room will include a space to receive visitors.

Logistic division, Administration, Financial & HRD (Ground floor): 71.05m^2

Twelve staff members who work for general office duties, accounting and public dissemination of hygiene education will be stationed in this room. Japanese experts who are supposed to join in a technical cooperation project will also use this room.

Equipment management (Ground floor): 50.05m^2

Five staff members who are in charge of operation and maintenance of equipment installed in the zonal laboratories in the whole country will be stationed in this room. Japanese experts who are supposed to join in a technical cooperation project will also use this room.

Meeting room (Ground floor): 35m^2

This room will be used for meetings. The room will be able to accommodate fifteen people

at the same time.

Drivers & cleaners room (Ground floor): 21.0m^2

Three drivers and two sweepers for the central laboratory will use this space as a waiting room in the day time and janitors will use this space as a rest room in the night time.

Warehouse (Ground floor):24.25m^2

Spare parts for analysis equipment will be reserved in this room.

Electricity / Machine room (Ground floor): 9.7m^2

Electric power distribution equipment will be installed in this room.

Analysis rooms (1st floor) 206m^2

The analysis rooms will be composed of several separate rooms in which the following major equipment will be installed. The major operators shall be staff of the analytical division and Japanese experts who are supposed to join in the technical cooperation project.

- Atomic absorption spectrophotometers 3 units: 20.0m^2
- Ion chromatograph 2 units: 15.0m^2
- Flow injection analyzer 1unit, UV-VIS spectrophotometer 2 units: 15.0m^2
- Gas chromatograph, ECD/FID: 15.0x2 rooms=30.0m^2
- Precision balance 1 unit: 6.0m^2
- Autoclave 1unit, Incubator 2units, Hot-air sterilizer 1unit, Dehydrator 2units: 42.0m^2
- Equipment for pre-processing 1 set: 78.0m^2

The gas cylinder necessary for analysis will be set on the veranda on the 1st floor. A cargo lift installed outside the building will be used to carry the cylinder to the 1st floor. As a safety precaution, the gas cylinder will be properly secured to prevent it from tipping or falling. The veranda is also designed to keep intruders out and prevent theft or damage to the gas cylinder.

Analytical Division (1st floor): 56.0m^2

Six staff members in charge of water quality analysis at the central and zonal laboratories will be stationed in this room. These staff members will work in the analysis rooms as well.

Waste Water Treatment (1st floor): 16.45m^2

Waste water containing heavy metals generated from the analysis rooms shall be transferred to this room after being placed in polythene containers.

Workshop (1st floor): 17.5m^2

Analysis equipment will be repaired in this room only when the problem is not very serious.

Data management (2nd floor): 56.0m^2

PCs and peripheral equipment will be installed and four staff members who manage the analysis data of the central and zonal laboratories will be stationed in this room.

Library (2nd floor): 33.45m^2

This room aims to preserve documents and data concerning water quality analysis. People can look into these documents in this room.

Training room (2nd floor): 83.06m^2

Lectures on water quality analysis will be given in this room. Thirty-five to 40 technical staff from the central and zonal laboratories will take part in the lectures. Lectures are planned about 26 times a year at this moment. The room can be separated into two with partition panels according to types of lectures.

Dormitory (2nd floor): 84.0m^2

This is an accommodation facility for staff members from the zonal laboratories on the occasions of long-term training. It can accommodate two people in a room and there are three rooms. Total six people can stay at the same time.

Pray room & Common space (2nd floor): 42.0m^2

This room will be used as an adoration space for Moslems, a rest space for people attending lectures and an eating space for people staying in the dormitory.

The calculation method is shown in Table 2-1.

b. Renovation plan for zonal laboratories

Jhenaidah zonal laboratory

The renovation plan is as follows.

- Window: 11
- Door: 2
- Wall tiles: 300m^2
- Coating for wall and ceiling: 600m^2
- Partition panel: 12m^2
- Electricity: 1 set
- Water supply and drainage: 1 set
- Air conditioner: 1 set

Noakhali zonal laboratory

The renovation plan is as follows.

- Window: 1
- Removal of wall (thickness=0.3m): 9.75m^2
- Coating for wall and ceiling: 300m^2
- Partition panel: 15.45m^2

- Electricity: 1 set
- Water supply and drainage: 1 set
- Air conditioner: 1 set

c. Central laboratory section plan

Since the central laboratory is planned to have analysis rooms on the first floor, a space for water supply and drainage beneath the first floor and a space for ventilation beneath the second floor need to be secured. Consequently, the floor heights of the ground and first floors are to be 3,750 mm, which is greater than normal height, and the floor height of the second floor is to be 3,250 mm, which is normal. An exhaust gas treatment device will be installed on the rooftop, which is accessed for maintenance from the veranda on the second floor by stairs. Unauthorized persons cannot enter the rooftop.

d. Central laboratory structural plan

The central laboratory will be a three-story building with reinforced concrete. Footing foundation shall be adopted as a foundation structure because the ground is composed of hard clayey silt (N value is about 10). Since there is no possibility of earthquake in Bangladesh, seismic load is not considered in the structural calculation. Instead, wind load is taken much into account due to a frequent occurrence of cyclone.

e. Central and zonal laboratories facility plan

A water supply and drainage facility and a ventilation facility are designed for the analysis rooms on the first floor of the central laboratory. As an electric installation plan, a generator will be installed so that analysis can continue in the analysis rooms even during an electric power failure. The generator needs to be placed in another building to prevent the vibration produced by the generator from affecting the results of analysis.

The water supply and drainage facility of the zonal laboratories in Jhenaidah and Noakhali have already been installed in the present buildings. Therefore, only extension and connection of pipes to sinks and work tables shall be planned.

Appropriate ventilation facilities that match the capacity of analysis equipment will be installed in the zonal laboratories to discharge gas produced during analysis process. An air conditioner will be installed in every room and it can also be operated during electric power failure by the generator.

f. Building material for the central and zonal laboratories

1) Roof

There will be elevated tanks for water supply and ventilation equipment on the rooftop of the central laboratory. For the purpose of maintenance of these facilities, pedestrian decks shall be installed on the rooftop. Since Dhaka is an area with a lot of rain, three layers of asphalt waterproofing and machine-made bricks (9.5" x 4.5" x 2.75") are designed.

2) Outer wall

The outer wall of the central laboratory will be a reinforced concrete structure with brick wall tiles as a waterproof measure. Brick wall tiles (dimension 210 x 60 x 7.5) will be procured in Bangladesh.

3) Inner wall

The inner walls of the central laboratory will be made from concrete brocks with mortar finishing. Inner walls of analysis rooms and toilets will be covered with ceramic tiles. Emulsion paint and ceramic tiles are procured in Bangladesh. Material of partition panels will be transparent glasses with aluminum frame (thickness=6mm). Partition panels will be used in the director's room, logistic division and equipment management division on the ground floor, analytical division on the first floor and data management division on the second floor.

The inner walls of zonal laboratories in Jhenaidah and Noakhali will be covered with ceramic tiles procured in Bangladesh. Material of partition panels will be transparent glasses with aluminum frame (thickness =6mm).

4) Ceiling

In the central laboratory, calcium silicate boards (6mm), vinyl paint for the toilet and kitchen, and light weight steels and decorated gypsum boards will be used for the other rooms. The electricity room on the ground floor and warehouse will be finished with emulsion painting.

There is no ceiling treatment in the zonal laboratory in Jhenaidah at this moment. Light weight steels and decorated gypsum boards will be used for the ceiling.

The ceiling at the zonal laboratory in Noakhali is simply covered with plywood which is about to decay. Therefore, it will be re-covered with lightweight steels and decorated gypsum boards.

5) Floor

Site-made terrazzo will be used for the general office rooms and steps and readymade terrazzo tiles will be used for the other rooms (except analysis rooms). The floors of the analysis rooms in which chemicals are used should be acid and alkaline resistant.

③ Environmental Measure for facility design

a. Central laboratory

1) Liquid waste treatment

The most serious environmental problem in water quality laboratory is treatment of liquid waste. Such liquid waste contains various heavy metals and thus treatment is complex and difficult.

Treatment facility for liquid waste will be introduced to the central laboratory to remove hazardous heavy metal from the waste. Treatment will be by Ferrite method, which can treat a wide range of heavy metals. Removed heavy metal forms residual sludge. The sludge is smaller quantities than original liquid waste and risk of leakage is low. Therefore, the sludge will be stored in the laboratory. The sludge generated by treatment from central and zonal laboratories in next over 20 years can be stored in the central laboratory.

It is necessary not to mix various liquid waste and waste water in order to effectively treat the waste. Such method of liquid waste management and operation of treatment facility will be guided during technical support under the Project.

2) Acidic gas treatment

Various acids are used for pretreatment of water samples. Operation using acid will be done in draft chamber and acidic gas will be discharged to the outside. Quantity of the acidic gas is very limited and can be easily diluted by the diffusion. However considering the condition that location of the central laboratory is in the center of commercial area and there are residential buildings around the site, exhaust gas treatment facility will be installed at the roof of the building. Treatment is by water or alkaline water cleaning which does not require difficult operation and maintenance.

3) Organic solvent treatment

Organic solvent is used for pretreatment of water samples. The vapor of the solvent may diffuse inside the laboratory and make working condition unhealthy. Therefore specific draft chamber will be installed in the dedicated room for solvent work to prevent the problem. The draft chamber will include adsorption system to prevent discharge of solvent to the outside. The absorption system utilizes activated charcoal and will not require special absorption media.

4) Safety measure

It is important to take special safety precautions when handling high-pressure gas cylinders utilized in water quality laboratories. At the central laboratory, a special lift will be installed to transport the cylinder so that accidents from hand carrying it up the stairs are prevented. In addition, the gas cylinder will be properly secured to prevent tipping or falling and the veranda is designed to keep intruders out.

Theft measures for chemicals and reagents are also important. All chemicals and reagents

will be stored only in the analytical room and cold storage room on the 1st floor to prevent intrusion from outside.

b. Zonal laboratories

1) Liquid waste treatment

Liquid waste in zonal laboratories will be kept in the laboratory for few months, and then will be transported to the central laboratory periodically to do centralized treatment. Therefore no facility for treatment will be introduced. It is necessary not to mix various waste liquid and waste water in order to treat the waste effectively. Such method of liquid waste management and operation of treatment facility will be guided during technical support under the Project.

2) Acidic gas treatment

As mentioned earlier, quantity of acidic gas is very limited and can be easily diluted by the diffusion. No treatment facility will be introduced to the zonal laboratories in Noakhali and Jhenaidah, because there is no residential building in the proximity of the laboratory.

3) Organic solvent treatment

Analysis of chlorinated phenol, which consumes large quantity of organic solvent, will not be done at the zonal laboratories. Therefore no specific facility will be introduced.

4) Safety measure

Fixing tool will be set at installation of the high-pressure vessel to prevent turnover.

Table 2-1 Use and area of each room

Division	Staff	Qty.	Area/person	Area(sft)	Are(m2)	Area of designed rooms (m2)
1)Director room	Superintending Engineer Director	1	160	160	15	
	AE/AD staff officer	1	100	100	9	
	Personal assistant	1	60	60	6	
	MLSS	1	60	60	6	
	Sub total	**4**		**380**	**36.00**	**49.00**
2)Logistic Division	Executive Engineer	1	160	160	15	
	Assistant Engineer	1	100	100	9	
	Training officer	1	100	100	9	
	Admin. Officer	1	100	100	9	
	Accountant	1	60	60	6	
	Computer operator	1	60	60	6	
	Procurement assistant	1	60	60	6	
	JICA expert	1	100	100	9	
	Sub total	**8**		**740**	**69.00**	**71.05**
3)Equipment Management	Sub Divisional Engineer	1	100	100	9	
	Assistant Engineer	2	100	200	18	
	Sub Assistant Enginer	2	100	200	18	
	JICA expert	1	100	100	9	
	Sub total	**5**		**600**	**54.00**	**50.05**
4)Meeting room						**35.00**
5)Driver&Cleaner room	Driver	4	60	240	22	
	Cleaner	2	60	120	11	
	Sub total	**6**		**360**	**33.00**	**21.00**
6)Warehuse						**24.25**
7)Electrocity						**9.70**
Common space	Entrance hall, toilet corridor					**154.15**
Total floor area (ground floor)						**414.20**
8)Laboratory						**206.00**
9)Analytical Division	Chief chemist	1	160	160	15	
Chemical analysis	Sr. Chemist	1	100	100	9	
	Chemist(AAS)	1	100	100	9	
	Chemist(IC/GC)	1	100	100	9	
	Sample Analyzer	2		0	0	Lab.
Bacteriological analysis	Sr. Bacteriologist	1	100	100	9	
	Bacteriologist	1	100	100	9	
	Sample analyzer	2		0	0	Lab.
	JICA expert	1		0	0	Lab.
	Sub total	**11**		**660**	**60.00**	**56.00**
10)Waste water treatment						**16.45**
11)Workshop						**17.50**
Common space	toilet, corridor					**129.65**
Total floor area (first floor)						**425.60**
12)Data Management	Deputy director	1	160	160	15	
	Assist director (GIS)	1	100	100	9	
	Assist director(MIS)	1	100	100	9	
	Computer operator	1	60	60	6	
	Sub total	**4**		**420**	**39.00**	**56.00**
13)Library						**33.45**
14)Training room	**35-40 persons**					**83.86**
15)Domitory	**28m2x3rooms for 6 persons**					**84.00**
16)Pray room & common space						**42.00**
Common space	**toilet, corridor**					**116.69**
Total floor area (second floor)						**416.00**
Total floor area						**1,255.80**

(3) Equipment Plan

In the selection of equipment, it is necessary to select the minimum required equipment while maintaining effectiveness, in consideration of the functions and special features of the central laboratory to be constructed and zonal laboratories to be renovated for strengthening of water quality examination system. The draft protocol for water quality analysis proposed by DPHE and BAMWSP, and the drinking water standard in Bangladesh were referred to when preparing the equipment plan.

In Bangladesh, roughly 25% of ten million tube wells show arsenic levels exceeding the water quality standard. Therefore, it is important to conduct not only on-site analysis for arsenic by field kit but also detailed examination in laboratories. Also, there is expected to be an increasing need for water quality analysis of parameters other then arsenic. Although it is not necessary to immediately target all tube wells for water quality analysis right away, the equipment plan should be sufficient for water quality analysis of at least the new deep tube wells to be constructed by DPHE, which is estimated as about 15,000 a year. The equipment planned in the basic design are described in sections A～F below:

A. Analysis equipment

In Bangladesh, water quality standards have been set for up to 55 parameters. As the two radiation-related parameters will be under the jurisdiction of the Atomic Energy Center (AEC), it is necessary to procure equipment with the capacity to analyze the remaining 53 parameters. As part of the effort to strengthen the water quality examination system, BAMWSP provided analysis equipment to nine zonal laboratories throughout the country. The two zonal laboratories targeted in this project, together with the nine laboratories, supported by BAMWSP form a national water quality examination and monitoring network. Therefore, in selecting the equipment to be procured for the two zonal laboratories, consideration must be given to consistency with the equipment provided under BAMWSP. The main equipment provided by BAMWSP is as follows:

- Atomic Absorption Spectrophotometer
- Pure water apparatus
- Precision Balance
- Dehumidifier
- UV-VIS Spectrophotometer
- Drying Oven
- Incubator
- Hot-air sterilizer

In the selection process, a list of all equipment necessary to analyze the 53 parameters according to the "Standard Methods" was made to ensure no required equipment was omitted. However, in some cases, a single instrument is used to measure multiple parameters. In order avoid duplication of instruments and ensure selection of the minimum required equipment, one of each type of instrument was selected whenever possible without hindering effectiveness of water quality analysis. The equipment selected is described below. The 55 standard water quality parameters in Bangladesh and the equipment used for analyzing those parameters are shown in Table 2.2.

A-01 Atomic absorption spectrophotometer (4 units)

This instrument is widely used to analyze water samples for trace amounts of heavy metals, and is specified in the "Standard Methods", the guideline adopted in Bangladesh for water quality analysis, for measuring heavy metals. Many heavy metals can be measured with this instrument. The "Standard Methods" gives the following three methods: using an air/acetylene flame, using a nitrous oxide/acetylene flame (for parameters such as Al, Ba, Na, etc., which require hotter flames), and using a reduction vaporization device. Three units are planned for the central laboratory, one for each method. One unit is also planned for the laboratory in Noakhali as it does not have one.

Table 2-2 Bangladesh water quality parameters and major equipment

No.	Bangladesh water quality standard parameters	Major equipment	
		Equipment No.	Equipment
1	Al	A-01-03	Atomic absorption spectrophotometer(Al、Ba、Na)
2	Ammonia	A-10	Ion meter
3	As	A-01-01	Atomic absorption spectrophotometer(HVG)
4	Ba	A-01-03	Atomic absorption spectrophotometer(Al、Ba、Na)
5	Benzene	A-04-02	Gas chromatograph (with verge & trap)
6	BOD	A-23、B-27	Incubator, BOD bottle
7	Boron	A-06	UV-VIS spectrophotometer
8	Cd	A-01-02	Atomic absorption spectrophotometer (heavy metal)
9	Ca	A-01-02	Atomic absorption spectrophotometer (heavy metal)
10	Cl	A-03-01	Ion chromatograph (Anion)
11	Chrolinated Alkane CTC	A-04-02	Gas chromatograph (with verge & trap)
	1,1-DCE	A-04-02	Gas chromatograph (with verge & trap)
	1,2-DCE	A-04-02	Gas chromatograph (with verge & trap)
	PCE	A-04-02	Gas chromatograph (with verge & trap)
	TCE	A-04-02	Gas chromatograph (with verge & trap)
12	Chrolinated Phenol Pentachlororphenol	A-04-01	Gas chromatograph (for solvent extruction)
	2,4,6 Trichloropheno	A-04-01	Gas chromatograph (for solvent extruction)
13	Chloride(residual)	A-39	End-point detection apparatus
14	Chloroform	A-04-02	Gas chromatograph (with verge & trap)
15	Cr(hexavalent)	A-03-02	Ion chromatograph (Sexivalent chrome)
16	Cr(total)	A-01-02	Atomic absorption spectrophotometer (heavy metal)
17	COD(Central lab.)	A-33、B-15、etc	Hot plate, buret etc.
	COD(zonal lob.)	A-14	COD meter
18	Coliform (fecal)	A-22、A-23、etc	Autoclave, incubator stc.
19	Coliform (total)	A-22、A-23、etc	Autoclave, incubator stc.
20	Color	A-06	UV-VIS spectrophotometer
21	Cu	A-01-02	Atomic absorption spectrophotometer (heavy metal)
22	Cynaide	A-10	Ion meter
23	Detergents	A-06	UV-VIS spectrophotometer
24	DO	A-11	DO meter
25	Fluoride	A-10	Ion meter
26	Hardness	—	Calculous
27	Fe	A-01-02	Atomic absorption spectrophotometer (heavy metal)
28	Nitorogen (total)	A-05	Flow injection analyzer
29	Pb	A-01-02	Atomic absorption spectrophotometer (heavy metal)
30	Mg	A-01-02	Atomic absorption spectrophotometer (heavy metal)
31	Mn	A-01-02	Atomic absorption spectrophotometer (heavy metal)
32	Hg	A-02	Atomic absorption spectrophotometer for Hg analysis
33	Ni	A-01-02	Atomic absorption spectrophotometer (heavy metal)
34	Nitrate	A-03-01	Ion chromatograph (Anion)
35	Nitrite	A-03-01	Ion chromatograph (Anion)
36	Odor	B-37	Aspirator bottle
37	Oil & grease	A-07	Infrared spectrophotometer
38	pH	A-10	Ion meter
39	Phenolic componds	A-06	UV-VIS spectrophotometer
40	Phosphate	A-03-01	Ion chromatograph (Anion)
41	Phosphorus	A-05	Flow injection analyzer
42	K	A-10	Ion meter
43	Radiation total alpha	-	-
44	Radiation total beta	-	-
45	Se	A-01-01	Atomic absorption spectrophotometer (HVG)
46	Ag	A-01-02	Atomic absorption spectrophotometer (heavy metal)
47	Na	A-01-03	Atomic absorption spectrophotometer (Al、Ba、Na)
48	SS	A-18、A-25、A-49、A-51	Precision balance, Dehydrator, Desiccator, Membrane filtration unit
49	Sulfide	A-10	Ion meter
50	Sulphate	A-03-01	Ion chromatograph (Anion)
51	TDS	A-18、A-25、A-49	Precision balance, Dehydrator, Desiccator, Membrane filtration unit
52	Temp.	A-42	Thermometer
53	Sn	A-01-02	Atomic absorption spectrophotometer (heavy metal)
54	Turbidity	A-12	Turbidity meter
55	Zn	A-01-02	Atomic absorption spectrophotometer (heavy metal)
—	TOC	A-15	TOC analyzer
—	EC	A-13	TDS/EC/salinity meter
—	Salinity	A-13	TDS/EC/salinity meter
—	ORP	A-09	ORP meter

A-02 Mercury analyzer (1 unit)

This instrument is used for measuring trace amounts of mercury (Hg) in water samples, and is specified in the "Standard Methods" as the instrument for Hg analysis. Based on the "Standard Methods", one atomic absorption spectrophotometer with a cold vapor attachment is planned. This special atomic absorption spectrophotometer for only Hg was adopted in order to reduce costs.

A-03 Ion chromatograph (2 units)

This instrument is widely used to measure ionic concentrations, and is specified in the "Standard Methods" as the instrument for ion analysis. Compared to the conventional absorption photometry and titration method, it is simple, highly sensitive, and can be used on small samples. Two units are planned, one is for conductivity detection of ionic concentrations such as nitrates, nitrites, phosphates, chlorides and sulfates, and the other one is equipped with a UV/VIS detector for analyzing hexavalent chromium.

A-04 Gas chromatograph (2 units)

This instrument can be used to analyze a wide range of substances excluding inorganic matter, nonvolatile organic matter and thermally decomposable organic matter, and is specified in the "Standard Methods" as the instrument for analyzing chlorinated phenol and chlorinated organic compounds. Two units are planned, one is for analyzing chlorinated phenol with liquid/liquid extraction and the other one with a purge and trap device for analyzing benzene and chlorinated organic compounds.

A-05 Flow injection analyzer (1 unit)

This instrument is widely used for analyzing nitrogen and phosphorous in water samples, and is specified in the "Standard Methods" as the instrument for nitrogen and phosphorous analysis. Since this equipment requires small volumes of water samples and chemicals, the amount of acid and alkali wastewater can be reduced.

A-06 UV-VIS spectrophotometer (3 units)

This instrument can be used to analyze a wide range of substances in water samples such as metallic compounds, inorganic matter and organic compounds, and is specified in the "Standard Methods" as the instrument for measuring phenol, boron, detergents and color. Two units are planned, one is for analyzing phenol, boron and detergent and the other one for color. One unit is also planned for the laboratory in Noakhali as it does not have one.

A-07 Oil concentration meter (1 unit)

This instrument is used to measure oil and grease by infrared absorption, and is specified in the "Standard Methods" as the instrument for quantitatively analysis for oil and grease. One unit is planned for analyzing oil and grease content.

A-08 pH meter (3 units)

This instrument is used to measure hydrogen ion concentration as one of the most common water quality parameter. Each one unit is planned for central laboratory and zonal laboratories at Noakhali and Jhenaidah.

A-09 ORP meter (3 units)

This instrument is used to measure oxidation-reduction potential as one of the most common water quality parameter. Each one unit is planned for central laboratory and zonal laboratories at Noakhali and Jhenaidah.

A-10 Ion meter with selective electrode (3 sets)

This instrument is a concentration meter using selective electrode to specific ion species and widely used for various water quality analysis. As it measures a specific selective ion, the unit has to be provided for each ion species to be measured. In the "Standard Methods", the ion meter with selective electrode is specified as the instrument for measuring ammonia, fluorine, cyanide, potassium and sulfide ions. Five units for each parameter will be count as a set. Each one set for central laboratory and zonal laboratories at Noakhali and Jhenaidah will be planned (total of 15 units).

A-11 DO meter (2 units)

This instrument is used to measure concentration of dissolved oxygen as one of the most common water quality parameter. Each one unit is planned for central laboratory and zonal laboratory at Noakhali.

A-12 Turbidity meter (2 units)

This is a specialized instrument for measuring turbidity, and is specified in the "Standard Methods" as the instrument for turbidity analysis. One each is planned for the central laboratory and zonal laboratory in Noakhali.

A-15 TOC analyzer (1 unit)

This instrument is used to analyze total organic carbon in water samples. As it is necessary for estimating BOD and COD concentrations, and for quality control of both parameters, one unit is planned for the central laboratory. With this instrument, it will be possible to greatly reduce the

time and chemicals required for analyzing BOD and COD.

A-16 Microwave digestion apparatus (1 unit)

This instrument is used to pre-treat samples for analyzing the heavy metals with equipment No. A-1 and A-2. Compared to pretreatment by acid decomposition, waste acid and hazardous fumes are not generated, which will greatly contribute to preserving the surrounding environment and the working environment inside the laboratory. Therefore, one unit is planned for the central laboratory. Pretreatment of samples using this instrument is specified in the "Standard Methods".

A-17 Pure water apparatus (3 units)

As purified water is needed in water quality analysis laboratories, this instrument is essential. One unit is planned for the central laboratory, Noakhali and Jhenaidah laboratories, respectively.

A-18 Precision balance (4 units)

This instrument is used to measure parameters (SS, TDS, etc,) by weight and to weigh standard samples precisely. It is essential for scientific laboratories. Two units are planned for the central laboratory, which will analyze a great number of water samples, and one each for the Noakhali laboratory and Jhenaidah laboratory.

A-19 Balance table (4 units)

These are special tables equipped with horizontal balance adjustment and are essential for precision weighing. In accordance with procurement plan of precision balance, two tables are planned for the balance room in the central laboratory and one table for the Noakhali and Jhenaidah laboratories respectively.

A-20 Draft chamber (3 units)

Acidic gas is generated when pretreating samples for heavy metal analysis. In order to keep the gas from spreading throughout the room, such work will be conducted within draft chambers. Extraction of chlorinated phenol will also be conducted within the draft chamber to prevent contamination by the organic solvents used in such work. Two draft chambers, one with standard feature, and another with organic solvent adsorption bed and exhaust fan, are planned for the central laboratory. One equipped with exhaust fan is planned for the Jhenaidah laboratory.

A-21 Clean Bench (3 units)

Clean benches provide required sterile workspace when analyzing general coliform and fecal coliform. It is essential for microbial testing. One mountable type is planned for the central laboratory, and one desktop type for the laboratories in Noakhali and Jhenaidah respectively.

A-22 Autoclave (3 units)

Autoclaves are specified in the "Standard Methods" as the instrument for sterilizing apparatus and culture media for microbial testing (general coliform and fecal coliform). One unit is planned for the central laboratory, Noakhali laboratory and Jhenaidah laboratory respectively.

A-23 Incubator (3 units)

Incubators are specified in the "Standard Methods" to maintain a temperature of 20 degrees C for a period of five days for BOD testing and 35 degrees C for a period of two days for microbial testing. Two units are planned for the central laboratory for BOD and microbial testing, and one unit for the Jhenaidah laboratory for common use.

A-24 Hot-air sterilizer (1 unit)

Hot-air sterilizers are specified in the "Standard Methods" to sterilize apparatus and sampling bottles used in microbial testing (general coliform and fecal coliform). One unit is planned for the central laboratory.

A-25 Drying oven (4 units)

A drying oven is specified in the "Standard Methods" for drying samples to a constant weight for measuring SS and TDS. As drying to a constant weight takes time, two units are planned for the central laboratory and one unit for the Noakhali laboratory and Jhenaidah laboratory, respectively.

A-26 Refrigerator for reagents (3 units)

This is used to store chemicals, standard solutions and samples temporarily that need to be maintained at a low temperature. Two units are planned for the pretreatment room and one for the microbial testing room in the central laboratory.

A-27 Dehumidifier (6 units)

Analytical equipment, such as atomic absorption spectrophotometers, cannot withstand high temperatures and humidity. Dehumidifiers will be placed in each analysis room to reduce the moisture in the rooms. Five units are planned for the central laboratory, one for each analysis room, and one for the laboratory in Noakhali.

A-28 Rotary evaporator (1 unit)

This instrument is used for evaporation of samples, evaporation of extracted solution and recycling of used organic solvents. One is planned for the central laboratory.

A-29 Pipette washer (1 unit)

This is used to clean used pipettes. In order to enhance the effectiveness, one unit equipped with an ultrasonic transmitter is planned for the central laboratory.

A-30 Shaker (1 unit)

This instrument is used to blend or agitate samples within separation funnel. This instrument is essential for agitating samples for extended periods of time. One unit is planned for the central laboratory.

A-57 Field water quality sensor (12 units)

A-58 Field water quality test kit (12 units)

These instruments will be used for training purpose. To supplement the lecture and desk study, practical exercise is required to obtain analytical skill. Training target will be local engineer of DPHE who is not specialized in chemical analysis. Those engineers will support the water quality monitoring activities of zonal laboratories and are expected to conduct sampling and field measurement of newly constructed tube wells. As there is a large number of DPHE engineers throughout the nation, training of approximately 25 engineers at one time is necessary. To ensure effective training, at least one unit per two trainees is required. Therefore, 12 units are planned.

A-59 Side work table (13 units)

The side work tables need to be highly resistant to chemicals, heat and water. They will be placed along the wall and may be moved to another location as occasion demands. Twelve tables are planned for the central laboratory to set up following instrument. In addition, one table is planned for Noakhali zonal laboratory.

Instrument in the Central laboratory	No. of side work table
Atomic Absorption Spectrophotometer	3 units
Hg analyzer	1 unit
Ion Chromatograph	2 units
Gas Chromatograph	2 units
Flow injection analyzer	1 unit
Spectrophotometer	1 unit
Oil concentration meter/Turbidity meter	1 unit
TOC analyzer/Microwave digestion unit	1 unit

Other laboratory equipment

This includes materials required for water quality analysis, such as filter paper and other minor goods. Materials to support operations for a period of approximately six months will be purchased.

B. Glassware

Regarding glassware, daily demand for each type of glassware was calculated to determine the minimum required volume to be procured for the central laboratory. As for the Noakhali and Jhenaidah laboratories, the equipment currently possessed was checked, and volume of glassware to be procured was determined based on the list of equipment provided by BAMWSP.

C. Chemicals

In order to facilitate smooth operation of the central laboratory in the initial stage, estimated volume of chemicals required to support activities for approximately six-months will be procured.

D. Support Vehicles

Since the central laboratory will analyze water quality parameters that the zonal laboratories cannot cover and will be responsible for quality control of zonal laboratories, samples have to be transported regularly from the zonal laboratories. Furthermore, as the central laboratory will be responsible for training to staff from the zonal laboratories, it will be necessary to transport participants from the zonal laboratories to the central laboratory. However, considering the distance between laboratories and the vehicles possessed by DPHE, DPHE is not adequately equipped to carry out the above mentioned activities. In order to improve the situation, it is necessary to provide support vehicles. The vehicles selected are as follows:

D-1 4WD Vehicles (2 units)

The 4WD vehicles will be used for the management and coordination of the zonal laboratories and for regular coordination activities among internal and external organizations of DPHE. One vehicle is expected to be used for management of the central laboratory itself and for regular visits to and from DPHE head office and various government agencies in carrying out the coordination activities of the Water Quality Monitoring and Surveillance Circle. The other vehicle will be used for the central laboratory's most important function, i.e. the management and coordination of the eleven zonal laboratories. As the zonal laboratories are scattered throughout the country, making visits to each laboratory once a month will require use of a vehicle for a

minimum of 33 days. (A visit to one laboratory is estimated to take three days on average.) As it will be difficult to perform the above activities with one vehicle, two vehicles are planned. The vehicles will be the property of the central laboratory, and will be managed according to service plan.

D-2 Microbus (1 unit)

The microbus will be used to transport staff from the zonal laboratories to the central laboratory for training. Depending on the contents of training, anywhere between five to ten participants will be transported at a time. A vehicle with the appropriate capacity is planned. It is also assumed that personnel from the central laboratory will visit the zonal laboratories with equipment to conduct training activities. The vehicle will be the property of the central laboratory and will be managed according to service plan.

D-3 Pickup Truck (1 unit)

The pickup truck will be used to transport water samples and spare parts for analytical instruments. For best results, water samples need to be analyzed immediately after they are collected. Parameters that the zonal laboratories cannot cover will be analyzed at the central laboratory so samples must be transported swiftly. Although support vehicles are also planned, a pickup truck is necessary for the speedy transport of water samples to ensure quality control. Therefore, a separate vehicle for transporting samples is planned. The vehicle will be the property of the central laboratory and will be managed according to service plan.

E. Equipment for Training Activities

The central laboratory will serve not only as a base for water quality analysis but also as a training center for its own staff and staff from the zonal laboratories. In addition to instruction on equipment operation to technical staff, basic training for new employees on water quality analysis and water sampling methods is also expected. It is necessary to implement training programs covering a wide range of topics according to the level of the participants. Therefore, mostly audio-visual equipment, which facilitates learning and acquisition of technical skills, was selected for training. The selected equipment is as follows:

E-1 Projector (1 unit)

This is for projecting digital data. Use of visual aids is the simplest and most effective way of carrying out training,. A projector can be used to show images to a large group of people at one time, and will be effective for training to be conducted by the central laboratory. The projector is hooked up to a laptop computer and/or a digital video camera to display digital data. As

presentations may be held at zonal laboratories, a small, portable projector is planned.

E-2 Opaque Projector (1 unit)

Unlike the projector in E-l, this projector displays analogue data such as paper documents. When the level of training becomes advanced, analytical textbooks and copies are likely to be used. With an ordinary overhead projector, it is necessary to prepare the transparent sheets, which is costly and time-consuming. In order to cut costs and time, an opaque projector, which does not require transparent sheets, is planned.

E-3 Screen (2 units)

These screens are to be used with the projectors mentioned above. When staff from the zonal laboratories come to the central laboratory for training, the amount of time will be limited and activities for participants of different technical levels and responsibilities are likely to be conducted at the same time. Therefore, one screen is planned for each projector.

E-4 Laptop computer (1 unit)

The laptop computer is for the projector in E-1 mentioned above. It will be used at the central laboratory for projecting digital data such as water quality analysis results, photographs, etc., and for editing raw digital data. Since the computer will also be used for preparing materials for training programs, wide-ranging use is expected. As with the projector, a portable laptop computer is planned considering its use at the zonal laboratories for presentations.

E-5 Digital Video Camera (1 unit)

The digital video camera will be used to film analysis work at the central laboratory and water sampling work at the zonal laboratories as teaching material for training programs. The video camera is also advantageous in that it can be directly hooked up to the projector in E-1 without a video player.

E-6 Printer (1 unit)

E-7 Copy Machine (1 unit)

The copy machine will be used to prepare materials and hand outs for various training activities.

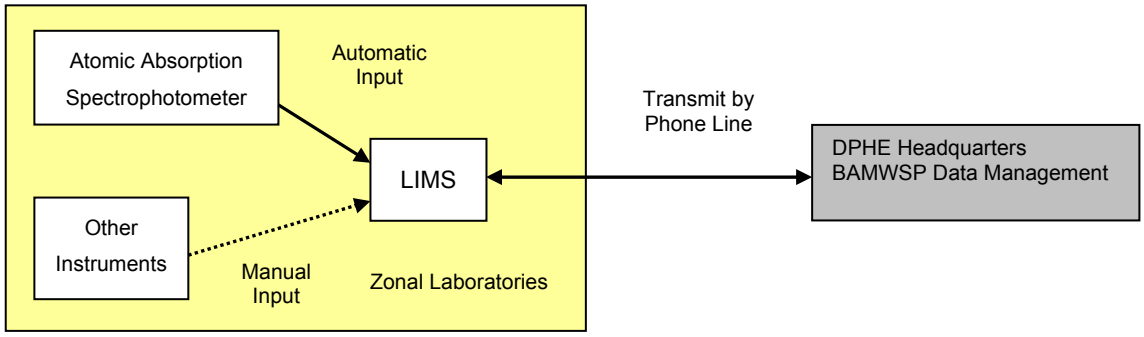
F. Equipment for Management of Water Quality Database

As mentioned earlier, one of the functions of the central laboratory is data management. When analysis activities at the zonal laboratories get going, large quantities of data will be sent to the central

laboratory on a regular basis, and the central laboratory must have the capacity to manage this data. Management of water quality data is essential for reflecting the results of water quality analysis in policy and measures related to drinking water. When the technical cooperation project is implemented, it is expected that technical support for not only water quality analysis but also establishment of an integrated system for management of all water quality data using GIS will be provided. Therefore, it is necessary to consider equipment compatible with the technical support under technical cooperation.

In data management, coordination with other agencies and organizations is vital. At present, NAMIC, which was set up in BAMWSP, is mainly managing the database of screening surveys on arsenic contamination conditions of all water supply facilities in Bangladesh. In addition to screening data, NAMIC is also integrating map data and data concerned with arsenic measures from other agencies. In order to promote arsenic measures, the integration of water quality data into NAMIC's database is desirable. However, it is very uncertain in what form NAMIC will continue, including the staff, from 2005 when BAMWSP is completed. Therefore, since detailed coordination on the assumption of data integration at the current stage is difficult, equipment compatible with the software currently being used by NAMIC is planned in consideration of sharing water quality data with NAMIC in the future.

DPHE and BAMWSP also plan to introduce Laboratory Information Management Systems (LIMS) to each zonal laboratory. LIMS are integrated management systems that incorporate not only water quality data but also all other information at the laboratories. It is necessary to discuss LIMS in specific terms after confirming the functions of the LIMS concerned with the project. The LIMS plan is summarized below.



The automatic input function shall be limited to the atomic absorption spectrophotometer, and the data shall be managed by the zonal laboratories and periodically sent to DPHE headquarters. BAMWSP is in the process of preparing specifications for system configuration and many areas are still uncertain including the software to be used.

Meanwhile, the existing zonal laboratories cannot carry out data management adequately even by manual input. Since they currently lack a proper system for operation and maintenance of the atomic absorption spectrophotometer, it seems that to introduce LIMS itself may be too big a leap. Progress of

the LIMS plan shall be carefully monitored to determine whether it can proceed according to plan and achieve the desired effect.

As mentioned above, detailed specifications of the LIMS plan have not yet been determined and many matters are still uncertain. However, introduction of LIMS to DPHE laboratories in the future is necessary in view of accuracy control and should proceed step by step as follows.

Phase 1	Thorough management of data by manual input
Phase 2	Smooth operation of all types of analytical instruments by computer control
Phase 3	Introduction of LIMS at each laboratory
Phase 4	Introduction of inter-laboratory LIMS via internet

At present, it is too early to include the software system required for LIMS in the project. Also, since specifications for equipment have not yet been decided, consistency with the BAMWSP plan cannot be ensured. However, considering the introduction of LIMS in the future, analytical instruments shall support LIMS whenever possible. In regard to data management, it is necessary to introduce general-purpose equipment that can be used for data management at all laboratories while at the same time support the basic requirements of LIMS.

The selected equipment is as follows.

F-1 Server PC (1 unit)

The central laboratory will be responsible for managing all water quality data. As there will be tens of thousands to hundreds of thousands of new data to be input each year, use of a computer is essential. A high-capacity server PC with reliability is necessary in order to manage vast amounts of data at the national level.

F-2 Personal Computer (10 units)

Data management at the central laboratory will be implemented not only to store all water quality data, but also to support the various functions of each division. The number of staff and required computers in each division and their intended use are summarized in the table below. Software to be used in the Data Management Division consists of ArcView, Access and digitizer software. The other divisions will use general-purpose software (i.e. Excel, Word, etc.) and Access.

Division	No. of Staff and No. of PCs	Intended Use	Description
Data Management Division	4 staff 3 PCs	Establishment, management, analysis and reporting of data	Establishment and management of water quality database
		Input to map data, etc.	Input of water quality data into digital map data
		establishment and management of LIMS	Establishment and management of LIMS system to be introduced for quality control of analysis results
Analytical Division	13 staff 3 PCs	Water quality data Quality Control/Quality Assurance	Statistical work of water quality data from chemical analysis section
			Statistical work of water quality data from bacteriological testing section
Logistic Division	11 staff 3 PCs	Purchase and management of chemicals	Management of chemicals for zonal laboratories
		Management of zonal laboratories	Overall management (finances, personnel, etc) of annual water quality monitoring program of zonal laboratories; work related to logistic division
Equipment Management Division	6 staff 1 PCs	Maintenance/ management of equipment	Management/maintenance of the various equipment and spare parts for the zonal laboratories

F-3 Printer (1 unit)

A printer is needed to show the contents and analysis results of the above-mentioned database to external divisions. An A3 color printer capable of displaying and outputting data linked to map data is required.

F-4 Scanner (1 unit)

A scanner is required for inputting map information, photos, etc. into the database. An A3 scanner is planned.

F-5 Digitizer (1 unit)

A digitizer is required to input map information into the database. An A3 digitizer is planned.

A list of the equipment to be procured in the project is shown in Table 2-3.

Table 2-3 List of Equipment

No.	Item	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
A. Equipment and material for analysis laboratories						
A-01-01	Atomic absorption spectrophotometer	As, Se	1			1
A-01-02	Atomic absorption spectrophotometer	Heavy metal	1			1
A-01-03	Atomic absorption spectrophotometer	AL, Ba	1			1
A-01-04	Atomic absorption spectrophotometer	All elements			1	1
A-02	Mercury analyser		1			1
A-03-01	Ion chromatograph	Anion	1			1
A-03-02	Ion chromatograph	Sexivalent chrome	1			1
A-04-01	Gas chromatograph	Solvent extraction	1			1
A-04-02	Gas chromatograph	With verge & trap	1			1
A-05	Flow injection analyzer	Total P & total N	1			1
A-06	UV-VIS spectrophotometer		2		1	3
A-07	Infrared spectrophotometer		1			1
A-08	pH meter		1	1	1	3
A-09	ORP meter		1	1	1	3
A-10	Ion meter with selective electrode	With selective electrodes	1	1	1	3
A-11	DO meter	Benchtop	1		1	2
A-12	Turbidity meter	Benchtop	1		1	2
A-13	TDS/EC/salinity meter	Benchtop		1	1	2
A-14	COD reactor	Benchtop	1	1	1	3
A-15	TOC analyzer		1			1
A-16	Microwave digestion apparatus		1			1
A-17-01	Pure water apparatus	80L/day	1			1
A-17-02	Pure water apparatus	40L/day		1	1	2
A-18	Precision balance		2	1	1	4
A-19	Balance table		2	1	1	4
A-20-01	Draft chamber with treatment	With acidic gas emission	1			1
A-20-02	Draft chamber with treatment	With solvent sdsorption device	1			1
A-20-03	Draft chamber without treatment	Without acid gas emission & solvent absorption device		1		1
A-21-01	Clean bench	Fixed type	1			1
A-21-02	Clean bench	Desktop type		1	1	2
A-22	Autoclave	Microorganisms, 47L	1	1	1	3
A-23	Incubator	BOD & microorganisms	2	1		3
A-24	Hot-air sterilizer	Microorganisms, 150L	1			1
A-25	Drying oven	SS, TDS	2	1	1	4
A-26	Refrigerator for reagent		3			3
A-27	Dehumidifier	15-20m2	5		1	6
A-28	Rotary evaporator	For waste solvent recycling V type	1			1
A-29	Pipette washer	Ultrasonic wave type	1			1
A-30	Shaker	Phenol chloride (for separatory funnel)	1			1
A-31	Muffle furnace		1			1
A-32	Water bath		3			3
A-33	Hot Plate		3	1	1	5
A-34	Magnetic Stirrer		3	1	1	5
A-35	Blender		1			1
A-36	Stirrer		1			1
A-37	Shaker	For single test tube	3	1	1	5
A-38	Centrifuge		1			1

No.	Item	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
A-39	End-point detection apparatus		1			1
A-40	Microscope and light source		1			1
A-41	Optical Counting Equipment		1			1
A-42-01	Temperature-Monitoring Devices		1			1
A-42-02	Thermometer	0-100℃ and others	5	4	4	13
A-42-03	Thermometer		3			3
A-43	Platinum sticks		3			3
A-44	Gas flow meter	For GC flow confirmation/detergent	3			3
A-45	Ice machine		1			1
A-46	Ultrasonic cleaner		1			1
A-47	Vacuum pump	Desktop compact type		1	1	2
A-48	Automatic dispenser	10 and 20ml	3			3
A-49	Desiccator		1			1
A-50	Balance	up to 3000g	1		1	2
A-51	Membrane filtration unit	0.45microm filter paper			1	1
A-52	UPS	5KVA	5		1	6
A-53	Stabilizer		1		1	2
A-54	Waste water treatment device		1			1
A-55	Strage cabin		2	1	1	4
A-56	Srying rack		2	1	1	4
A-57	Potable water quality sensor		12			12
A-58	Potable water quality test kit		12			12
A-59-01	Side work table	0.75x1.5m	12		1	13
A-59-02	Side work table	0.75x3.0m	2			2
B. Glassware						
B-01-01	Beaker	50ml	40	10	10	60
B-01-02	Beaker	100ml	20			20
B-01-03	Beaker	200ml	20	20	20	60
B-01-04	Beaker	300ml	20	20	20	60
B-01-05	Beaker	500ml	20	5	5	30
B-01-06	Beaker	1000ml	5	5	5	15
B-01-07	Beaker	2000ml	5	2	2	9
B-02-01	Conical beaker	50ml		5	5	10
B-02-02	Conical beaker	100ml	20	20	20	60
B-02-03	Conical beaker	200ml	20			20
B-02-04	Conical beaker	300ml	20	20	20	60
B-02-05	Conical beaker	500ml	10	6	6	22
B-02-06	Conical beaker	1000ml	5	5	5	15
B-03-01	Odor flasks	200ml		11	11	22
B-03-02	Odor flasks	300ml		6	6	12
B-03-03	Odor flasks	500ml	50			50
B-03-04	Odor flasks	1000ml		4	4	8
B-04-01	Round bottom flask	200ml	10			10
B-04-02	Round bottom flask	500ml	10	6	6	22
B-04-03	Round bottom flask	1000ml	5	5	5	15
B-04-04	Round bottom flask	2000ml		3	3	6
B-05-01	Erlemyer flask	50ml	20			20
B-05-02	Erlemyer flask	100ml	20			20

No.	Item	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
B-05-03	Erlemyer flask	200ml	20			20
B-05-04	Erlemyer flask	300ml	20	5	5	30
B-05-05	Erlemyer flask	500ml	10	5	5	20
B-05-06	Erlemyer flask	1000ml	5	3	3	11
B-06-01	Volumetric flask, TS stopper	25ml	100			100
B-06-02	Volumetric flask, TS stopper	50ml	100	11	11	122
B-06-03	Volumetric flask, TS stopper	100ml	20	16	16	52
B-06-04	Volumetric flask, TS stopper	200ml	20			20
B-06-05	Volumetric flask, TS stopper	250ml	20	16	16	52
B-06-06	Volumetric flask, TS stopper	500ml	10	6	6	22
B-06-07	Volumetric flask, TS stopper	1000ml	5	5	5	15
B-06-08	Volumetric flask, TS stopper	2000ml	5			5
B-06-09	Volumetric flask, TS stopper	3000ml	5			5
B-06-10	Volumetric flask, TS stopper	5000ml	5			5
B-07-01	Kjeldahl flask	100ml	5			5
B-07-02	Kjeldahl flask	300ml	5			5
B-07-03	Kjeldahl flask	500ml	5			5
B-08-01	Measuring pipette	1ml	10	6	6	22
B-08-02	Measuring pipette	2ml	10			10
B-08-03	Measuring pipette	5ml	10	6	6	22
B-08-04	Measuring pipette	10ml	10	6	6	22
B-08-05	Measuring pipette	20ml	10			10
B-08-06	Measuring pipette	25ml	10	5	5	20
B-08-07	Measuring pipette	50ml	5	5	5	15
B-09-01	Volumetric pipette	1ml	20			20
B-09-02	Volumetric pipette	2ml	20			20
B-09-03	Volumetric pipette	5ml	20	5	5	30
B-09-04	Volumetric pipette	10ml	20	5	5	30
B-09-05	Volumetric pipette	20ml	20			20
B-09-06	Volumetric pipette	25ml	20	3	3	26
B-09-07	Volumetric pipette	50ml	10	3	3	16
B-09-08	Volumetric pipette	100ml	10			10
B-10-01	Komagome pipette	1ml	10			10
B-10-02	Komagome pipette	3ml	10			10
B-10-03	Komagome pipette	5ml	10			10
B-10-04	Komagome pipette	10ml	10			10
B-10-05	Komagome pipette	20ml	5			5
B-11	Rubber blower		20			20
B-12-01	Cylinder, Graduated	25ml	10			10
B-12-02	Cylinder, Graduated	50ml	10	6	6	22
B-12-03	Cylinder, Graduated	100ml	10	8	8	26
B-12-04	Cylinder, Graduated	200ml	10			10
B-12-05	Cylinder, Graduated	250ml	10	6	6	22
B-12-06	Cylinder, Graduated	300ml	10			10
B-12-07	Cylinder, Graduated	500ml	10	6	6	22
B-12-08	Cylinder, Graduated	1000ml	5	5	5	15
B-13-01	Test tube, dia. 21mm	12mm dia. x120mm(H), plastic coated	100			100
B-13-02	Test tube, dia. 21mm	15mm dia. x120mm(H), plastic coated	100			100
B-14-01	Reagent bottle, Narrow mouth, plane	50ml	5	5	5	15
B-14-02	Reagent bottle, Narrow mouth, plane	100ml	10	10	10	30

No.	Item	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
B-14-03	Reagent bottle, Narrow mouth, plane	250ml	10	10	10	30
B-14-04	Reagent bottle, Narrow mouth, plane	500ml	5	5	5	15
B-14-05	Reagent bottle, Narrow mouth, plane	1000ml	5	5	5	15
B-14-06	Reagent bottle, Narrow mouth, amber	50ml	10	10	10	30
B-14-07	Reagent bottle, Narrow mouth, amber	100ml	10	10	10	30
B-14-08	Reagent bottle, Narrow mouth, amber	250ml	10	11	11	32
B-14-09	Reagent bottle, Narrow mouth, amber	500ml	5	5	5	15
B-14-10	Reagent bottle, Narrow mouth, amber	1000ml	5	5	5	15
B-14-11	Reagent bottle, Wide mouth, plane	250ml	10			10
B-14-12	Reagent bottle, Wide mouth, plane	500ml	5			5
B-14-13	Reagent bottle, Wide mouth, plane	1000ml	5			5
B-14-14	Reagent bottle, Wide mouth, amber	250ml	10			10
B-14-15	Reagent bottle, Wide mouth, amber	500ml	5			5
B-14-16	Reagent bottle, Wide mouth, amber	1000ml	5			5
B-15-01	Burette	10ml, plane	5			5
B-15-02	Burette	25ml, plane	5			5
B-15-03	Burette	50ml, plane	5	5	5	15
B-15-04	Burette	10ml, amber	5			5
B-15-05	Burette	25ml, amber	5			5
B-15-06	Burette	50ml, amber	5			5
B-16-01	Separatory funnel	200ml	10			10
B-16-02	Separatory funnel	500ml	10	3	3	16
B-16-03	Separatory funnel	1000ml	5			5
B-16-04	Separatory funnel	2000ml	5			5
B-17-01	Funnel for filtering, Plain	45mm dia.	10			10
B-17-02	Funnel for filtering, Plain	60mm dia.	10			10
B-17-03	Funnel for filtering, Plain	90mm dia.	10	3	3	16
B-17-04	Funnel for filtering, Plain	105mm dia.		3	3	6
B-17-05	Funnel for filtering, Plain	120mm dia.	10			10
B-18-01	Dropping bottle, Plane	60ml	5			5
B-18-02	Dropping bottle, Plane	120ml	5			5
B-18-03	Dropping bottle, Plane	250ml	5			5
B-18-04	Dropping bottle, Amber	60ml	5			5
B-18-05	Dropping bottle, Amber	120ml	5			5
B-18-06	Dropping bottle, Amber	250ml	5			5
B-19-01	Weighing bottle	40mm dia. x 30mm(H)	10			10
B-19-02	Weighing bottle	40mm dia. x 40mm(H)	10			10
B-19-03	Weighing bottle	40mm dia. x 50mm(H)	10			10
B-19-04	Weighing bottle	50mm dia. x 30mm(H)	10			10
B-19-05	Weighing bottle	50mm dia. x 40mm(H)	10			10
B-19-06	Weighing bottle	50mm dia. x 50mm(H)	10			10
B-19-07	Weighing bottle	24ml (30φmm x50(H)mm)		3	3	6
B-19-08	Weighing bottle	58ml (60φmm x40(H)mm)		3	3	6
B-20-01	Petri dish	60mm dia.		16	16	32
B-20-02	Petri dish	90mm dia.	20			20
B-20-03	Petri dish	100mm dia.	50	16	16	82
B-20-04	Petri dish	120mm dia.	20			20
B-21-01	Watch glass	60mm dia.	20			20
B-21-02	Watch glass	80mm dia.		5	5	10
B-21-03	Watch glass	120mm dia.	20			20

No.	Item	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
B-22-01	Evaporating dish, Porcelain	90mm dia.	20			20
B-22-02	Evaporating dish, Porcelain	120mm dia.	20			20
B-23-01	Color comparison tube, TS stopper 100ml	50ml, 24/25	10			10
B-23-02	Color comparison tube, TS stopper 100ml	100ml, 24/25	10			10
B-24-01	Desiccators with plate	240mm dia.	3	3	3	9
B-24-02	Desiccators with plate	300mm dia.	3			3
B-24-03	Dessicator with vacuum	180mm, with flange & lid		3	3	6
B-25-01	Glass tube	8mm dia.	5			5
B-25-02	Glass tube	10mm dia.	5			5
B-26-01	Washing bottle	250ml	10			10
B-26-02	Washing bottle	500ml	5			5
B-26-03	Wash bottle (plastic)	250ml		5	5	10
B-26-04	Wash bottle (plastic)	500ml		5	5	10
B-27	BOD bottle	100ml	100			100
B-28-01	Centrifugal tubes	10ml	20			20
B-28-02	Centrifugal tubes	15ml	20			20
B-28-03	Centrifugal tubes	50ml	10			10
B-28-04	Centrifugal tubes	100ml	50			50
B-29-01	Filtering bottle	3L	3			3
B-29-02	Filtering bottle	5L	3			3
B-30-01	Condenser Liebig	300mm	10			10
B-30-02	Condenser Liebig	200mm		3	3	6
B-31	Filtration apparatus	47mm	3			3
B-32-01	Auto buret, plane	25ml	3	2	2	7
B-32-02	Auto buret, amber	25ml	3	2	2	7
B-33	Sample bottle, amber	Glass with a screw cap lined with TFE	50			50
B-34	Chromatographic column	100mm×10mm ID, with TFE stopcock with reagent	5			5
B-35	Reaction flask	15 to 25mL, with standard tapered joint	10			10
B-36-01	Tall beaker	100ml	10			10
B-36-02	Tall beaker	200ml	10			10
B-37	Aspirator bottle	5000ml		3	3	6
B-38-01	Bottle with screawcap	25ml		5	5	10
B-38-02	Bottle with screawcap	50ml		5	5	10
B-38-03	Bottle with screawcap	250ml		5	5	10
B-38-04	Bottle with screawcap	500ml		5	5	10
B-38-05	Bottle with screawcap	1000ml		3	3	6
B-39	BDH crucible with sintered disk, grade 40	50ml		3	3	6
B-40	Buchner funnel with sintered disk	80ml		3	3	6
B-41	Mortar with pestle (porcelain)	Volume 400cm (300φmm)		3	3	6
B-42	Alchol lamp			5	5	10
B-43	Filter paper Whatmann grade 1	9cm dia.		5		5
B-44	Pasture pipette	250pcs pack		3	3	6
B-45	Pipette filler (rubber made)	10ml		5	5	10
B-46	Chemical gloves			3	3	6
B-47	Heat resistance glove			3	3	6
B-48	Glassware dry stand	24 holds		3	3	6
B-49	Safety glass	UV proof and chemical resistance		3	3	6
B-50	Millipore filter paper, size 47φmm	0.45U		3	3	6
B-51	Glass-fiber filter disks		3			3
B-52	Membrane filter	For micro-organisms test	3			3

No.	Item	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
B-53	Membrane filter	47mm dia.	3			3
B-54	Filter funnels	55mm dia.	3			3
B-55	Filter paper for phase separation		3			3
B-56	Ion-exchange column		5			5
B-57	Soxhlet extraction apparatus	150mL	1			1
B-58	Filter paper		3			3
B-59-01	Gas dispersion tube	1.2m, 6mm dia.	3			3
B-59-02	Gas dispersion tube	1.2m, 7mm dia.	3			3
B-60-01	Syringes	0.5mL	3			3
B-60-02	Syringes	1.0mL	3			3
B-60-03	Syringes	5.0mL	3			3
B-60-04	Syringes	25.0mL	3			3
B-61-01	Microsyringes	10-iL	3			3
B-61-02	Microsyringes	25-iL	3			3
B-61-03	Microsyringes	100-iL	3			3
B-62-01	Gastight syringe	10-iL	3			3
B-62-02	Gastight syringe	25-iL	3			3
B-62-03	Gastight syringe	100-iL	3			3
B-63	Kuderna-Danish apparatus		3			3
B-64	Concentrator tube		50			50
B-65	Vials		50			50
B-66	Boiling chips		1			1
B-67-01	Sample bottle	General water quality elements	1,000			1,000
B-67-02	Sample bottle	For heavy metal	1,000			1,000
B-67-03	Sample bottle	For micro-organisms test	500			500
B-67-04	Sample bottle	For odor	500			500
B-68	Dilution bot‡le	Effluvium	100			100
B-69	Fermentation Tubes and Vials		100			100
B-70-01	Micro pipetter	1-5ml	3		1	4
B-70-02	Micro pipetter	2-10ml	3		1	4
B-71	Crucible, made by Alumina		5			5
B-72	Crucible tong	300ml	2			2
B-73	Combustion Tube, Alumina made		5			5
C. Reagent for initial operation						
C-01	pH standard solution 4.01		20			20
C-02	pH standard solution 6.86		20			20
C-03	(NH2)2･H2SO4		2			2
C-04	(CH2)6N4		20			20
C-05	KH2PO4		2			2
C-06	K2HPO4		8			8
C-07	Na2HPO4･7H2O		2			2
C-08	NH4Cl		4			4
C-09	MgSO4･7H2O		2			2
C-10	CaCl2		2			2
C-11	FeCl3･6H2O		2			2
C-12	sodium hydroxide		2			2
C-13	Na2SO3		2			2
C-14	glucose		4			4
C-15	glutamic acid		4			4
C-16	K2Cr2O7		2			2

No.	Item	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
C-17	Ag2SO4		2			2
C-18	H2SO4		10			10
C-19	1,10-phenanthroline monohydrate		4			4
C-20	FeSO4·7H2O		2			2
C-21	Fe(NH4)2(SO4)2·6H2O		2			2
C-22	HgSO4, crystals or powder		2			2
C-23	HOOCC6H4COOK		4			4
C-24	K2S2O8		8			8
C-25	NH4OH		6			6
C-26	H3PO4		4			4
C-27	Sulfanilamide		2			2
C-28	N-(1-naphthyl)ethylenediamine dihydrochloride	NED	2			2
C-29	CuSO4·5H2O		3			3
C-30	Copperized cadmium granules		3			3
C-31	KNO3.		3			3
C-32	NaOH		8			8
C-33	NH3	1000mg/L	2			2
C-34	CH3COOH		2			2
C-35	NaCl		6			6
C-36	1,2-cyclohexylenediaminetetraacetic acid	CDTA	3			3
C-37	F	1000mg/L	2			2
C-38	KOH		2			2
C-39	CN	1000mg/L	2			2
C-40	KCl		2			2
C-41	Ascorbic acid		3			3
C-42	Na2H2		2			2
C-43	Na2S-9H20		2			2
C-44	K2SO4		2			2
C-45	Na2S2O3·5H2O		6			6
C-46	1,1-Dichloroethylene in methanol	packed in pierceable ampules	2			2
C-47	1,2-Dichloroethylene in methanol	packed in pierceable ampules	3			3
C-48	Tetrachloroethylene in methanol	packed in pierceable ampules	3			3
C-49	Trichloroethylene in methanol	packed in pierceable ampules	3			3
C-50	Cloroform in methanol	packed in pierceable ampules	3			3
C-51	Benzene in methanol	packed in pierceable ampules	3			3
C-52	Na2SO4		4			4
C-53	Acetone		2			2
C-54	Methanol		10			10
C-55	Methylene chloride		2			2
C-56	K2CO3		2			2
C-57	a-bromopentafluorotoluene		2			2
C-58	1,4,7,10,13,16-hexaoxacyclooctadecane		2			2
C-59	2-propanol		2			2
C-60	Hexane		2			2
C-61	Toluene		2			2
C-62	Silica gel		6			6
C-63	Sodium carbonate		2			2
C-64	Standard solutions	1000mg/L	2			2
C-65	Standard solutions	1000mg/L	2			2
C-66	H2SO4		4			4

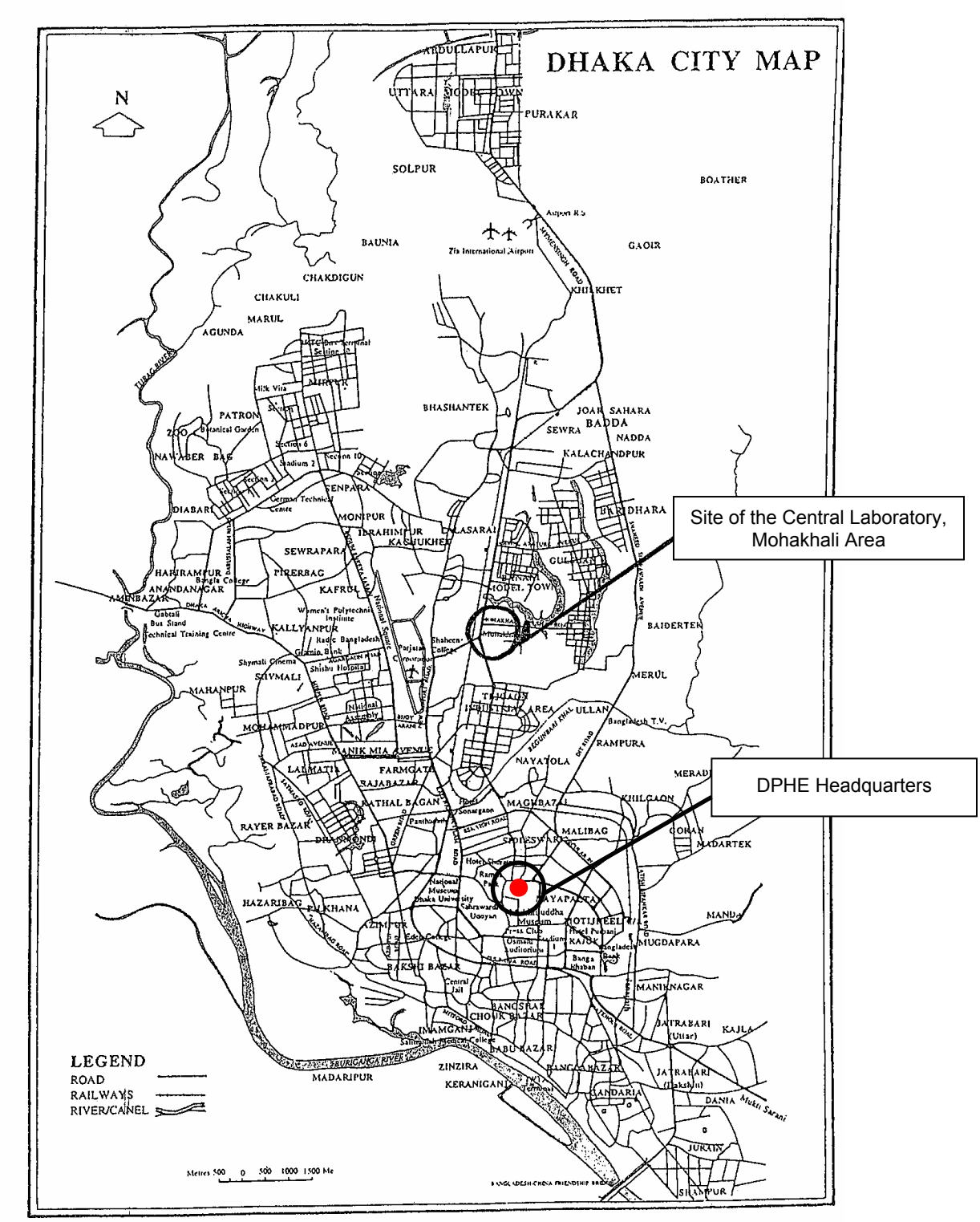
No.	Item	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
C-67	(NH4)6Mo7O24·4H2O		2			2
C-68	C8H4K2O12Sb2·3H2O		2			2
C-69	KH2PO4		2			2
C-70	Standard solutions	1000mg/L	2			2
C-71	HNO3, conc.		6			6
C-72	Aluminum	1000mg/L	2			2
C-73	Ammonium acetate		2			2
C-74	8-hydroxyquinoline		2			2
C-75	Reagent grade		2			2
C-76	Hydroxylamine hydrochloride		2			2
C-77	Barium	1000mg/L	2			2
C-78	Curcumin		2			2
C-79	Oxalic acid		2			2
C-80	Ethyl alcohol		2			2
C-81	Hydrochloric acid, conc		10			10
C-82	CL2	1000mg/L	2			2
C-83	SO4	1000mg/L	2			2
C-84	CaCO3		2			2
C-85	Lanthanum oxide		8			8
C-86	Hydrogen peroxide	30%	2			2
C-87	Ca	1000mg/L	2			2
C-88	Mg	1000mg/L	2			2
C-89	Phenol		2			2
C-90	KBrO3		2			2
C-91	KBr		2			2
C-92	starch powder		2			2
C-93	KH2PO4		6			6
C-94	4-aminoantipyrine		2			2
C-95	K3Fe(CN)6		2			2
C-96	CHCL3		2			2
C-97	anhydrous Na2SO4, granular		2			2
C-98	Potassium bi-iodate anydrous		2			2
C-99	Phenylarsine oxide		2			2
C-100	anhyrous NaC2H3O2		2			2
C-101	Tryptose		4			4
C-102	Lactose		4			4
C-103	Sodium lauryl sulfate		2			2
C-104	Nitogen gas		2			2
C-105	Ethyl acetate		2			2
C-106	NaHCO3		4			4
C-107	1,1,2-trichloro-1,2,2-trifluoro ethane		2			2
C-108	Isooctane		2			2
C-109	Hexadecane		3			3
C-110	Benzene		2			2
C-111	NaBH4		2			2
C-112	KI, crystals		4			4
C-113	conc H2SO4		2			2
C-114	K2S2O8		2			2
C-115	HClO4, conc		2			2
C-116	HCl conc		4			4

No.	Item	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
C-117	As	1000mg/L	2			2
C-118	Se	1000mg/L	2			2
C-119	Cd	1000mg/L	2			2
C-120	Cr	1000mg/L	2			2
C-121	(NH4)2SO4		2			2
C-122	1,5-diphenylcarbazide		2			2
C-123	HPLC-grade methanol		2			2
C-124	K2Cr2O7 standard grade		2			2
C-125	Cu	1000mg/L	2			2
C-126	Fe	1000mg/L	2			2
C-127	Pb	1000mg/L	2			2
C-128	Mn	1000mg/L	2			2
C-129	KMnO4		2			2
C-130	NH2OH･H2SO4		2			2
C-131	SnCl2		2			2
C-132	Ni	1000mg/L	2			2
C-133	Sn	1000mg/L	2			2
C-134	Zn	1000mg/L	2			2
C-135	Ag	1000mg/L	2			2
C-136	Na	1000mg/L	2			2
C-137	Na2CO3		2			2
D. Supporting vehicle						
D-01	4WD passenger vehicle	For management of zonal Lab.	2			2
D-02	Microbus	For training	1			1
D-03	Pick-up truck	To transport samples and material	1			1
E. Training equipment						
E-01	Projector		1			1
E-02	Opaque projector		1			1
E-03	Screen		2			2
E-04	Laptop PC		1			1
E-05	Digital video camera		1			1
E-06	Printer		1			1
E-07	Photocopy machine		1			1
F. Equipment for water quality database management						
F-01	PC for server		1			1
F-02	PC		10			10
F-03	Printer		1			1
F-04	Scanner		1			1
F-05	Digitaizer		1			1
F-06	Software		1			1

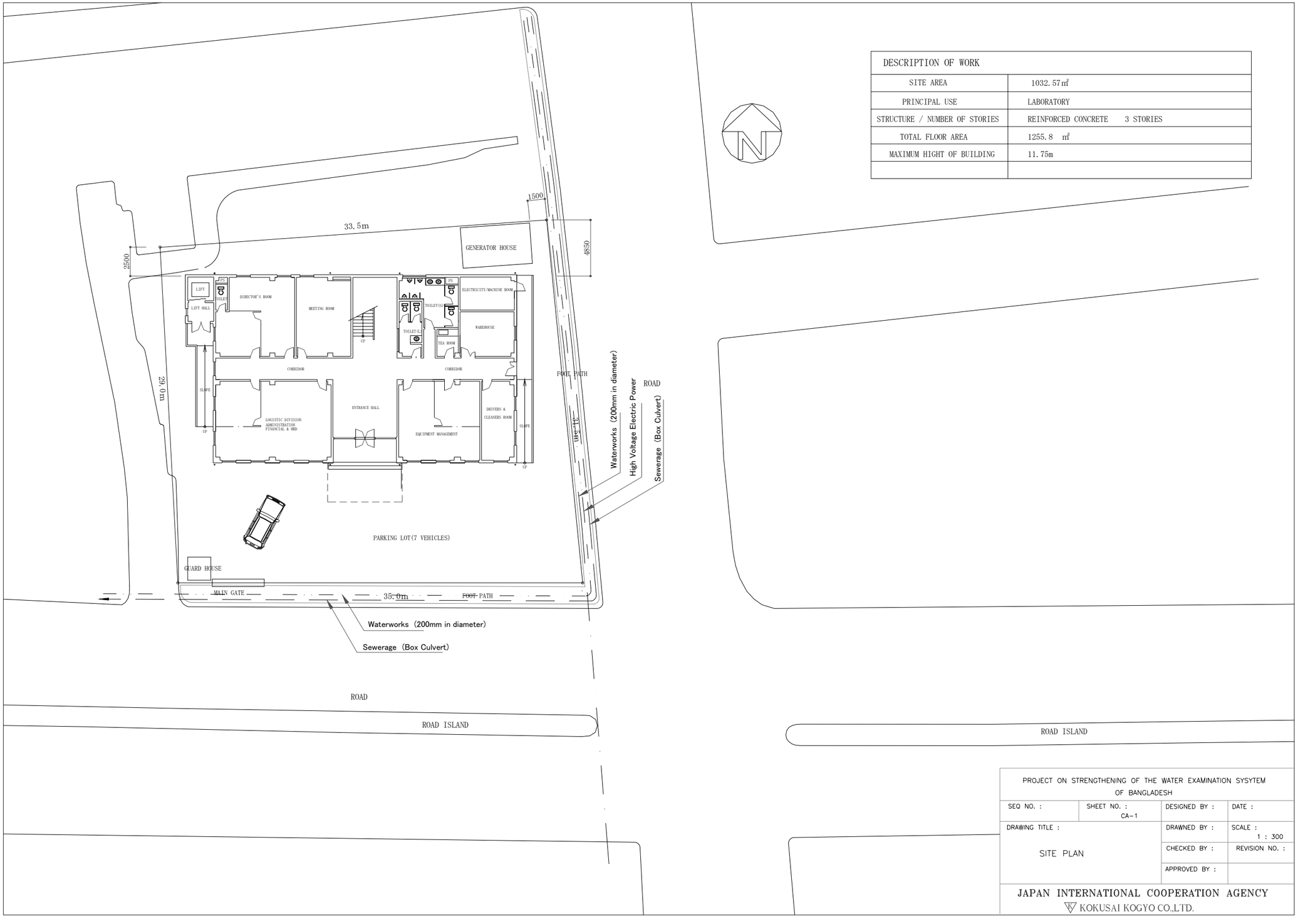
2-2-3 Basic Design Drawing

The following figures are shown in this section:

Location Map, Facility Layout, Ground Floor Plan, 1st Floor Plan, 2nd Floor plan, A-A Section, B-B Section, North Elevation, South Elevation, renovation plan for Jhenaidah zonal laboratory, and renovation plan for Noakhali zonal laboratory.

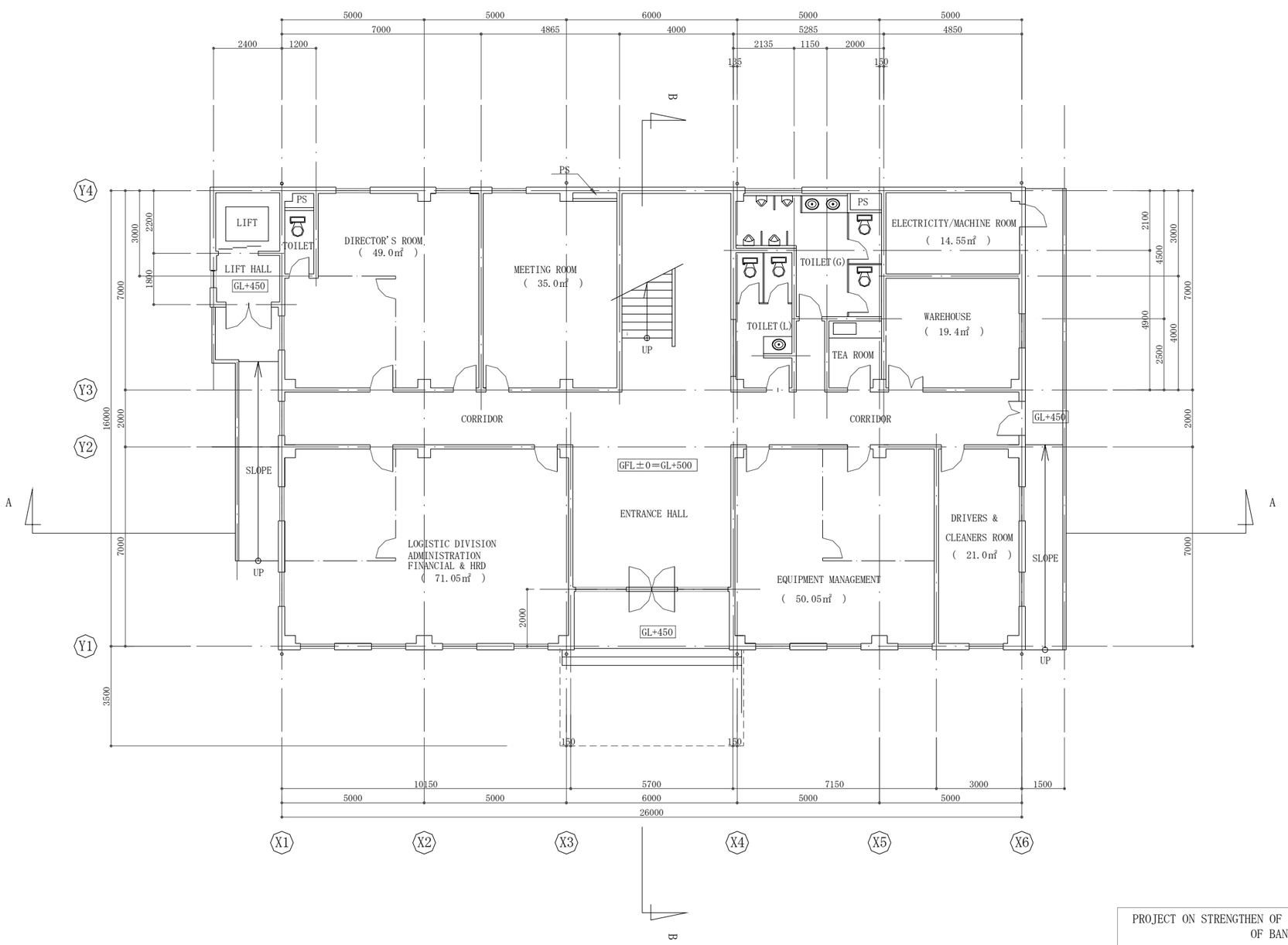


Location Map of the Central Laboratory



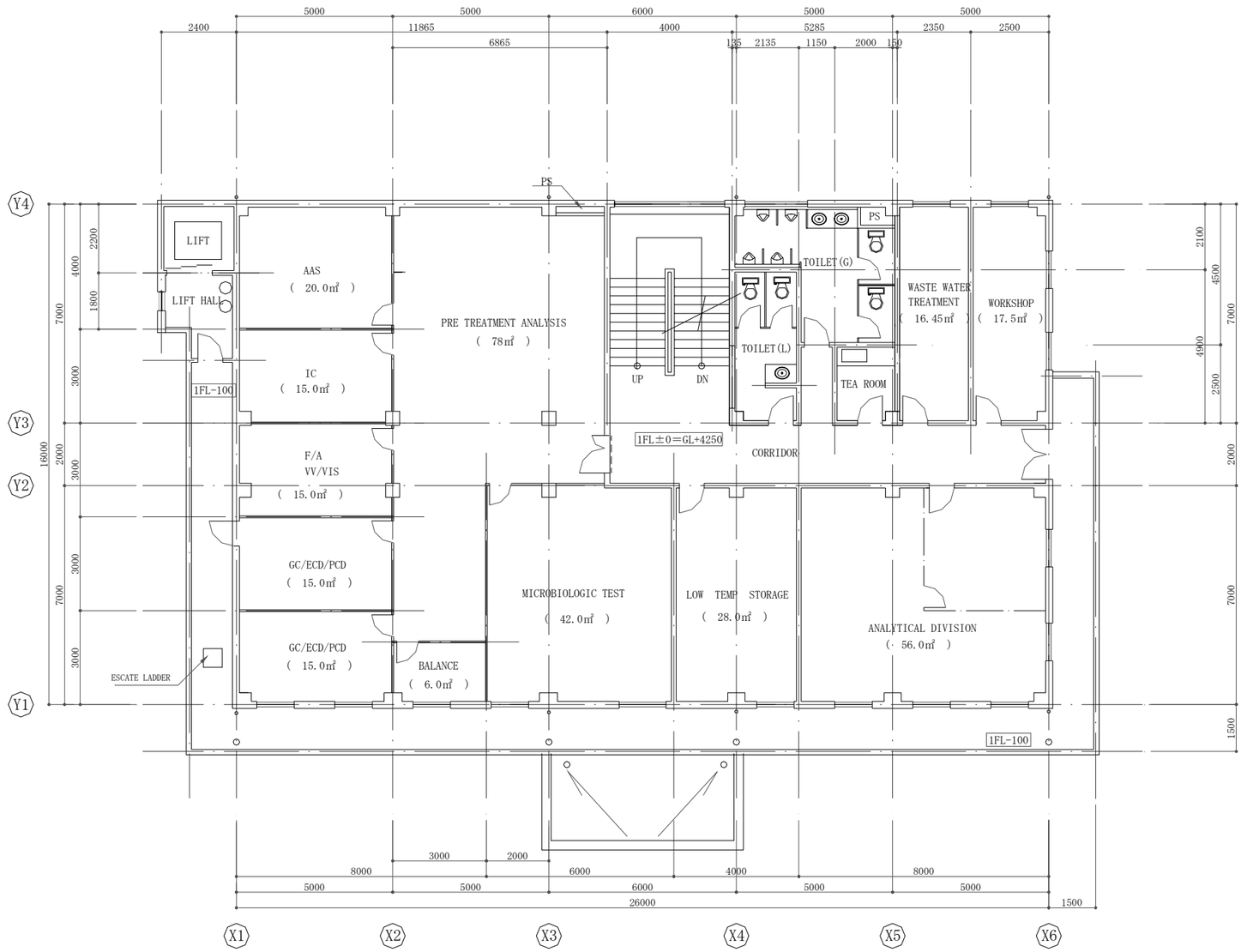
DESCRIPTION OF WORK	
SITE AREA	1032.57㎡
PRINCIPAL USE	LABORATORY
STRUCTURE / NUMBER OF STORIES	REINFORCED CONCRETE 3 STORIES
TOTAL FLOOR AREA	1255.8 ㎡
MAXIMUM HIGHT OF BUILDING	11.75m

PROJECT ON STRENGTHENING OF THE WATER EXAMINATION SYSYTEM OF BANGLADESH			
SEQ NO. :	SHEET NO. : CA-1	DESIGNED BY :	DATE :
DRAWING TITLE : SITE PLAN		DRAWNED BY :	SCALE : 1 : 300
		CHECKED BY :	REVISION NO. :
		APPROVED BY :	
JAPAN INTERNATIONAL COOPERATION AGENCY KOKUSAI KOGYO CO.,LTD.			



GROUND FLOOR PLAN S=1/100

PROJECT ON STRENGTHEN OF THE WATER EXAMINATION SYSTEM OF BANGLADESH			
SEQ NO. :	SHEET NO. : CA-5	DESIGNED BY :	DATE :
DRAWING TITLE : GROUND FLOOR PLAN		DRAWNED BY :	SCALE : 1 : 100
		CHECKED BY :	REVISION NO. :
		APPROVED BY :	
JAPAN INTERNATIONAL COOPERATION AGENCY KOKUSAI KOGYO CO.,LTD.			

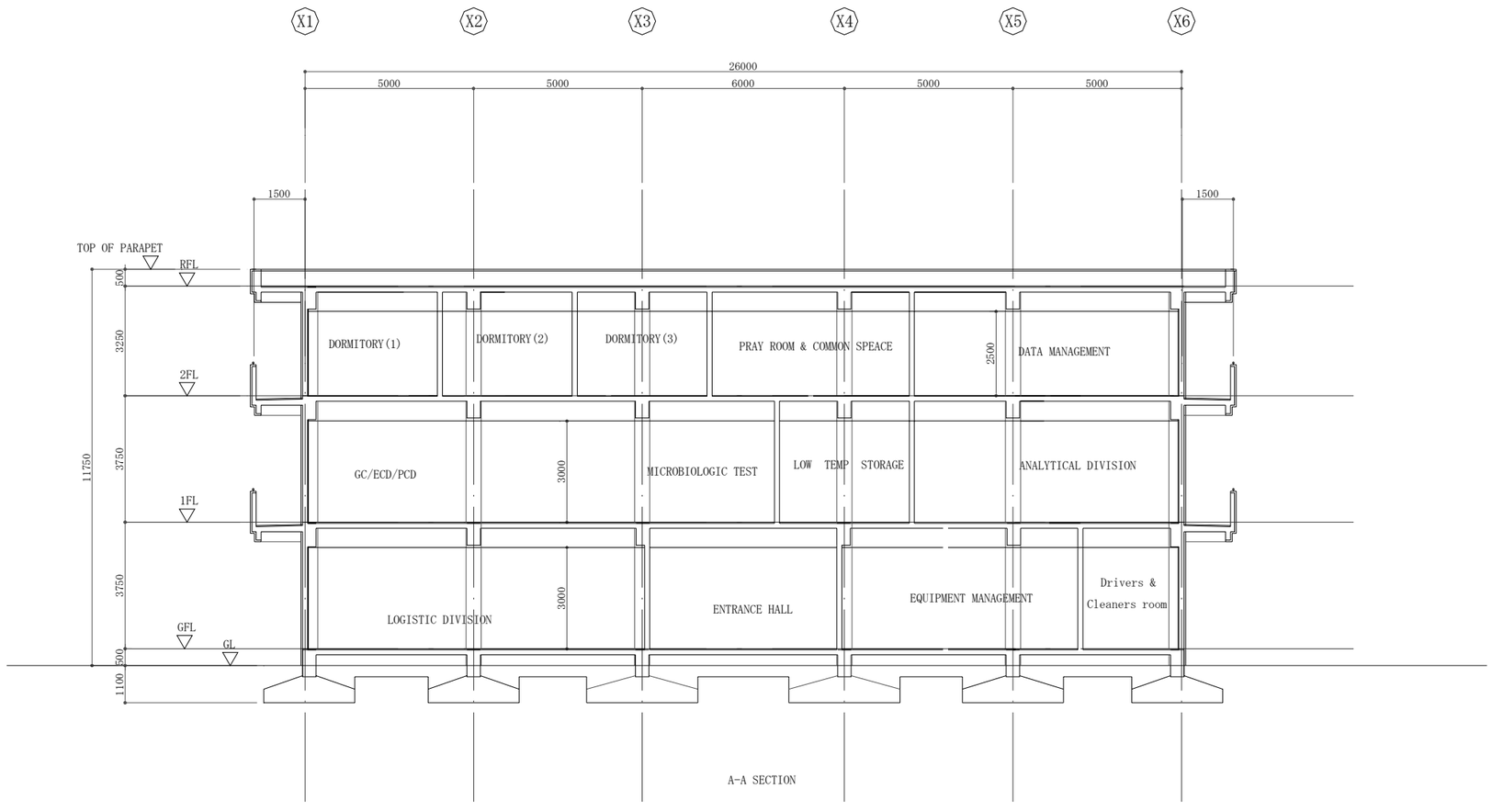


1ST FLOOR PLAN S=1/100

PROJECT ON STRENGTHEN OF THE WATER EXAMINATION SYSTEM OF BANGLADESH			
SEQ NO. :	SHEET NO. : CA-6	DESIGNED BY :	DATE :
DRAWING TITLE : 1ST FLOOR PLAN		DRAWNED BY :	SCALE : 1 : 100
		CHECKED BY :	REVISION NO. :
		APPROVED BY :	
JAPAN INTERNATIONAL COOPERATION AGENCY KOKUSAI KOGYO CO.,LTD.			

2ND FLOOR PLAN S=1/100

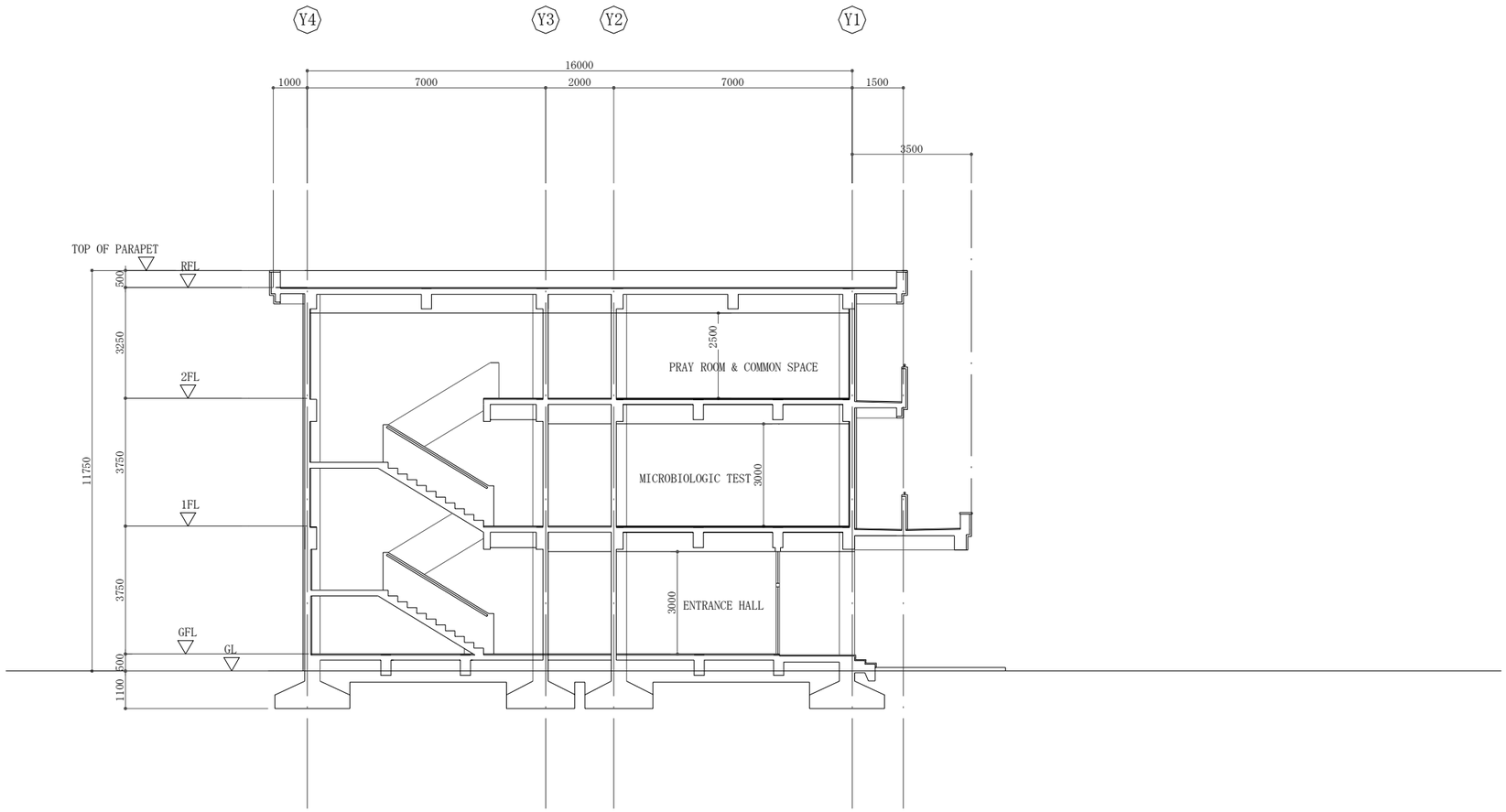
PROJECT ON STRENGTHEN OF THE WATER EXAMINATION SYSTEM OF BANGLADESH			
SEQ NO. :	SHEET NO. : CA-7	DESIGNED BY :	DATE :
DRAWING TITLE : 2ND FLOOR PLAN		DRAWNED BY :	SCALE : 1 : 100
		CHECKED BY :	REVISION NO. :
		APPROVED BY :	
JAPAN INTERNATIONAL COOPERATION AGENCY KOKUSAI KOGYO CO.,LTD.			



A-A SECTION

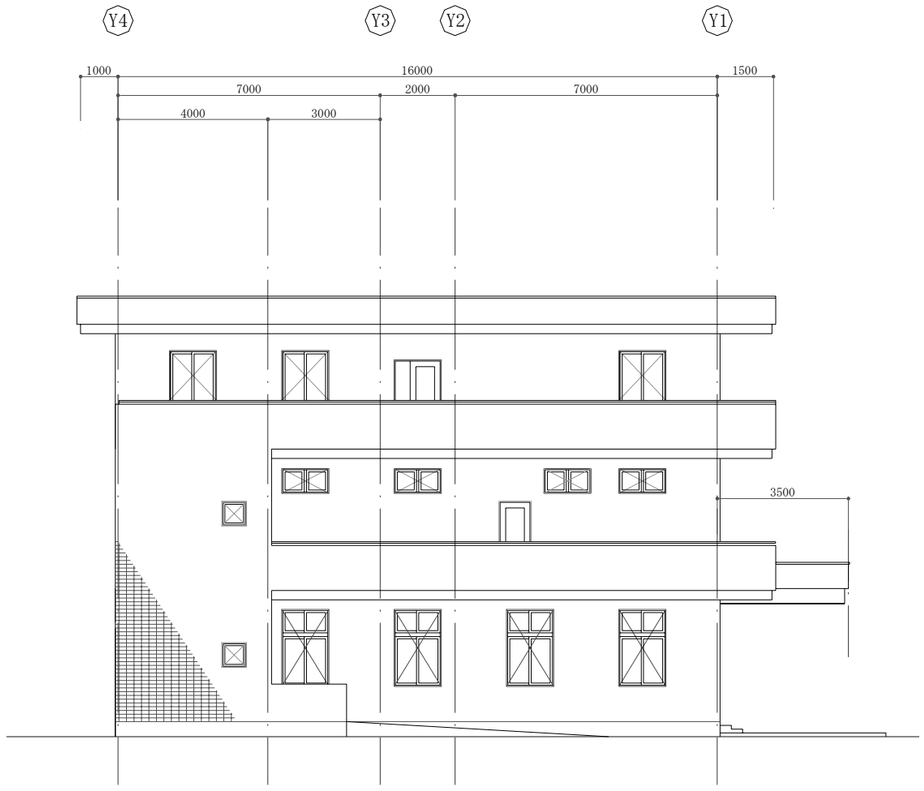
PROJECT ON STRENGTHEN OF THE WATER EXAMINATION SYSTEM OF BANGLADESH			
SEQ NO. :	SHEET NO. : CA-12	DESIGNED BY :	DATE :
DRAWING TITLE : A-A SECTION		DRAWNED BY :	SCALE : 1 : 100
		CHECKED BY :	REVISION NO. :
		APPROVED BY :	

JAPAN INTERNATIONAL COOPERATION AGENCY
KOKUSAI KOGYO CO.,LTD.



B-B SECTION

PROJECT ON STRENGTHEN OF THE WATER EXAMINATION SYSTEM OF BANGLADESH			
SEQ NO. :	SHEET NO. : CA-13	DESIGNED BY :	DATE :
DRAWING TITLE : B-B SECTION		DRAWNED BY :	SCALE : 1 : 100
		CHECKED BY :	REVISION NO. :
		APPROVED BY :	
JAPAN INTERNATIONAL COOPERATION AGENCY KOKUSAI KOGYO CO.,LTD.			

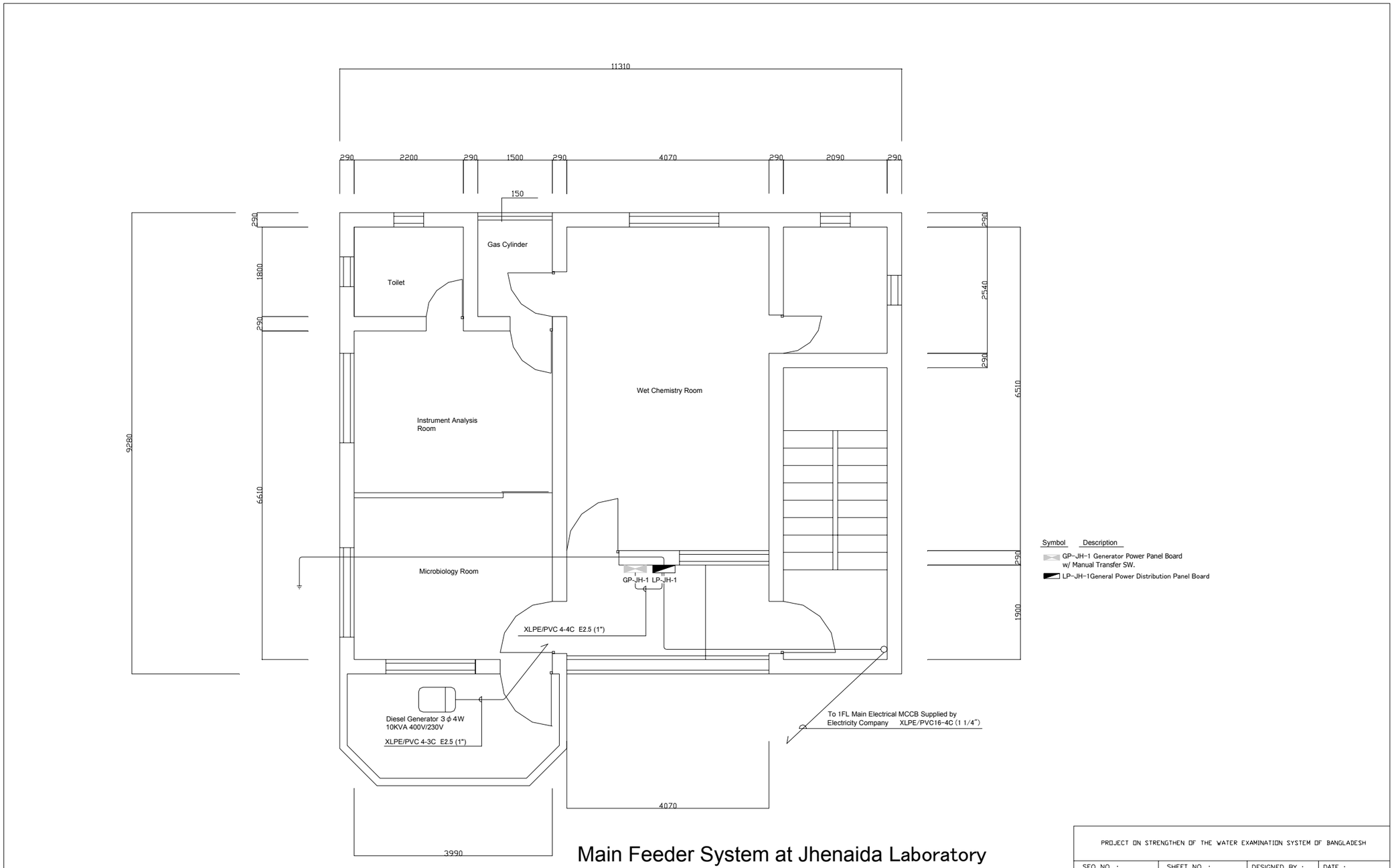


WEST ELEVATION S=1/100

EAST ELEVATION S=1/100

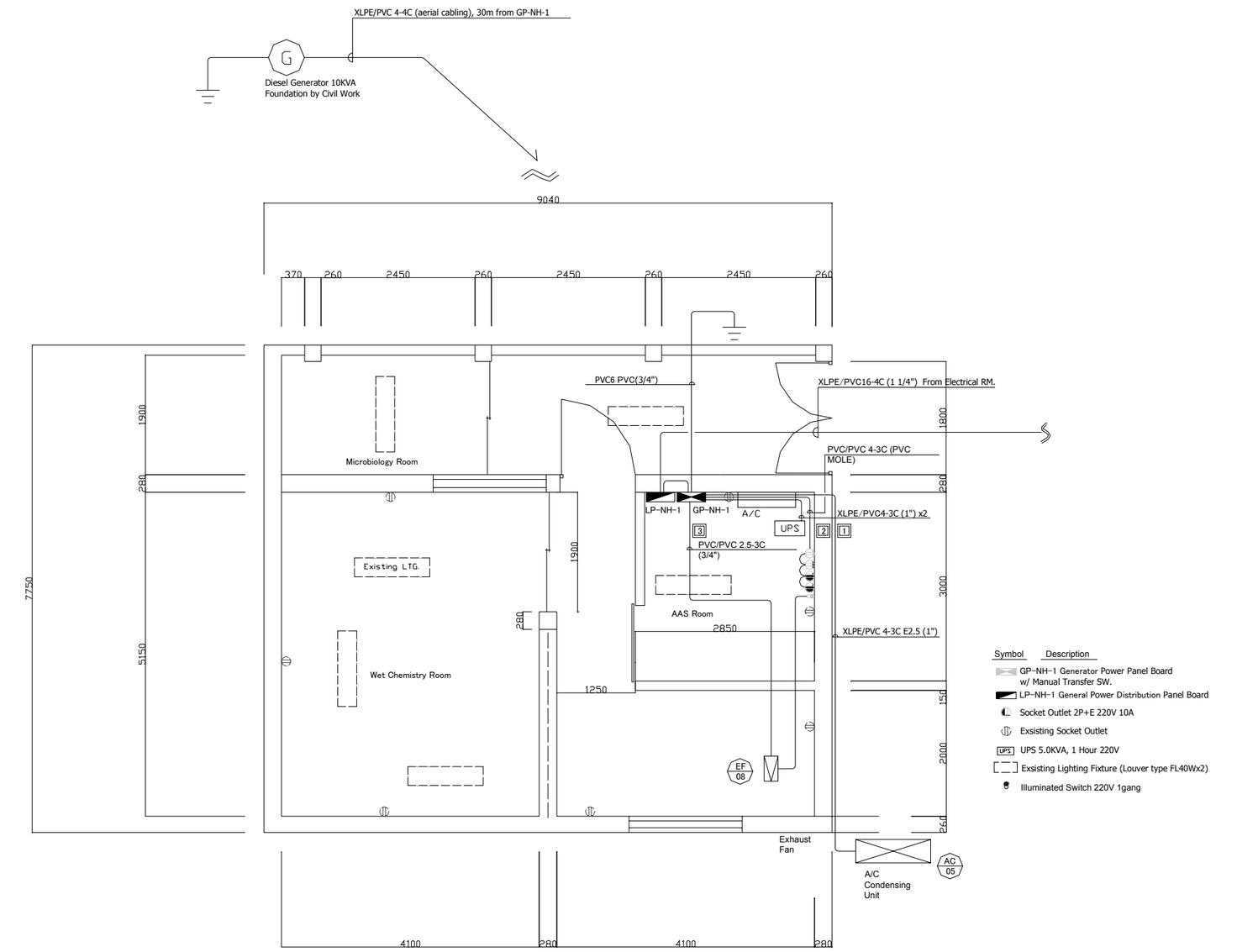
PROJECT ON STRENGTHEN OF THE WATER EXAMINATION SYSTEM OF BANGLADESH			
SEQ NO. :	SHEET NO. : CA-10	DESIGNED BY :	DATE :
DRAWING TITLE : NORTH ELEVATION		DRAWNED BY :	SCALE : 1 : 100
		CHECKED BY :	REVISION NO. :
		APPROVED BY :	
JAPAN INTERNATIONAL COOPERATION AGENCY KOKUSAI KOGYO CO.,LTD.			

PROJECT ON STRENGTHEN OF THE WATER EXAMINATION SYSTEM OF BANGLADESH			
SEQ NO. :	SHEET NO. : CA-9	DESIGNED BY :	DATE :
DRAWING TITLE : SOUTH ELEVATION		DRAWNED BY :	SCALE : 1 : 100
		CHECKED BY :	REVISION NO. :
		APPROVED BY :	
JAPAN INTERNATIONAL COOPERATION AGENCY KOKUSAI KOGYO CO.,LTD.			



Main Feeder System at Jhenaida Laboratory

PROJECT ON STRENGTHEN OF THE WATER EXAMINATION SYSTEM OF BANGLADESH			
SEQ NO. :	SHEET NO. : JE−1	DESIGNED BY :	DATE :
DRAWING TITLE : JHENAIDA LABORATORY MAIN FEEDER SYSTEM		DRAWNED BY :	SCALE : 1 : 50
		CHECKED BY :	REVISION NO. :
		APPROVED BY :	
JAPAN INTERNATIONAL COOPERATION AGENCY KOKUSAI KOGYO CO.,LTD.			



Symbol	Description
	GP-NH-1 Generator Power Panel Board w/ Manual Transfer SW.
	LP-NH-1 General Power Distribution Panel Board
	Socket Outlet 2P+E 220V 10A
	Exsisting Socket Outlet
UPS	UPS 5.0KVA, 1 Hour 220V
	Exsisting Lighting Fixture (Louver type FL40Wx2)
	Illuminated Switch 220V 1gang

Electrical System at Noakhali Laboratory

PROJECT ON STRENGTHEN OF THE WATER EXAMINATION SYSTEM OF BANGLADESH			
SEQ NO. :	SHEET NO. : NE-1	DESIGNED BY :	DATE :
DRAWING TITLE : NOAKHALI LABORATORY ELECTRICAL SYSTEM		DRAWNED BY :	SCALE : 1 : 50
		CHECKED BY :	REVISION NO. :
		APPROVED BY :	

JAPAN INTERNATIONAL COOPERATION AGENCY
KOKUSAI KOGYO CO.,LTD.

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

After Exchange of Notes is made between the Governments of Bangladesh and Japan, the Government of Bangladesh will enter into an agreement with a consulting firm recommended by JICA. The consultant will implement the detailed designing for the project, preparation of documents for tenders and contracts, and supervision for construction and equipment procurement.

After entering into the agreement, the consulting firm will design the facility construction and equipment procurement. After the designing, tenders will take place to select Japanese contractors for the facility construction and equipment procurement in the presence of representatives from the Government of Bangladesh, as the client.

Contractors will implement facility construction and equipment procurement in accordance with the following polices under the instruction and supervision of the consultant.

① The periods to complete the works for facility construction, equipment procurement and technical support will be 12 months, 3 months and 7 months from the day the contract is made, respectively. All the works will be implemented under a single-year budget system.

② To complete all the works efficiently within the planned periods, contractors to be selected shall have many similar experiences in Bangladesh, south Asia and south-eastern Asia.

③ For the equipment procured from Japan, methods of transport by both air and sea are available. However, transport by sea is desirable because the distance between Japan and Bangladesh is relatively near and since equipment and material are installed only after the completion of the construction of the central laboratory, there will be enough time for their transport. It will take 6 weeks at the maximum for the procurement of equipment and material from Japan to Bangladesh.

④ Burdens and responsibilities of Bangladesh shall be confirmed through many discussions with Bangladeshi side so that problems related to facility construction and equipment procurement could be avoided. This will make all the procedures smooth.

⑤ The construction of foundation and waterproofing work shall not be implemented during the rainy season.

⑥ Construction shall be implemented in accordance with the laws on construction of Bangladesh.

⑦ Equipment will be basically procured from Japan and Bangladesh. However, procurement of equipment from a third country shall be considered if it satisfies the quality and specifications required.

⑧ The supervision by the consultant aims to inspect, instruct and supervise the works conducted

by the contractors concerning the facility construction and equipment procurement in accordance with the contract, special conditions and specifications.

- Supervise full-time from the commencement to completion of the works.
- Examine the use of local contractors, especially construction firms and water quality analysis firms.
- Technical Support will be offered efficiently in a short period taking the progress of construction and timing of equipment procurement into account. The training will include operation and maintenance of the laboratories, instruction for analysis equipment and database management.

The structure for implementation of the project is shown in Figure 3-7.

2-2-4-2 Implementation Conditions

(1) Labor conditions

Many construction laborers and skilled workers are now working in Dhaka city due to the recent construction boom. At the same time, wages for laborers and skilled workers are rising. Although hiring labors has become a seller's market, laborers should be selected taking their skills and wages into consideration.

In the case of construction of the zonal laboratories, laborers shall be basically hired locally, but skilled workers need to be brought from Dhaka because there is no skilled worker in local areas.

(2) Construction material

Concrete material such as cement, aggregate and reinforcing bar shall be produced in Bangladesh. The material that is not produced in Bangladesh but imported from Thailand and India is available in the market. Cost comparison is the basic method to decide from where to procure construction material; however, final decisions shall be made taking quality, ability to supply, reliability for delivery and easiness to maintain and operate into consideration.

(3) Construction machine

Major construction machines are available in Bangladesh.

2-2-4-3 Scope of Works

Necessary works implemented by the Japanese and Bangladeshi sides are demarcated as shown in Table 2-4.

Table 2-4 Construction and procurement demarcation

Item	Works implemented by the Japanese side	Works implemented by the Bangladeshi side
Construction	• Building works, electric and plumbing works and temporary works for the central laboratory (Dhaka) • Interior renovation works and electric and plumbing works for the zonal laboratories (Jhenaidah and Noakhali)	• Securing of land for the construction site and leveling/clearing of the land prior to commencement of construction • Securing of primary electric source (up to distribution board) • Installation of water meters for water supply, if necessary
Equipment procurement	• Equipment and material for laboratories, glassware, reagents for initial operation (for 6 months), supporting vehicles, equipment and material for training and database management	• Fuel for supporting vehicles • Reagents, all necessary equipment out of that procured by Japanese side. • General equipment (office desk, chair and other furniture) • Telephone line, telephone
Transport of equipment and material and installation	• Transport to the central laboratory and zonal laboratories and installation	• Nothing particular
Operation and maintenance for facilities and equipment	• Technical support for operation and management of laboratories, instruction for operation and maintenance of analysis equipment and database management	• Establish organizations for operation and maintenance and secure personnel and budget • Various costs for operation and maintenance (water, electricity, fuel etc.)
Customs duty	• Nothing particular	• Commission of A/P, B/A • Payment of customs duty
Defect liability	• Responsible for all the facilities and equipment for a year after the handover, only in the case of failures through normal operation.	• Responsible for all except that described the left column.

2-2-4-4 Consultant Supervision

After Exchange of Notes, the works carried our by the consultant are divided into the detailed design stage and supervision stage. Details of each stage are mentioned below.

(1) Consultant's major works in detailed design stage

Formulate facility plan, electricity and plumbing plan and carry out structural calculation

Finalize specification and required quantities of procured equipment and material

Prepare contract documents for construction works and equipment procurement, particular specification, specification and schedule chart

Calculate estimated prices for tender

Execution of tender

(Works in Bangladesh)

Check and promote progress of undertakings that are the obligation of the Bangladeshi side

Conduct study for unconfirmed matters occurring after basic design study

Support formulation of national water quality examination program and support workshop implementation (technical support)

(2) Consultant's major works in the stage of the supervision for construction and equipment procurement

Guidance in management of laboratories (technical support)

Instruction for operation and maintenance of analysis equipment (technical support)

Instruction for database management (technical support)

Examination and approval for equipment manufacture drawing

Confirmation for shipping of equipment

Supervision for temporary works, building works, electricity and plumbing works and finishing works for facilities

Reporting on the progress of construction works to the Client and the Government of Japan

Inspection for final completion

Confirmation of inspection and handover concerning constructed facilities and procured equipment

Other official procedures including payment procedures for construction work

(3) Mobilization of consultants

Detailed design stage

- Project manager : 1 person : Overall management
- Facility planning : 1 person : Detailed designing for facilities

- Electricity and plumbing planning : 1 person : Confirmation of Electricity and plumbing plan
- Structure calculation : 1 person : Confirmation of structure calculation for facilities
- Equipment planning : 1 person : Confirmation of equipment procurement plan
- Procurement/Cost planning : 1 person : Confirmation of specifications for equipment and work schedule
- Tender document preparation : 1 person : Preparation for tender and contract documents

Supervision stage

- Full-time supervision : 1 person : Fulltime supervision of all construction works
- Construction supervision (inspection at the start, during, and after the completion of works) : 1 person : Supervision of all construction works
- Supervision (architecture) : 1person : Supervision of architecture
- Supervision (installation) : 1 person : Supervision of installation
- Supervision for equipment procurement : 1person : Supervision of equipment procurement

Technical Support Stage

- Laboratory management and analysis instruction : 1 person : Support for planning water quality examination system and holding workshops, instruction for management of the central and zonal laboratories and technical instruction for analysis
- Equipment operation/maintenance instruction 1 : 1 person : Instruction for operation and maintenance mainly for atomic absorption spectrophotometer

- Equipment operation/maintenance instruction 2
  : 1 person : Instruction for operation and maintenance mainly for ion chromatograph and gas chromatograph
- Equipment operation/maintenance instruction 3
  : 1person : Instruction for operation and maintenance mainly for spectrophotometer
- Database management : 1person : Instruction for database management

2-2-4-5 Procurement Plan

(1) Procurement plan

The conditions of equipment and material procured in Bangladesh are mentioned below.

a. Equipment and material for analysis

In Bangladesh, there are several agencies of water quality analysis equipment from foreign countries including Japan. Each agency is staffed with personnel who were trained by the equipment manufacturer. One agency has received trainees from neighboring countries and given opportunities for training for equipment operation, which indicates the technical level of these agencies is generally high. Therefore, there will be no major problem in terms of after-sales service and spare parts procurement in Bangladesh.

b. Glassware and other equipment

When it comes to water quality analysis, accuracy of glassware used in analysis is very important because a titration error of a few milliliters can develop into a crucial mistake. On the other hand, because durability also becomes an important factor to reduce the costs, high quality equipment needs to be planned. Although a lot of glassware can be produced in Bangladesh, their accuracies vary. Moreover, the thickness of the glass is not uniform so that the durability is unreliable. Indian-made glassware, which is also available in Bangladesh, is also unreliable in terms of accuracy and quality. Therefore, it is appropriate to plan to procure glassware from Japan and third countries.

c. Reagents for initial operation

Because most reagents used for water quality analysis are dangerous chemicals, procedures for export and import .are complicated. Some reagents are prohibited to be exported from Japan. On the other hand, there are some agencies that handle these reagents in Bangladesh and they have experience in supplying these reagents to local private laboratories. All the reagents handled by these agencies are manufactured in foreign countries and the quality and quantity of them are not different from Japanese ones. Considering procurement of spare parts by DPHE after the project and after-sales service, reagents shall be procured in Bangladesh.

d. Supporting vehicles

There are agencies of vehicle manufactures from foreign countries in Bangladesh. Therefore, there is no problem to procure supporting vehicles in Bangladesh as well as Japan even taking after-sales service and spare parts procurement into consideration.

e. Equipment and material for training

OA equipment such as personal computers can be procured in Bangladesh but it is difficult to secure high quality equipment. Since personal computers sold in Bangladesh are usually assembled in shops with imported parts, there are problems with quality. However, this commercial custom makes the procurement of spare parts and repair easier and there is no problem in after-sales services. Therefore, general-purpose goods available in Bangladesh shall be procured locally whenever possible and those that are difficult to procure locally shall be procured in Japan.

f. Equipment and material for water quality database management

Although it is difficult to procure high quality equipment and material in Bangladesh, procurement of spare parts and repair in local workshops are possible. Therefore, general-purpose goods available in Bangladesh shall be procured locally whenever possible and those that are difficult to procure locally shall be procured in Japan.

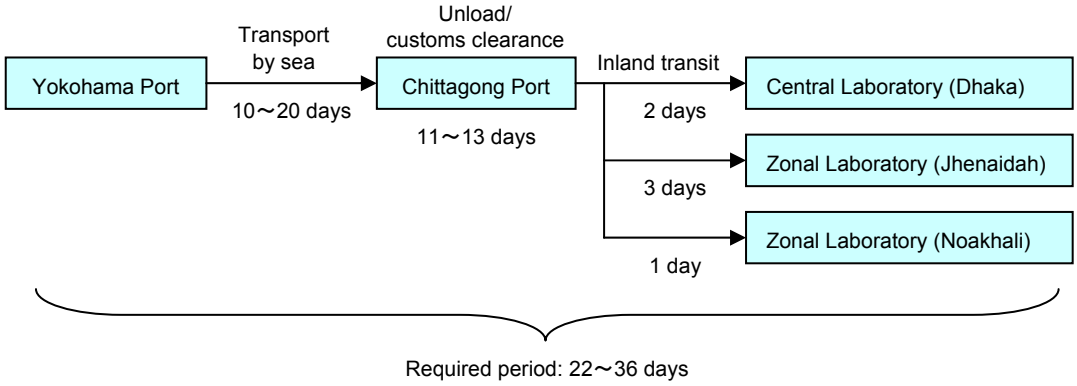
(2) Transportation plan

Most manufacturers and agencies of equipment, material and reagents are located in Dhaka and these goods can usually be procured in Bangladesh. However, almost all of them are imported from foreign countries and some items might be difficult to obtain.

If the necessary equipment and material are not available in Bangladesh, they need to be imported from other countries including Japan. For the equipment procured from Japan, transport by both air and sea are available. However, transport by sea is desirable because the distance between Japan and Bangladesh is relatively near and since equipment and material are installed only after completion of construction of the central laboratory, there will be enough time for their transport. Moreover, conventional ships are regularly operated and some container ships are also available for the transport of particular equipment and material.

When transported by sea, it takes 10 to 20 days to reach Bangladesh from Japan. Customs are cleared at Chittagong Port, which is the port where all the goods arrive. It takes 2 days for the authority of custom duty to check the loads at Chittagong Port, 9 to 11 days (7 working days) for customs clearing and unshipping, 1 to 3 days for inner transport to Dhaka and the zonal laboratories, which totals 12 to 16 days to complete whole procedures of customs clearing.

Therefore, it will take 3 to 6 weeks to complete transportation of equipment and material from Japan to the sites.



2-2-4-6 Quality Control Plan

Method and Criteria of Quality Control

Concrete Work

Freshly mixed concrete shall be transported from the mixer truck to the work site by crane. In Bangladesh, the common method for transporting concrete from the mixer truck is by wheel barrow and manpower. However, the method takes time and the quality of concrete deteriorates. Therefore, the method in Bangladesh is not adopted for the work.

The design strength of the concrete is 21N（+3N）/mm^2.

A quality control manager for concrete will be appointed. Slump tests and sampling of concrete at the time of placement of major structures such as pillars, beams, and so on, will be conducted to ensure consistancy of concrete. To prevent the concrete from drying after placement, the surface of concrete will be kept moist by spraying it with water. For quality control, compression tests will be conducted 11 times in total (Refer to Table 2- 1). For spray curing, gunny bags shall be used.

Quality Control Tests

a. Soil Surveys

Prior to commencement of work, the contractor will conduct a Plate Loading Test or Standard Penetration Test at the site planned for the central laboratory to test bering capacity of soil.

b. Compression Tests for Concrete

The frequency of compression testing for concrete is shown in the table below. Compression tests will be conducted on three concrete specimens per test, at a laboratory in Dhaka.

Table 2- 1 Breakdown of Compression Test for Concrete

	Ground Floor	1st Floor	2nd Floor	Roof	Total
Foundation/ Underground Beam	1 time	—	—	—	1 time
Floor	1 time	1 time	1 time	1 time	4 times
Pillar	1 time	1 time	1 time	—	3 times
Beam	1 time	1 time	1 time	—	3 times
Total	4 times	3 times	3 times	1 time	11 times

c. Tensile Test for Reinforcing Steel Bars

Tensile tests for reinforcing steel bars shall be carried out ten times in total, twice each for the respective five sizes, D10, D13, D16, D19, and D22.

Quality Control Plan for Subcontractor

To control sub-contractors whose technical levels vary and to secure common quality control, the construction shall be implemented in accordance with the following points.

- Guidelines for method of construction and inspection describing specifications, material, construction procedures and inspection methods shall be prepared for major work types. Based on them, common quality control is carried out at each site.
- Demonstrations of construction works shall be carried out for each major work type. The demonstrations will target supervisors of sub-contractors and other persons in charge, and aim to make them specifically understand material management, construction machines, construction procedures and required quality.
- Necessary tests shall be carried out to secure appropriate quality for structurally critical part, reinforcing bars and ground.
- Through the instruction of thorough usage of survey equipment, quality of gallows and marking shall be secured. Quality of overall construction shall be secured by selecting material for scaffolding and frameworks.

2-2-4-7 Implementation Schedule

(1) Detailed design

The detailed design commences after verification of the agreement for consulting services made between the consulting firm and the Government of Bangladesh by the Japanese Government. The detailed design is conducted in Bangladesh and Japan, based on the basic design, and followed by the preparation of tender documents including specifications of equipment. The contents of the documents are discussed with the Government of Bangladesh and needs to be approved by it. Three months are considered to be required for the detailed design.

(2) Construction of the central laboratory and renovation of the zonal laboratories

① Central laboratory

Since the building structure and foundation structure of the central laboratory are relatively simple, about 11 months will be required for construction. The rainy season in Bangladesh is for 5 months from June to October. This period needs to be avoided for foundation works. After installation of analysis equipment, training for equipment operation and maintenance will be carried out for a month as technical support. This period needs to be considered in the construction schedule.

② Zonal laboratories

The renovation works of the zonal laboratory in Noakhali mainly include interior works such as re-cover of the walls and ceiling in the existing analysis room, installation of partition panels and electric works. It does not include renovation works for building structure itself. Expected period of works is about 2 months.

The existing laboratory in Jhenaidah will be relocated to the first floor of the neighboring building after the floor is renovated. The reason to relocate the laboratory is to secure space for the installation of the new analysis equipment. Renovation of the neighboring building includes interior works, installation of windows, electric works and water supply and drain works. It will take about 3 months for the construction work.

(3) Equipment procurement

Procurement of equipment will commence after completion of a sequence of procedures including tendering, entering into a contract and verification by the Government of Japan. Procurement of equipment from Japan will require one to two months for manufacture, one month for packing in Japan or third countries and sea transport, and one month for customs clearance and inner transport to the sites, which totals three and a half months at maximum. The delivery site will be the central laboratory in Dhaka and the zonal laboratories in Jhenaidah and Noakhali.

(4) Adjustment and test operation plan

Since the analysis equipment procured under the project is precision instruments, adjustment and test operation shall be carried out by experts dispatched from manufacturers. The required periods for adjustment and test operation are as follows.

Adjustment and test operation for zonal laboratories (0.33 months)

Adjustment and test operation for central laboratory (0.33 months x 2 persons = 0.66 man-months)

The commissioning of equipment by manufacturers consists of a general explanation of the installation and handling of equipment, and not specialized technical instruction for each parameter on equipment analysis like the technical support. The equipment that needs to be installed and adjusted is as follows:

Central Laboratory

- Atomic absorption spectrophotometer: 3 units
- AAS for HG analysis: 1 unit
- Ion chromatograph: 2 units
- Gas chromatograph: 2 units
- Flow injection analyzer: 1 unit
- UV-VIS spectrophotometer: 1 unit
- Pure water apparatus: 1 unit
- Draft chamber with treatment: 2 units
- Clean bench: 2 units
- Waste water treatment device: 1 unit

Zonal Lboratory in Jhenaidah

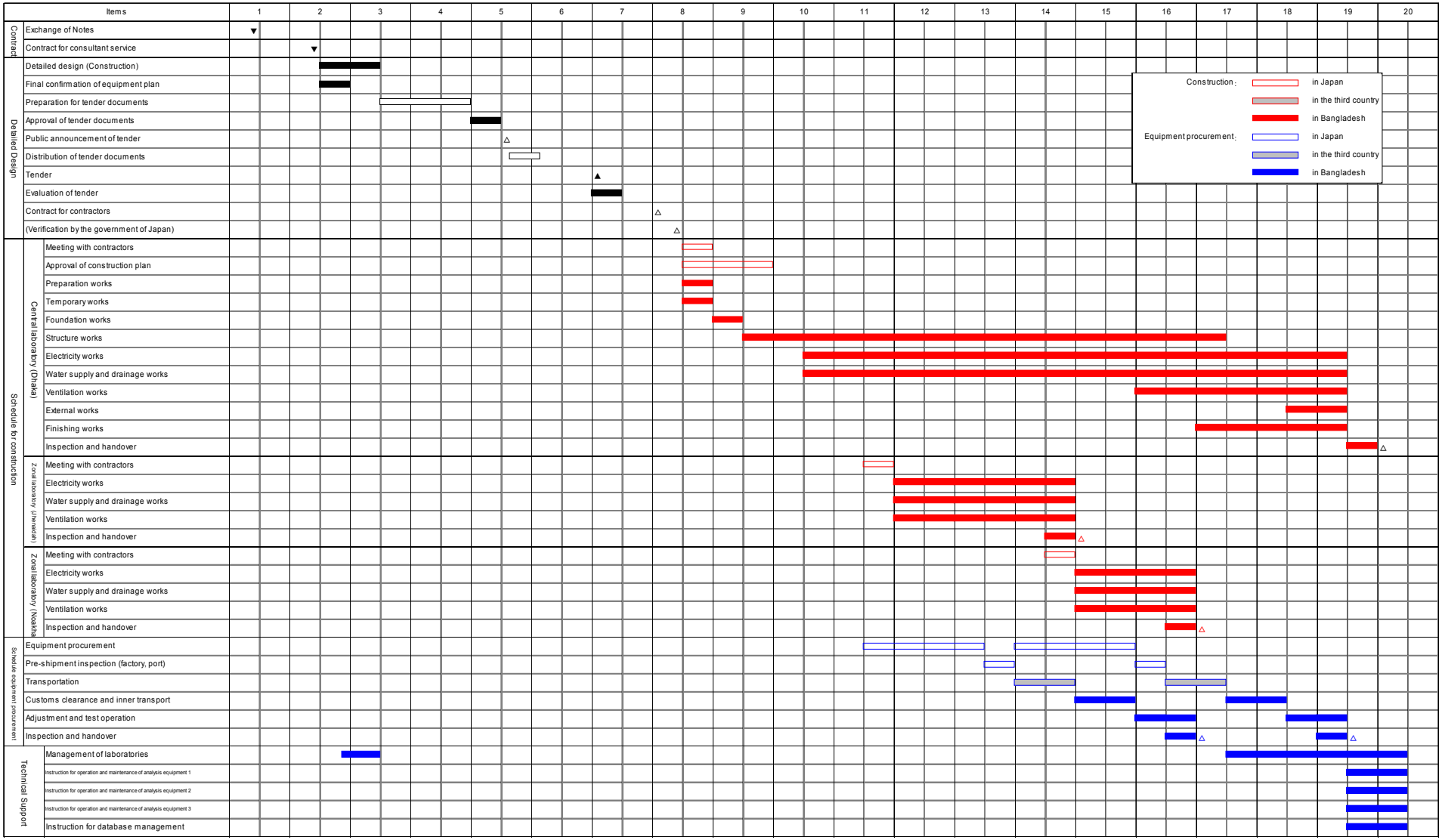
- Pure water apparatus: 1 unit
- Draft chamber with treatment: 1 unit

Zonal Lboratory in Noakhali

- Atomic absorption spectrometer: 1 unit
- UV-VIS spectrophotometer: 1 unit
- Pure water apparatus: 1 unit

The implementation schedule of the Grant Aid project is shown in Table 2-5.

Table 2-5 Implementation schedule



2-2-4-8 Estimated Cost of Grant Aid Project

This project is to be implemented within a period of one fiscal year under Japan's Grant Aid and is estimated to cost 495 Billion Yen. This cost estimate is provisional and would be further examined by the Government of Japan for approval of the Grant.

(1) Estimated Project Cost Covered by Japan's Grant Aid

Table 2-6 Estimated Project Cost Covered by Japan's Grant Aid

Estimated Project Cost Approx. 495 Million Yen

Construction of Central Laboratory and Procurement of Equipment

Renovation of Two Zonal Laboratories and Procurement of Equipment

Expense Item		Estimated Project Cost (Million Yen)	
Construction	Construction of Central Laboratory (temporary works, permanent works, electricity, water supply and drainage facilities, ventilation system), Renovation of Zonal Laboratories (electricity, water supply and drainage system, ventilation system)	217	413
Equipment	Analytical Equipment, Glassware, Chemicals for Initial Operation, Support Vehicles, Equipment for Training, Equipment for Data Management	196	
Design of Execution & Construction / Procurement/ Technical Support			82
Total			495

(2) Conditions for Cost Estimation

The currencies to be used in the project shall be limited to Japanese Yen, US Dollars (USD) and the Bangladeshi Taka (TK). The currency exchange rates are determined by averaging the exchange rate over a six month period beginning from March 31, 2004. The respective exchange rates are as follows:

US Dollars (USD) to Japanese Yen USD1.00＝108.14 Yen

Bangladeshi Taka (TK) to Japanese YenTK1.00＝1.89 Yen

Period of Construction: 15 months (Detailed Design: 3 months, Construction Works: 11 months, Inspection: 1 month)

Other: This project will be implemented in accordance with the Japan's Grant Aid scheme.

2-3 Obligations of Recipient Country

(1) Outline

The agency responsible for the project is DPHE. As long as the project is implemented by the Japan's Grant Aid, it needs to follow the budgetary system of the Government of Japan. To proceed official works smoothly, organizations concerned in Bangladesh need to conduct the following works without delay.

1) Procedures

- ♦ An agreement with a Japanese consulting firm and contracts with Japanese contractors based on Exchange of Notes
- ♦ Immediate arrangement of B/A (Banking Arrangement) at a Japanese bank that deals with foreign exchange and A/P (Authorization to Pay) for the contract payment to the consultant and contractors after entering into the agreement
- ♦ Immediate payment of commission to the abovementioned bank after opening B/A in accordance with the agreement between banks
- ♦ Issue of entry permits and visa for long-stay to Japanese consultants and contractors who are concerned with the project
- ♦ Tax exemption for equipment and material procured
- ♦ Prompt handling for the equipment imported from Japan or third countries and payment for necessary expense for customs clearance
- ♦ Issue of necessary certificates for completion of work at each step

2) Project

- ♦ Land levelling of the site for the central laboratory by September 2004
- ♦ Provision of space to store equipment and materials near the central laboratory
- ♦ Acquisition of construction permission for the central laboratory
- ♦ Preparation of utilities such as electricity (installation of high voltage cables and electric transformers with a capacity of 150KVA), water service (installation of water meter if necessary, and connection to the existing waterworks), sewerage (installation of catch pits and connection to the existing sewage system), and telephone (new contract of telephone and connection)for the central laboratory
- ♦ Construction of fences and outer walls surrounding the central laboratory
- ♦ Procurement of general furniture for the central laboratory (desks and chairs for staff, bookshelf, file cabinet, beds for dormitory, desks and chairs for training rooms)
- ♦ To remove temporarily the existing equipment and material during renovation of the

zonal laboratories in Jhenaidah and Noakhali and replace them as requiring

- ♦ Preparation of utilities such as electricity, water service and gas for the zonal laboratories in Jhenaidah and Noakhali
- ♦ To secure offices for staff in zonal laboratories in Jhenaidah and Noakhali and procure general furniture

3) Organization and institutions

- ♦ Introduction and improvement of regulatory framework for drinking water quality examination
- ♦ To secure the Water Quality Monitoring & Surveillance Circle (WQMSC) in DPHE
- ♦ Establishment of revolving fund system to secure budget for laboratory management and operation before completion of the Project
- ♦ To secure budget for laboratory management and operation until the revolving fund system can provide full cost
- ♦ To secure posts for staff of the central laboratory on a revenue basis and recruitment of staff by September 2005 at latest
- ♦ To secure posts for staff of the zonal laboratories in Jhenaidah and Noakhali on a revenue basis and recruitment of staff by September 2005 at latest
- ♦ To secure posts for staff of the other nine zonal laboratories on a revenue basis and recruitment of staff by Sep. 2005 at latest

(2) Feasibility and validity

The obligations of the Bangladeshi side mentioned in "2) Project" are all basic matters for Japan's Grant Aid to implement the construction. The amount required for the Bangladeshi side to carry out its obligation is 11% of the previous annual budget of DPHE so allocation of the budget is considered feasible. However, as it accounts for a relatively large portion of the annual budget, securing of budget by setting up a revolving fund system for operation of the laboratory is indispensable.

Regarding the obligations of the Bangladeshi side described in "3) Organization and Institutions", a new circle (WQMSC) specializing in water quality monitoring is to be set up in DPHE. It is essential for MLGRD&C, which is the controlling ministry of DPHE, to make every effort, including facilitating approval of the PCP, for final budget arrangements.

The revolving fund is a system to secure budget for operation of the laboratories through collection of water quality analysis fees.

DPHE has introduced revolving fund systems based on similar concepts in two other activities, one for the provision of spare parts for hand pumps and the other for the construction of sanitation facilities. Therefore, introduction of this kind of system is considered to be feasible. It is strongly

recommended that the Bangladeshi side take necessary steps to realize the revolving fund system.

(3) Costs to be borne by the Bangladeshi side

Of the overall project costs, the costs to be borne by the Bangladeshi side are shown in Table 2.6.

Table 2-7 Costs to be borne by the Bangladeshi Side

Item		Cost (Sep.2004-Jun.2005)	Deadline	Cost (Jul.2005-Mar.2006)	Deadline
Costs related to construction of central laboratory	Leveling of ground	360,000	Sep.2004	0	—
	Construction permit	50,000	Dec.2004	0	—
	Installation of electricity	200,000	Feb.2005	200,000	Nov.2005
	Connection of water supply, telephone line, etc.	50,000	Feb.2005	50,000	Aug.2005
	Installation of fence and outer wall	30,000 (temporary)	Feb.2005	140,000 (permanent)	Feb.2006
	Purchase of general furniture	0	—	1,800,000	Dec.2005
Costs related to renovation of zonal laboratories	Relocation of facilities for renovation work	0	—	100,000	Aug.2005
	Connection of electricity, water supply, telephone line, etc.	0	—	300,000	Jul.2005
	Purchase of general furniture	0	—	400,000	Dec.2005
Operation & Maintenance (for 6 months)		0	—	6,044,000	Nov 2005
Customs duty, B/A set up fee		4,125,000	Sep.2004	6,000,000	Jul.2005
Total		4,815,000	—	15,034,000	—

Unit: TK The B/A set up fee is assumed to be 0.05% of the estimated project cost.

2-4 Project Operation Plan

(1) Current Situation and Issues

As mentioned earlier, issues concerning the current water quality examination system in Bangladesh can generally be divided into an institutional/regulatory aspect and an implementation aspect. The institutional/regulatory aspect includes ① lack of regulations/systematic plans for water quality monitoring and surveillance, ② lack of budget for water quality monitoring and surveillance, and ③ lack of an organization responsible for water quality monitoring and surveillance in DPHE. Regarding ① and ②, because water quality analysis of drinking water sources is not mandatory at present, it is impossible to secure a budget. As for ③, the Ground Water Evaluation and Development Circle in DPHE is not responsible for overall management of the zonal laboratories so water quality examination is not systematically implemented and managed (Refer to Figure 2.6).

From an implementation aspect, the most fundamental problem is lack of an organization responsible for water quality monitoring and surveillance. Specific problems include ①shortage of water analysis laboratories and personnel, ②lack of accuracy control and data management, ③ limited number of parameters that can be analyzed, ④difficulty with equipment maintenance and procurement of chemicals/spare parts, and ⑤lack of policies/measures reflecting water quality analysis results. Issues concerning the current water quality examination system are summarized in Figure 2-7.

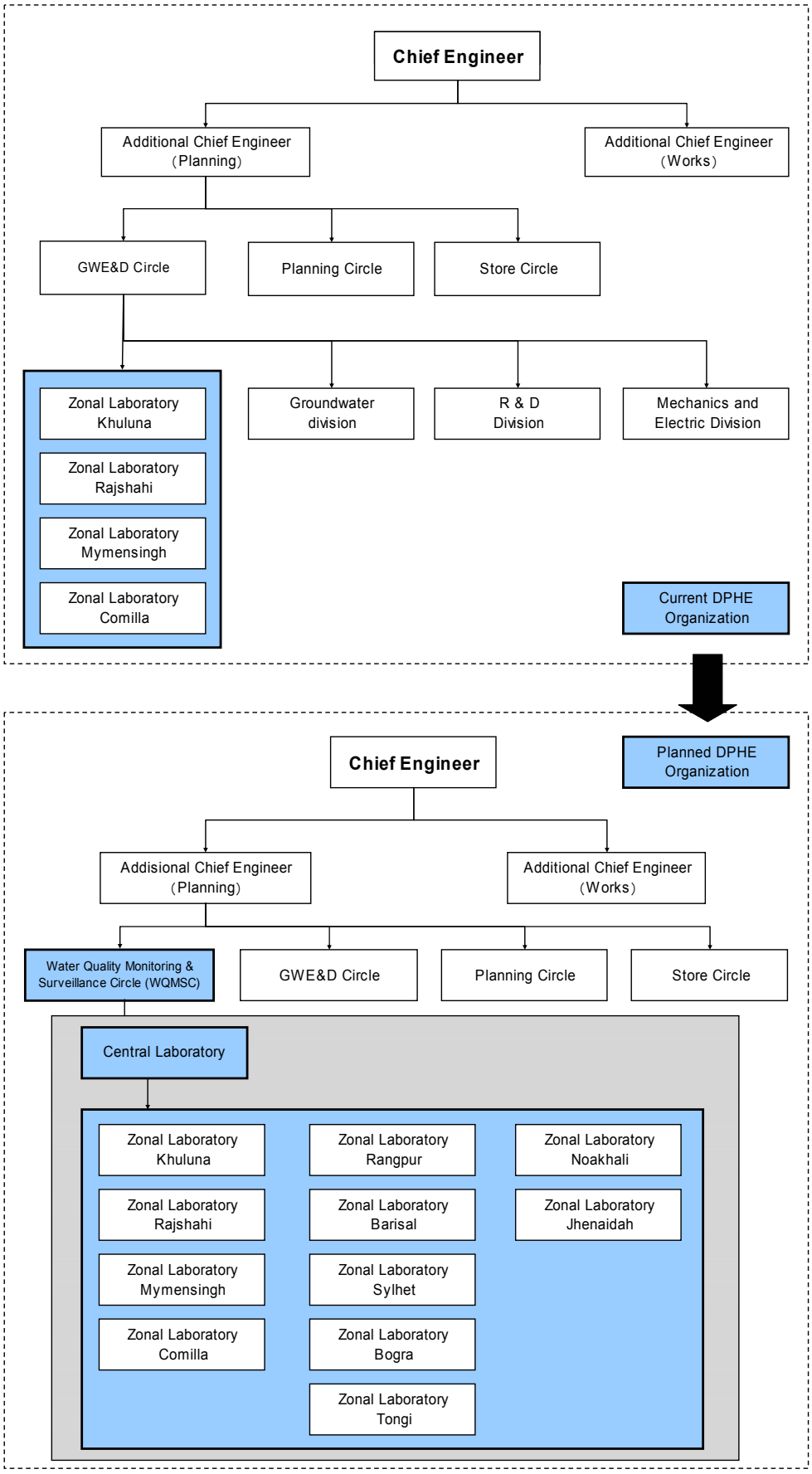
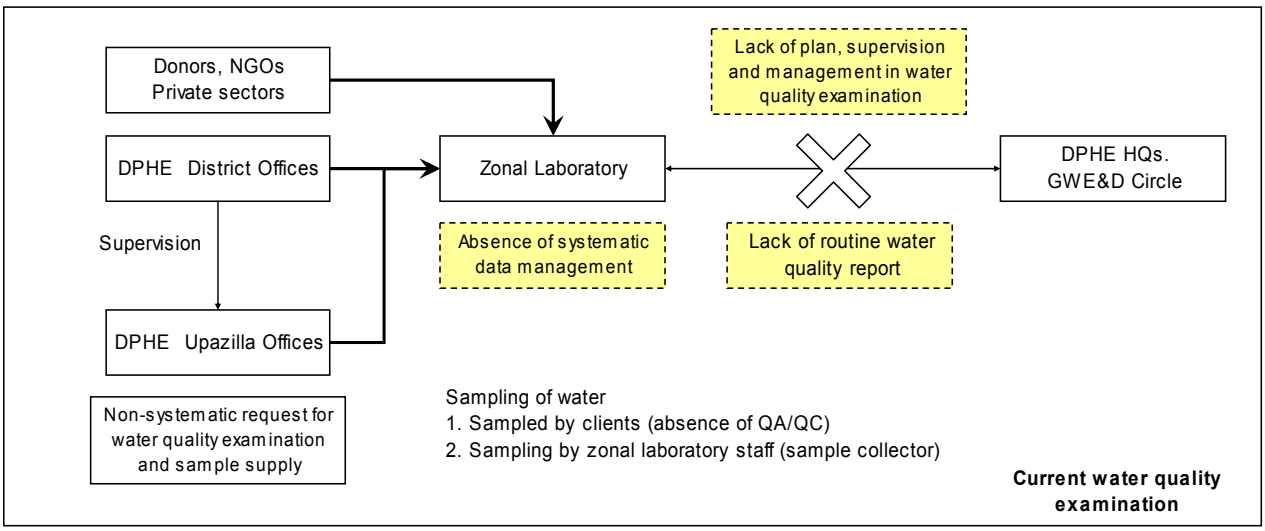
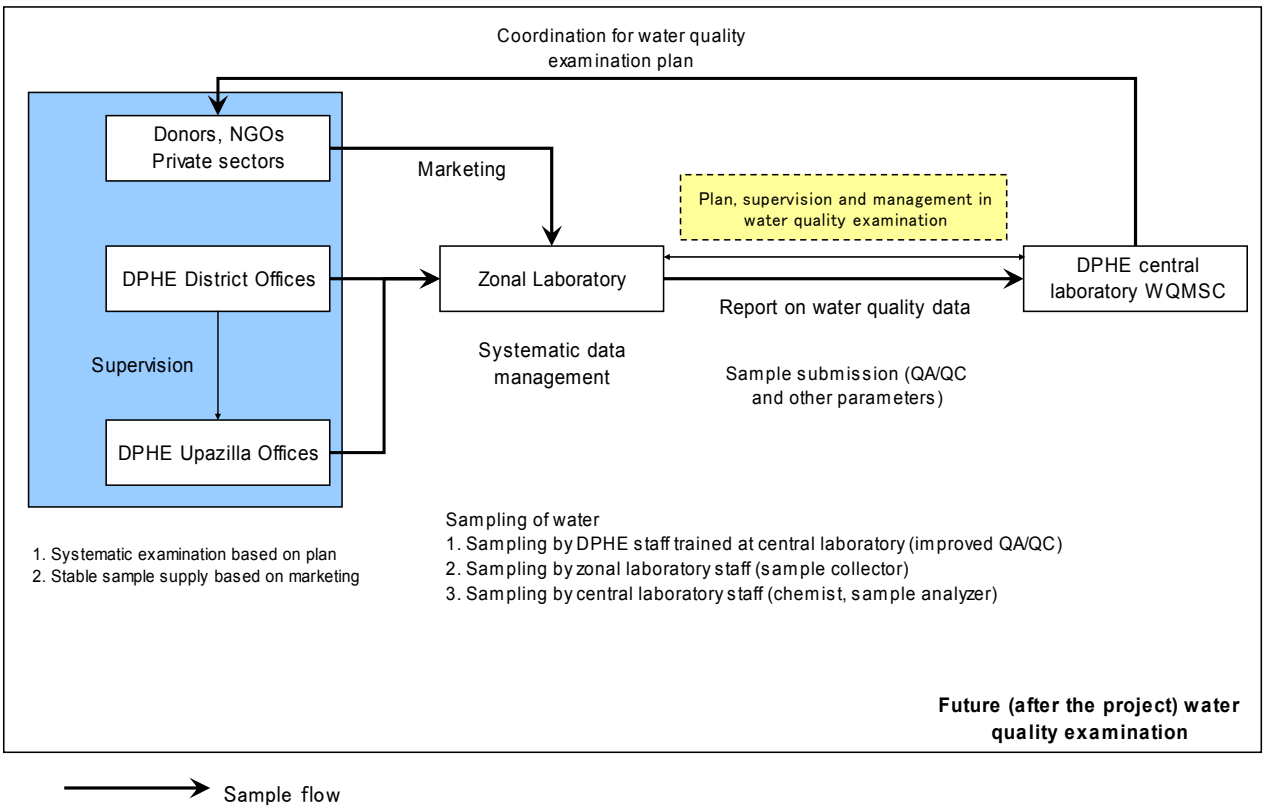

Chief Engineer
Additional Chief Engineer (Planning)
Additional Chief Engineer (Works)
GWE&D Circle
Planning Circle
Store Circle
Zonal Laboratory Khuluna
Zonal Laboratory Rajshahi
Zonal Laboratory Mymensingh
Zonal Laboratory Comilla
Groundwater division
R & D Division
Mechanics and Electric Division
Current DPHE Organization
Chief Engineer
Planned DPHE Organization
Addisional Chief Engineer (Planning)
Additional Chief Engineer (Works)
Water Quality Monitoring & Surveillance Circle (WQMSC)
GWE&D Circle
Planning Circle
Store Circle
Central Laboratory
Zonal Laboratory Khuluna
Zonal Laboratory Rajshahi
Zonal Laboratory Mymensingh
Zonal Laboratory Comilla
Zonal Laboratory Rangpur
Zonal Laboratory Barisal
Zonal Laboratory Sylhet
Zonal Laboratory Bogra
Zonal Laboratory Tongi
Zonal Laboratory Noakhali
Zonal Laboratory Jhenaidah

Figure 2-6 Organizational Chart of DPHE





Sample flow

Figure 2-7 Current and Future Situation of Water Quality Monitoring

In order to strengthen the water quality examination system, the above-mentioned institutional/regulatory issues and implementation issues must be resolved concurrently. The Grant Aid project will contribute to improving implementation management through construction of the central laboratory and procurement of equipment/materials and upgrading of zonal laboratories, in

coordination with the BAMWSP project (i.e. upgrading and expansion of zonal laboratories).

(2) Management system of Laboratories

One of the main problems with the water quality examination system is lack of an organization responsible for water quality analysis in DPHE. It is, therefore, necessary to set up a new circle, the Water Quality Monitoring & Surveillance Circle (WQMSC) with the central laboratory to be constructed as the core. The position of WQMSC in DPHE is shown in Figure 2-6. The new circle will manage the 11 zonal laboratories and be in charge of introducing/establishing water quality regulations and programs and coordinating various activities within and between DPHE and external organizations. In view of its roles and functions, the central laboratory will serve as a center for water quality analysys and provide services and technical support to the 11 zonal laboratories.

The central laboratory will consist of four divisions: Data Management Division, Logistic Division, Equipment Management Division and Analytical Division. The respective roles of each division are shown as follows. The organizational chart of the central laboratory is shown in Figure 2-8.

Division	Roles
Director (Equivalent to Superintending Engineer	– Overall management of DPHE laboratories – Coordination within and between DPHE and external organizations – Plan to obtain ISO-17025 certification – Liaison, awareness raising activities
1.Data Management Division	– Management of LIMS (Laboratory Information Management System) – Acquisition and recording of water quality data – Management and analysis of water quality data – Publication of reports, maps, etc
2.Logistic Division	– Assistance to Director in terms of management and financial affairs – Coordination for human resources development – Procurement, storage and distribution of chemicals, etc.
3.Equipment Management Division	– Maintenance and repair work for equipment and spare parts of all DPHE laboratories – Assistance to Director and Chief Chemist in the procurement of equipment and spare parts
4.Analytical Division	– Water quality monitoring and surveillance – Chemical analysis of water samples – Bacteriological analysis of water samples – Quality control of analysis results of all DPHE laboratories – Capacity building of laboratory staff through OJT – Implementation and support of research and studies

The zonal laboratories are mainly responsible for water quality analysis, and consist of the following personnel:

- 1 Senior Chemist
- 1 Junior Chemist

- 2 Sample analyzers
- 1 Computer operator
- 2 Sample collectors
- 1 Driver
- 1 Cleaner / MLSS

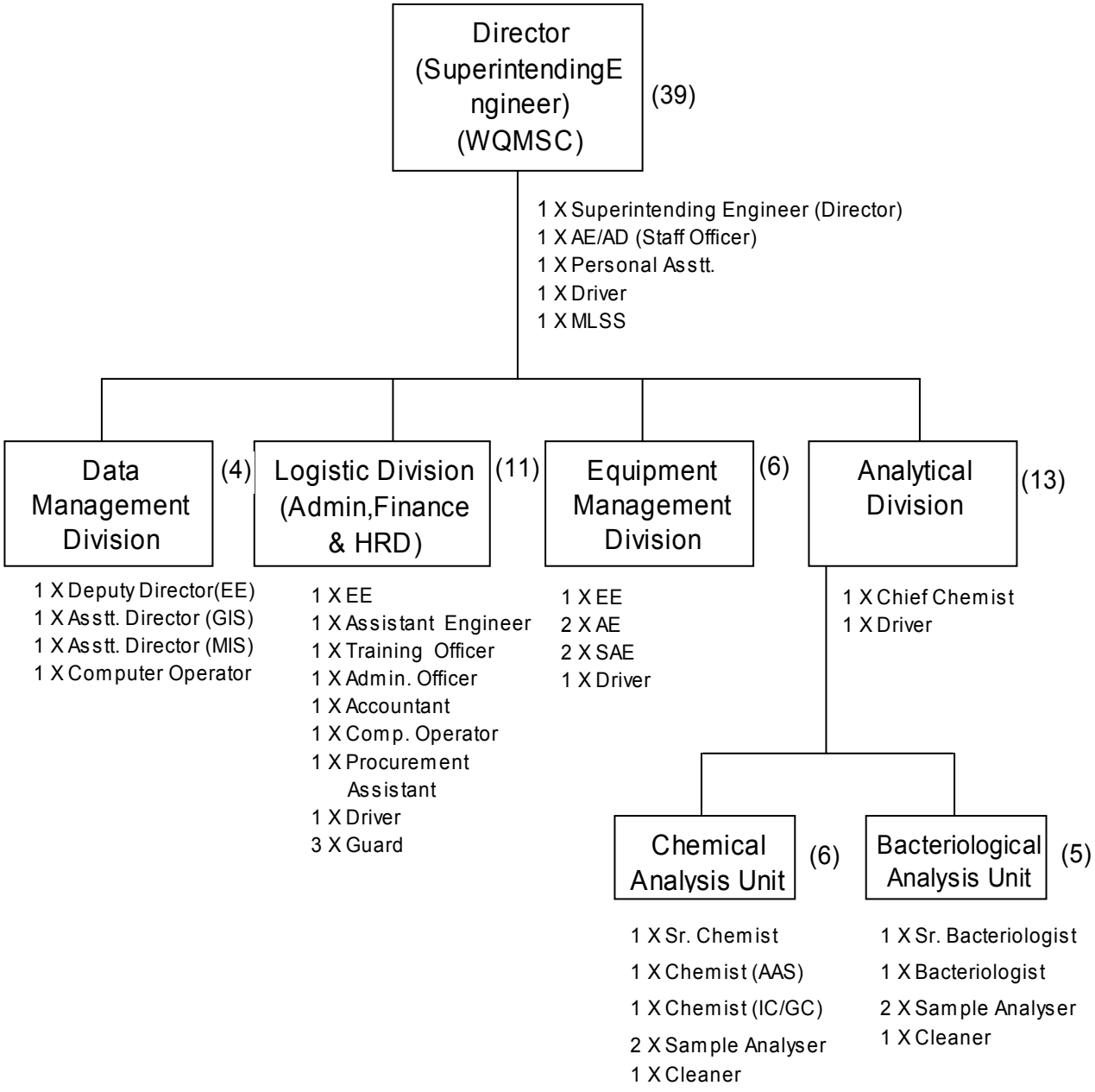


Figure 2-8 Organizational Chart of the Central Laboratory

(3) Introduction and establishment of water quality examination program

At present, DPHE zonal laboratories do not have an annual program for water quality examination. They simply analyze samples taken to the laboratories on a day-to-day basis. The newly set up central laboratory needs to develop short-term and mid- and-long term programs and take necessary budgetary measures and realize the aforementioned revolving fund system. The main targets of water quality examination are expected to be as follows:

- Wells, mainly deep wells to be installed by DPHE — Approx. 15,000 samples per year
- Piped water supply systems, mainly in urban areas — Approx. 6,000 samples per year

DPHE is planning to introduce regulatory framework for water quality examination and is considering necessary budgetary steps. DPHE is also examining measures such as to stipulate water quality analysis of new water sources in agreements with well drilling contractors and to not make payment of the contract amount without the analysis results.

Nationwide water quality monitoring without the collection of analysis fees is expected to target the following water supply sources:

- Wells selected from the 4500 Unions (administrative villages) in the country — Approx.9,000 samples per year

If water quality examination is conducted in accordance with this program, the laboratories will analyze about 20,000 samples at a fee of about 4,000TK/sample (calculated based on current fees proposed by DPHE). The annual amount of fees collected would be about 80 million TK in total. Judging from the annual operational cost of the laboratories mentioned later, this revenue should be sufficient to cover the cost of operation of the laboratories.

(4) Prospect for setting up a revolving fund system for laboratory operation

As mentioned earlier, DPHE is examining the revolving fund system to secure budget for operation of the laboratories. In order to realize the system, it is necessary to ensure a steady flow of samples and revenue to cover the cost of water quality analysis by establishing and strengthening the implementation system for water quality examination. DPHE is examining an appropriate analysis fee according to the cost of water quality analysis, while considering market competitiveness. The competitive advantage of DPHE's rate over external laboratories such as BUET (Bangladesh University of Engineering & Technology), BCSIR (Bangladesh Council for Scientific & Industrial Research), and AEC (Atomic Energy Center) is being confirmed.

Water quality examination must be systematically implemented based on this analysis fee.

(5) Operation and Mantenance Plan

1) Personnel Allocation Plan

It is necessary to allocate appropriately qualified staff to the central and zonal laboratories. It is also important to create permanent posts on a revenue basis, not temporary ones on a project basis. As DPHE has 7,590 staff in total, the plan to allocate 39 staff (about 0.5% of the total staff) for the central laboratory is not unrealistic. However, in order to secure posts and budget for the new central laboratory, DPHE needs to appeal to the concerned organizations at an early time. DPHE must recognize that success of the project depends on securing the posts and budget in time.

Once the posts and budget are secured, recruitment of staff is not expected to be a major concern because there is an abundance of people with advanced degrees (university level and higher) in chemistry and biology. As for the recruitment method, Class 1 staff will be recruited through Bangladesh's Public Service Commission, and the lower level staff will be recruited based on final approval by the Chief Engineer of DPHE. In either case, posts will be advertised through newspapers, etc., which normally receive several hundred applicants per post advertised.

2) Human Resources Development Plan

As DPHE does not have its own staff training program for water quality analysis, technical cooperation will be needed to develop the capacity of its staff in the future. In particular, the central laboratory will function not only as a water quality analysis center, but also as a service provider involving the zonal laboratories and local residents. Therefore, the human resources development plan must take into consideration the securing and training of personnel in view of these roles and functions. Regarding DPHE's overall personnel training program, a plan is being formulated by its Training Division. The development of training programs for the central laboratory needs to be examined referring to this plan.

3) Staff Requirements

It is necessary to recruit staff for the central laboratory according to DPHE's recruitment criteria. The staff requirements presented by the Bangladeshi side are as in Table 2-8. However, to ensure the central laboratory staff carry out their roles efficiently, the staff requirements and experience proposed in Table 2-9 should be considered.

Table 2-8 Required qualifications and experience

	Position	Requirements
1	Superintending Engineer (Director) of Central Laboratory	-Senior level PHE officer as per DPHE rule.
2	Deputy Director, Logistic Division	-Middle level PHE officer as per DPHE rule.
3	Deputy Director, Data Management Division	B.Sc. Eng. in Computer and IT. M.Sc. preferred. 10 years experience.
4	Deputy Director, Equipment Management Division	B.Sc. Eng. in Electric / Electronics. M.Sc. preferred. 10 years experience.
5	Chief Chemist, Analytical Division	Senior chemist in DPHE zonal laboratory. For direct recruitment, M.Sc. in Chemistry 10 years experience.
6	AE/AD (Staff Officer)	B.Sc. Eng. Civil or Chemical
7	Assistant Director（MIS）, Data Management Division	B.Sc. Eng. in Electrical or Computer or M.Sc. in Applied Physics in Electronics 5 years experience. Of which 2 years in MIS.
8	Assistant Director（GIS）, Data Management Division	B.Sc. Eng. in Electrical or Computer or M.Sc. in Geography 5 years experience. Of which 2 years in GIS.
9	Assistant Engineer, Logistic Division	B.Sc. Eng. in Civil or Chemical
10	Training Officer, Logistic, Division	Bachelor in Engineering or Master in Social Science Experience in training is added advantage.
11	Administrative Officer, Logistic Division	Administrative and accounting experience within DPHE and as per DPHE rule.
12	Assistant Engineer (1), Equipment Management Division	B.Sc. Eng. in Mechanical
13	Assistant Engineer (２), Equipment Management Division	B.Sc. Eng. in Electric / Electronics
14	Sr. Chemist, Analytical Division	M.Sc. in Chemistry 5 years experience
15	Chemist（AAS）, Analytical Division	M.Sc. in Chemistry 2 years experience
16	Chemist（IC/GC）, Analytical Division	M.Sc. in Chemistry 2 years experience
17	Sr. Bacteriologist, Analytical Division	M.Sc in Microbiology 5 years experience
18	Bacteriologist, Analytical Division	M. Sc in Microbiology 2 years experience

(6) Operation and Maintenance Costs

The necessary cost for operation and maintenance of the central laboratory is summarized in the table below. A total budget of approximately 8,000 thousand TK is required (Refer to Table 2-9)

Table 2-9 Annual Operation and Maintenance Cost of the Central Laboratory

Item	Annual cost(TK)	Explanation
Equipment maintenance/ Repair (including consumable and spare parts)	1,500,000	4% of cost of main equipment
Fuel (for vehicle)	700,000	50l fuel/refill x100 refill/year x4vehicle x35TK/l＝700,000TK
Chemicals	2,780,000	Based on number of parameters and equipment
Utilities		
Electricity	1,450,000	Base 10KVx24hrsx365days x6.82TK/KVH=597,000TK Additional oepration 50KV x10hrsx250daysx6.82TK/KVH=853,000TK
Water	142,000	30m3/day x300daysx15.75TK/m3 ＝ 142,000TK
Gas	19,000	400TK/install line x 4 lines x12months＝19,000TK
Telephone	360,000	5000TK/lines/month x6lines x12months＝360,000TK
Buidling maintenance/ repair (including fuel for generator)	750,000	Approx. 0.75% of construction cost
Vehicle maintenance /repairs	192,000	4000TK/vehicle/month x4vehicles x12months ＝192,000TK
Software support fee	150,000	Annual support fee of ArcView
Total	8,043,000	

The annual operation and maintenance cost for the zonal laboratories, estimated based on a past JICA development study, is approximately 2,000 thousand TK respectively for Jhenaidah laboratory and Noakhali laboratory.

The annual personnel costs, which were examined based on the expected personnel organization of DPHE, are shown in Table 2-9 and Table 2-10.

Table 2-10 Annual Personnel Costs of the Central Laboratory

Position/Status	No. of Persons	Breakdown					Annual Cost/ Person (TK)	Total (TK)
		Director's Room	Data Mgnt. Div.	Logistic Div.	Equip. Mgnt. Div.	Analytical Div.		
Director	1	1					300,000	300,000
Exective Engineer	4		1	1	1	1	210,000	840,000
Senior Chemist/AE	8	1	2	1	2	2	150,000	1,200,000
Junior Chemsit/SAE	7			2	2	3	136,000	952,000
Sample analyzer/Comp operator	6		1	1		4	104,000	624,000
Accountant	1			1			100,000	100,000
Assistant	2	1		1			95,000	190,000
Driver	4	1		1	1	1	95,000	380,000
MLSS	1	1					60,000	60,000
Guard	3			3			60,000	180,000
Cleaner	2					2	60,000	120,000
Total	39	5	4	11	6	13		**4,946,000**

＊ Positions/Status corresponds to the organizational chart of the central laboratory in Figure 2-8.

Position/Status	Director's Room	Data Management Division	Logistic Division	Equipment Management Division	Analytical Division
Executive Engineer		1.Deputy Director	1.EE	1.EE	1.Chief Chemist
Senior Chemist/AE	1.AE/AD (staff Officer)	1.Asstt.Director (GIS) 2.Asstt.Director (MIS)	1.Assistant Engineer	AE 2 staff	1.Sr.Chemist 2.Sr. Bacteriologist
Junior Chemist/SAE			1.Training Officer 2.Admin,Officer	SAE 2 staff	1.Chemist (AAS) 2.Chemist (IC/GC) 3.Bacteriologist
Sample analyzer /Computer operator.		1.Computer operator	1.Computer operator		Sample analyzer 4 staff

Table 2-11 Annual Personnel Costs for each Zonal Laboratory

Position/Status	No. of Persons	Annual Cost/ Person(TK)	Total (TK)
Senior Chemist	1	150,000	150,000
Junior Chemsit	1	136,000	136,000
Sample analyzer/Comp operator	3	104,000	312,000
Sample collector	2	100,000	200,000
Driver	1	95,000	95,000
Cleaner/MLSS	1	60,000	60,000
Total	9		953,000

From the above tables, the annual operation and maintenance cost is estimated in Table 2-12. As the overall project plan is to strengthen the water quality examination system nationwide, the cost includes all 11 zonal laboratories.

Table 2-12 Annual Operation and Maintenance Cost

Unit: TK

Item		Cost
Personnel Costs	Central Laboratory	5,000,000
	Zonal Laboratory	11,000,000
Administrative Costs	Central Laboratory	8,000,000
	Zonal Laboratory	22,000,000
Total		46,000,000

The annual budget of DPHE for the past five years is shown in Table 2-13. The five-year average is 415,393,400 TK/year. The expected annual operation and maintenance cost mentioned above is approximately 11% of the annual budget. Provided that budget measures are similar to past years, allocation of funds should be feasible. However, as the annual operation and maintenance cost

accounts for a large percentage of the budget, efforts by the Government of Bangladeshi to set up the revolving fund for operation of the laboratories is essential.

Table 2-13 DPHE Annual Budget over Five Year Period

	Fiscal Year	LGD (lakh=100 thousand Tk)	DPHE (lakh=100 thousand Tk)
1	1999-2000	29,230.28	3,843.10
2	2000-2001	31,435.20	3,981.73
3	2001-2002	34,791.81	4,198.56
4	2002-2003	37,675.36	4,324.47
5	2003-2004	44,868.17	4,421.81
	5 year average	35,600.16	4,153.93

2-5 Technical Support Plan

(1) Background of technical support plan

To implement the project, DPHE assured to set up WQMSC (Water Quality Monitoring & Surveillance Circle) as the responsible body for water quality examination, and allocation of manpower and operational budget for the central laboratory as well as for zonal laboratories. On the other hand, it is estimated that the capability and experience of the new organization and staff will not be adequate at the start up time. Therefore, it is important to provide technical support to the staff for basic skills and know-how of laboratory operation during the initial phase, to assure the effective utilization of equipment and sustainable water quality examination by DPHE thereafter.

At present, water quality examination of drinking water in Bangladesh is under the jurisdiction of the Ground Water Evaluation and Development Circle and is being implemented by four zonal laboratories. However, as stated in Section 2-2-1 (1), the following problems and issues exist concerning water quality examination in Bangladesh.

Institutional and regulatory problems

- Absence of examination system and systematic budget allocation
- Unclear responsibility of examination body

Implementation problems

- Lack of examination laboratory, instrument and staff
- Absence of data management and QA/QC
- Lack of equipment for examination in some parameters
- Difficulties in instrument maintenance and in procurement of spare parts and chemical.
- Absence of policy/measures reflecting water quality analysis results

In order to solve the above problems and issues, the Central Laboratory is to be constructed under the project. In addition to water quality examination, the Central Laboratory is expected to carry out the following roles and functions.

① Coordinate and manage all zonal laboratories

② Train and develop human resources in the zonal laboratories

③ Manage the zonal laboratories in terms of quality control

④ Provide technical support for equipment maintenance

⑤ Analyze water samples that cannot be covered by the zonal laboratories

⑥ Manage water quality data at the national level

⑦ Conduct research to support the development of water quality policies and measures

It is quite difficult for DPHE to absorb all the technology and know-how required to perform all the functions listed above to become self-sustainable within a short period. Since the technical support under the Grant Aid Project is limited in duration, a technical cooperation project is under consideration, and formulation of such a project is currently underway. Therefore, a clear demarcation between technical support by Grant Aid and technical cooperation is required.

Figure 2.9 shows the demarcation among technical support under the Grant Aid, technical cooperation project and long-term expert at DPHE, with regard to the above-mentioned functions of the central laboratory. Of the seven functions, the long-term expert at DPHE and the technical cooperation project will assist in management and coordination of all laboratories. Technical support under the Grant Aid will cover a part of the management and coordination function, instrument maintenance, water quality examination for parameters to supplement zonal laboratories, and water quality data management. The technical cooperation project will support all areas. The components of the technical cooperation project are still under consideration and may be changed depending on the consultation hereafter.

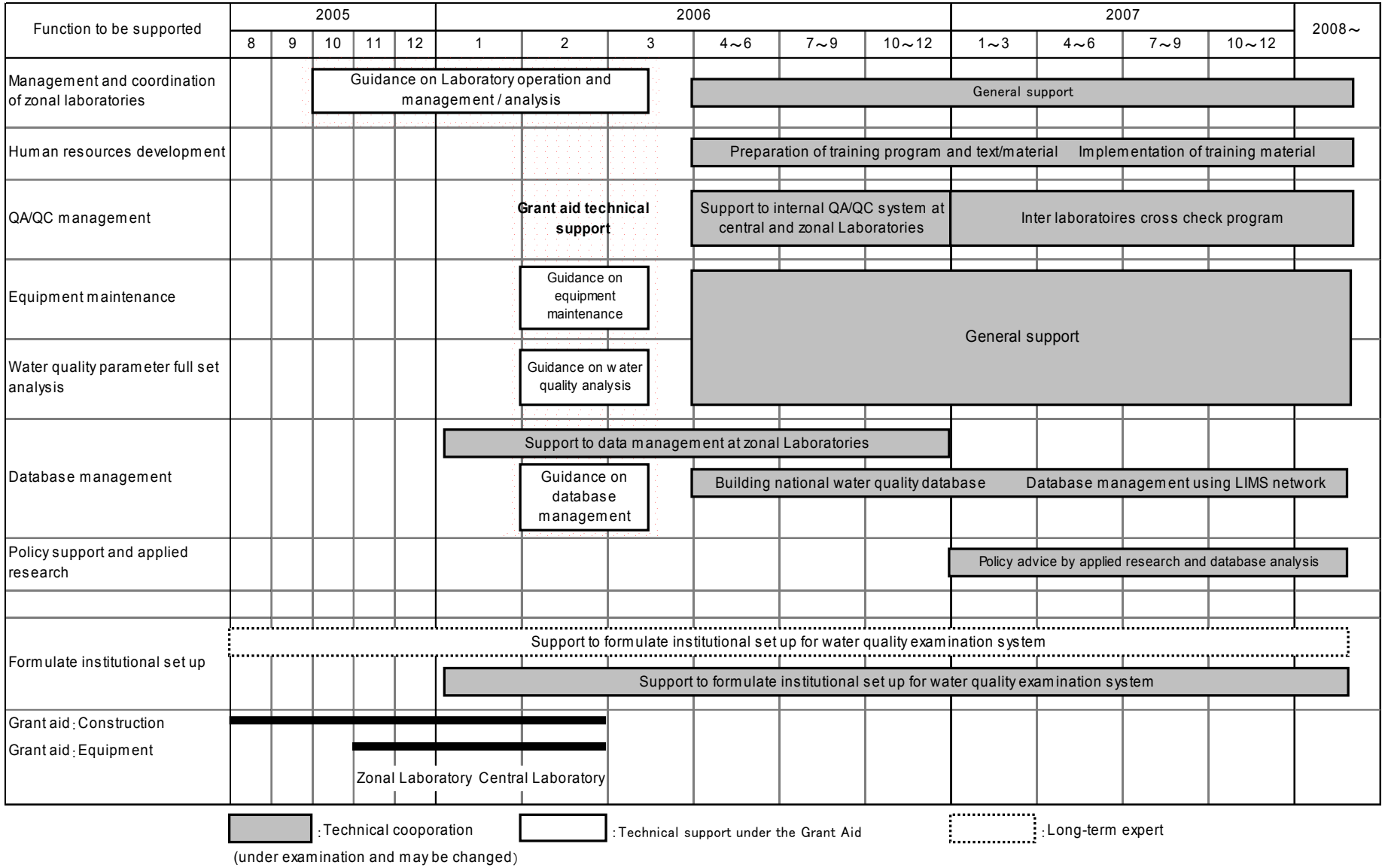


Figure 2-9 Demarcation and Tentative schedule proposal for technical support to strengthening of water quality examination system in Bangladesh

(2) Objective and output of technical support

The objective of the overall project plan, which includes the Grant Aid, is to "strengthen the water quality examination system". Technical support under the Grant Aid is for fundamental technical guidance necessary for laboratories in the initial startup stage. It has the following objectives, outputs and indicators. During implementation of the Grant Aid, short-term outputs of the technical support will be checked. Mid to long-term outputs for the water quality examination system will be set and confirmed under the framework of the technical cooperation project.

Objectives	Outputs
Sustainable water quality examination using procured equipment at the central and zonal laboratories in Jhenaidah and Noakhali. (Effective utilization of facility and equipment)	(At central and zonal laboratories in Jhenaidah and Noakhali) ● Capability for fundamental management of laboratories. ● Capability of water quality examination using analytical instruments. ● Capability of fundamental maintenance of analytical instruments. ● Capability to design and build water quality database using the facility provided.

Indicators of output
● Guideline prepared for fundamental management of central and zonal laboratories. ● Manual prepared for instrument analysis. ● Manual prepared for fundamental maintenance of analytical instrument. ● Guideline prepared for management of water quality database. ● Fundamental knowledge and skill for water quality examination obtained by DPHE staff using prepared guideline and manual (to be confirmed by check-list)

(3) Activities of technical support (Input plan)

The following fields are planned for the technical support in order to obtain the output.

Laboratory operation and management/ analysis guidance

Instrument analysis and maintenance guidance 1

Instrument analysis and maintenance guidance 2

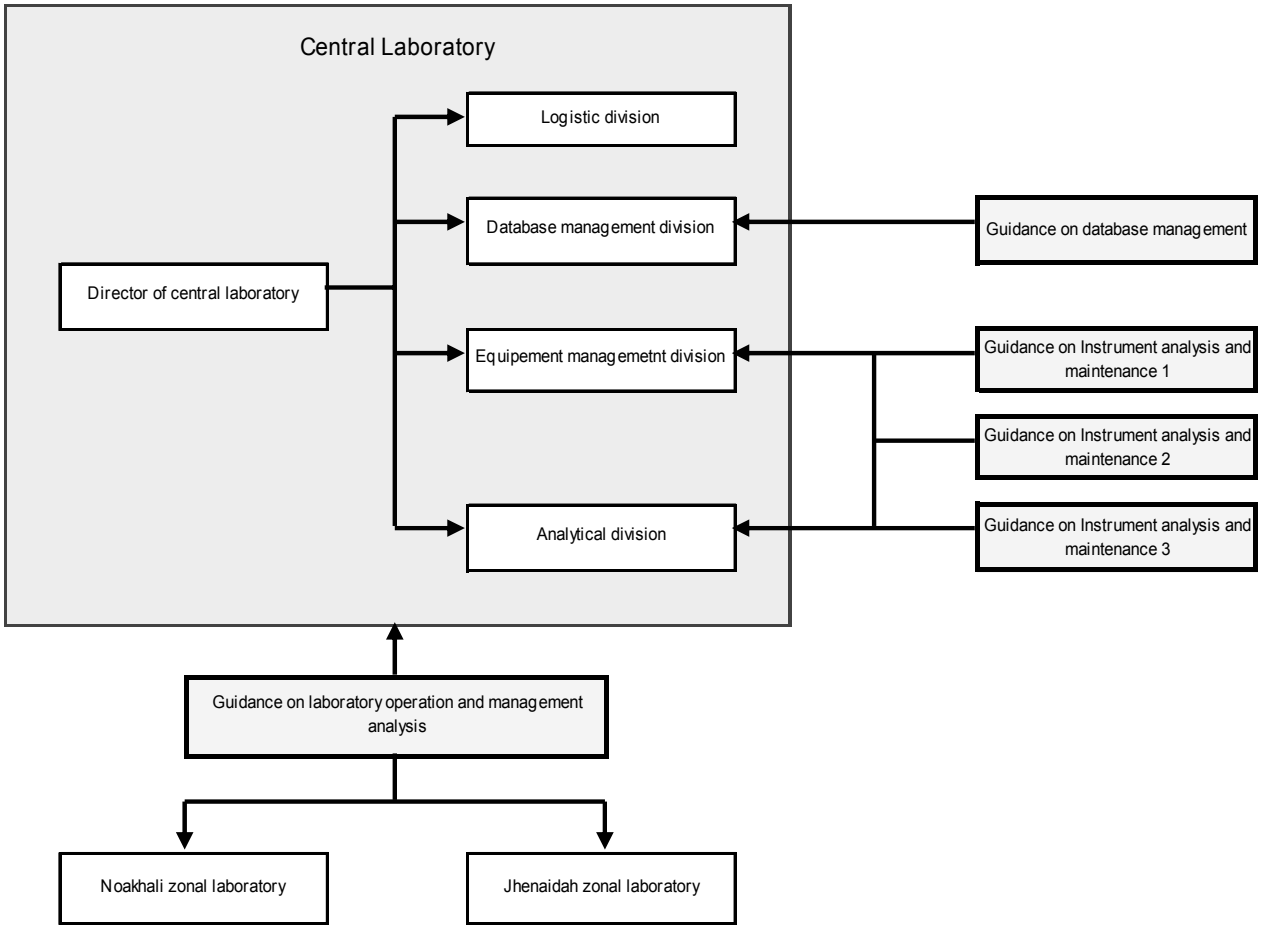
Instrument analysis and maintenance guidance 3

Database management guidance

Guidance for laboratory operation and management/analysis will be conducted at two zonal

laboratories (Jhenaidah and Noakhali), and guidance for laboratory operation and management/analysis, instrument analysis and maintenance and database management will be conducted at the central laboratory.

The following figure shows the relationship between the input of technical support and the divisions in the Central Laboratory.



A. Laboratory Operation and Management/ Analysis Guidance

① Objective

Activity of laboratories is not limited to water quality examination itself. For example, activities at the zonal laboratories shall include planning of water quality examination, management of chemicals, maintenance of analytical instruments, management of sampling, transportation, acceptance and storage of water samples, QA/QC, data management and marketing for contracted water examination. Laboratories cannot stand firm with only technical staff. At the central laboratory, coordination and management of zonal laboratories, planning of national level water examination, coordination with other agencies and securing budget are important task. Institutionalization of water quality examination will be studied and planned during detailed design stage in consultation with

DPHE. The objective of assistance in this field is to assure a smooth shift of laboratories operation to the technical cooperation project by providing guidance in fundamental laboratory management at the initial stage at the central and the zonal laboratories. Technical guidance for analytical aspect to the zonal laboratories will be also covered.

② Major subject of guidance and counterparts

Major subject of guidance and counterparts are summarized in the following table.

Major subject of guidance	Counterpart
● Planning of institutional setup of water quality examination and support to organize workshops	● Planning staff of DPHE
● Operation and management of zonal laboratories	● Staff at zonal laboratories（mainly for Senior Chemist, Junior Chemist, Sample Analyzer）
● Analytical technology and instrument maintenance of zonal laboratories	● All staff at zonal laboratories
● Operation and management of central laboratory	● Director of Central Laboratory, Deputy Director of Logistic Division, Analytical Division, Equipment Management Division and Data Management Division

③ Schedule and duration

Activities in this field consist of planning the institutional setup of water quality examination and support to organize workshops in October 2004, guidance to zonal laboratories at the end of 2005, and guidance to the central from January 2006.

At the zonal laboratories, guidance on overall operation and management will be provided immediately after the completion of renovation work and installation/commissioning of the equipment, followed by training on analytical technology. In order to confirm the effect of technical support, practical hands-on examination will be done before departure of the consultant with checklist. The duration for individual tasks was set based on experience from the previous JICA development study in Bangladesh.

Schedule (Guidance to the zonal laboratories)	Duration
● Guidance on management of laboratory. and joint preparation of guideline at Noakhali	8.0 days
● Guidance on analysis and maintenance of Atomic Adsorption Spectrophotometer at Noakhali	7.0 days
● Guidance on analysis and maintenance of Spectrophotometer at Noakhali	7.0 days
● Guidance on management of laboratory. and joint preparation of guideline at Jhenaidah	8.0 days
● Guidance on analysis and maintenance of Atomic Adsorption Spectrophotometer at Jhenaidah	7.0 days
● Guidance on analysis and maintenance of Spectrophotometer at Jhenaidah	7.0 days
Total days	44.0 days
44.0 days（total required days）÷30.0 days/month（working days/month）＝1.5 months （required M/M）	

At the central laboratory, the consultant will provide guidance on overall operation and management to the director of the laboratory and other management staff immediately before the completion of facility. In addition, guidance on environmental aspects (liquid waste treatment, exhaust gas treatment), safety aspects (chemical management) and laboratory infrastructure (electricity backup, pure water system, and cold storage room) will be provided.

As for planning of institutional setup of water quality examination, a draft plan will be prepared after a series of consultations with DPHE. As the plan has strong relevance to the technical cooperation project under consideration, adequate consultation with the JICA long-term expert and JICA Bangladesh office is required. After preparation of the draft plan, workshops will be organized by DPHE.

The following is the workshop plan.

a. Initial meeting:

Participants: Relevant officers of DPHE, BAMWSP and LGD.

Content: Criteria for water quality examination, working plan of DPHE, internal coordination, etc.

b. Workshop for research/analysis organizations related to water quality:

Planned participants: DOE (Department of Environment:), BCSIR (Bangladesh Council for Scientific & Industrial Research), ICDDR,B (International Center for Diarrhoeal Disease Research, Bangladesh), AEC, BUET (Bangladesh University of Engineering and Technology)

Content: Announcement of Plan of DPHE water quality examination system and exchange of opinions

c. Workshop for Donors and NGOs:

Planned participants: WHO,WB, UNICEF, DANIDA, CIDA, APSU, AAN, NGO Fotrum, etc.

Contents: Announcement of Plan of DPHE water quality examination system and exchange of opinions

d. 2nd meeting:

Participants: Relevant officers of DPHE, BAMWSP and LGD.

Content: Further discussion and clarification on criteria for water quality examination, working plan of DPHE, internal coordination, upon reflecting the output from the workshops. Plan for announcement/awareness/training for DPHE district and upazilla offices.

Schedule (Guidance to the central laboratories)	Duration
● Planning for institutional setup of water quality examination and support workshops	15.0 days
● Overall operation and management of central laboratory. and joint preparation of guideline	15.0 days
● Guidance on management and coordination of zonal laboratory.	10.0 days
● Guidance on environmental aspect	8.0 days
● Guidance on safety aspect	8.0 days
● Guidance on laboratory infrastructure	10.0 days
Total days	66.0 days
66.0 days（total required days）÷30.0days/month（working days/month）＝2.2 months （required M/M）	

④ Output and monitoring method

Output and monitoring method of this field is as follows.

Output	Indicators	Method to confirm
• Capability to formulate a plan for institutional setup of water quality examination by DPHE	• Draft plan for water quality examination system	• Presence/absence of draft plan
• Organization of workshops	• Record of workshops	• Minutes of workshops
• Capability for basic operation and management of the zonal laboratories.	• Prepared guidelines for operation and management	• Presence/absence of guidelines
• Capability to analyze water sample using the equipment at the zonal laboratories.	• Prepared manuals for analysis and maintenance	• Presence/absence of manuals
• Capability for basic operation and management of the central laboratories.	• Prepared guidelines for operation and management	• Presence/absence of guidelines
	• Upgraded knowledge and skill of staff at the zonal and the central laboratory.	• Result of practical examination using checklist

B. Instrument Analysis and Maintenance Guidance 1

① Objective

It is not possible for one consultant to provide technical support for all the equipment/instruments in a short period, as numerous analytical instruments will be procured for the central laboratory. Therefore, consultants specializing in the major analytical instruments at the central laboratory will be assigned to ensure efficient technology transfer. The consultant in this field is in charge of instrumental analysis and maintenance of Atomic Absorption Spectrophotometers. Manuals (English

and Bengali) for analysis and maintenance will be jointly prepared with DPHE staff.

② Major subject of guidance and counterparts

The major subject of guidance and counterparts are summarized in the following table.

Major subject of guidance	Counterpart
● Joint preparation of analytical manual using Atomic Absorption Spectrophotometers (AAS) as specified below. ➢ Flame AAS ➢ NO_2 Flame AAS ➢ Hydride Vapor Generation AAS ➢ Hg analytical unit ● Joint preparation of maintenance manual of the above. ● Practical training of analysis and maintenance of the above	Staff of analytical division of the central laboratory

③ Schedule and duration

The consultant will provide guidance on analysis and maintenance to the staff of the Analytical Division of the central laboratory, immediately after the completion of facility and installation/commissioning of the equipment. In order to confirm the effect of technical support, practical hands-on examination will be done before departure of the consultant by checklist. The duration for individual tasks was set based on experience from the previous JICA development study in Bangladesh.

Schedule (Guidance to the central laboratories)	Duration
● Guidance on Flame AAS analysis and maintenance	13.0 days
● Guidance on NO_2 Flame AAS analysis and maintenance	5.0 days
● Guidance on Hydride Vapor Generation AAS analysis and maintenance	7.0 days
● Guidance on Hg analytical unit	5.0 days
Total days	30.0 days
30.0 days（total required days）÷30.0 days/month（working days/month）＝1.0 month（required M/M）	

④ Output and monitoring method

The output and monitoring method of this field is as follows.

Output	Indicators	Method to confirm
• Capability of staff of the central laboratory to examine water quality using Atomic Absorption Spectrophotometer • Capability of staff of the central laboratory to provide fundamental maintenance to Atomic Absorption Spectrophotometer	• Prepared manuals for analysis • Prepared manuals for maintenance • Upgraded knowledge and skill of staff at the central laboratory	• Presence/absence of analytical manuals • Presence/absence of maintenance manuals • Result of practical examination using checklist

C Instrument Analysis and Maintenance Guidance 2

① Objective

The basic objective is the same as that of Instrument Analysis and Maintenance Guidance 1. The consultant in this field is in charge of the instrumental analysis and maintenance of gas chromatograph and ion chromatograph. Manuals (English and Bengali) for analysis and maintenance will be jointly prepared with DPHE staff.

② Major subject of guidance and counterparts

The major subject of guidance and counterparts are summarized in the following table.

Major subject of guidance	Counterpart
● Joint preparation of analytical manuals using gas chromatograph and ion chromatograph as specified below. ➢ Purge & Trap / Gas chromatograph analysis ➢ Solvent extraction / Gas chromatographic analysis ➢ Ion chromatograph analysis of anion species ➢ Ion chromatograph analysis of Cr(VI) ● Joint preparation of maintenance manuals ● Practical training in analysis and maintenance	Staff of analytical division of the central laboratory

③ Schedule and duration

A consultant will provide guidance on analysis and maintenance to the staff of analytical division of the central laboratory, immediately after the completion of facility and installation/commissioning of the equipment. In order to confirm the effect of technical support, practical hands-on examination will be done before departure of the consultant by checklist. The duration for individual tasks was set based on experience from the previous JICA development study in Bangladesh.

Schedule (Guidance to the central laboratories)	Duration
● Guidance on Purge & Trap / Gas chromatograph analysis and maintenance	10.0 days
● Guidance on Solvent extraction / Gas chromatographic analysis and maintenance	5.0 days
● Guidance on Ion chromatograph analysis of anion species and maintenance	10.0 days
● Guidance on Ion chromatograph analysis of Cr(VI) and maintenance	5.0 days
Total days	30.0 days
30.0 days（total required days）÷30.0days/month（working days/month）＝1.0month（required M/M）	

④ Output and monitoring method

Output and monitoring method of this field is as follows.

Output	Indicators	Method to confirm
• Capability of staff of the central laboratory to examine water quality using gas chromatograph and ion chromatograph • Capability of staff of the central laboratory to provide fundamental maintenance to gas chromatograph and ion chromatograph	• Prepared manuals for analysis • Prepared manuals for maintenance • Upgraded knowledge and skill of staff at the central laboratory	• Presence/absence of analytical manuals • Presence/absence of maintenance manuals • Result of practical examination using checklist

D. Instrument analysis and maintenance guidance 3

① Objective

The basic objective is the same as that of Instrument Analysis and Maintenance Guidance 1. A consultant in this field is in charge of instrumental analysis and maintenance of spectrophotometer, oil detector, flow injection analyzer, and TOC meter. Manuals (English and Bengali) for analysis and maintenance will be jointly prepared with DPHE staff.

② Major subject of guidance and counterparts

Major subject of guidance and counterparts are summarized in the following table.

Major subject of guidance	Counterpart
● Joint preparation of analytical manual using the following instruments: ➢ Spectrophotometer ➢ Oil detector ➢ Flow injector analyzer ➢ TOC meter ● Joint preparation of maintenance manuals ● Practical training in analysis and maintenance	Staff of analytical division of the central laboratory

③ Schedule and duration

A consultant will provide guidance on analysis and maintenance to the staff of analytical division of the central laboratory, immediately after the completion of facility and installation/commissioning of the equipment. In order to confirm the effect of technical support, practical hands-on examination will be done before departure of the consultant with checklist. The duration for individual tasks was set based on experience from the previous JICA development study in Bangladesh.

Schedule (Guidance to the central laboratories)	Duration
● Guidance on Spectrophotometer and maintenance	7.0 days
● Guidance on Oil detector and maintenance	7.0 days
● Guidance on Total Nitrogen and Phosphorus detector and maintenance	10.0 days
● Guidance on TOC meter and maintenance	6.0 days
Total days	30.0 days
30.0 days（total required days）÷30.0 days/month（working days/month）＝1.0 month（required M/M）	

④ Output and monitoring method

Output and monitoring method of this field is as follows.

Output	Indicators	Method to confirm
• Capability of staff of the central laboratory to examine water quality using spectrophotometer, oil detector, total Nitrogen and Phosphorus detector, TOC meter • Capability of staff of the central laboratory to provide fundamental maintenance to spectrophotometer, oil detector, total Nitrogen and Phosphorus detector, TOC meter	• Prepared manuals for analysis • Prepared manuals for maintenance • Upgraded knowledge and skill of staff at the central laboratory	• Presence/absence of analytical manuals • Presence/absence of maintenance manuals • Result of practical examination using checklist

E. Database management guidance

① Objective

DPHE is planning to transfer the water quality data management function of NAMIC and function of LIMS function which are to be installed under the BAMWSP project to the central laboratory. In this view, the Grant Aid will provide the fundamental facility and software necessary for water quality database management. The objective of the technical support is to provide guidance on fundamental training of the facility and software. The fundamental software to be procured will be Microsoft ACCESS and Arc View.

② Major subject of guidance and counterparts

The major subject of guidance and counterparts are summarized in the following table.

Major subject of guidance	Counterpart
● Basic lecture about database and GIS management ● Guidance on database design and building ● Hand-on practice on database software ● Hand-on practice on GIS software ● Hand-on practice on spatial information input to database ● Joint preparation of the manuals	Staff of data management division of the central laboratory

③ Schedule and duration

A consultant will provide guidance on database management to the staff of database management division of the central laboratory, immediately after the completion of facility and installation/commissioning of the equipment. In order to confirm the effect of technical support, practical hand-on examination will be done before departure of the consultant with checklist. The duration for individual tasks was set based on experience from the previous JICA development study in Bangladesh.

Schedule (Guidance to the central laboratories)	Duration
● Basic lecture about database and GIS management	5.0 days
● Guidance on database design and building	3.0 days
● Hand-on practice on database software	8.0 days
● Hand-on practice on GIS software	7.0 days
● Hand-on practice on spatial information input to database	7.0 days
Total days	30.0 days
30.0 days（total required days）÷30.0 days/month（working days/month）＝1.0 month（required M/M）	

④ Output and monitoring method

Output and monitoring method of this field is as follows.

Output	Indicators	Method to confirm
• Capability of the staff at the central laboratory to use facility and software for database management.	• Prepared manuals • Upgraded knowledge and skill of staff at the central laboratory	• Presence/absence of manuals • Result of practical examination using checklist

(4) Method to confirm output

The following checklists have been prepared to confirm the output of the technical support. The lists may be modified through the practical guidance during technical support.

A. Laboratory operation and management/ analysis guidance

Output	Method to confirm the output
Capability for basic operation and management of the zonal laboratories.	Is ledger for equipment maintenance prepared?
	Is ledger for chemical prepared?
	Can staff operate and maintain pure water system?
Capability to analyze water sample using the equipment at the zonal laboratories	Can staff examine water quality using Atomic Absorption Spectrophotometer? Following sub-item shall be checked (same for all water quality examination hereunder) • Pretreatment of sample • Set up and preparation of instrument • Calibration • Analysis of sample • Calculate sample concentration
	Can staff provide basic maintenance of Atomic Absorption Spectrophotometer? Following sub-item shall be checked (same for all maintenance hereunder) ・ Dairy inspection and maintenance during operation ・ Monthly inspection and maintenance ・ Yearly inspection and maintenance
	Can staff examine water quality using Spectrophotometer?
	Can staff provide basic maintenance of Spectrophotometer?
Capability for basic operation and management of the central laboratories	Is ledger for equipment maintenance prepared?
	Is ledger for chemical prepared?
	Can staff operate and maintain pure water system?
	Can staff operate and maintain liquid waste treatment unit?
	Can staff operate and maintain exhaust gas treatment unit?
	Can staff operate and maintain power backup system?

B. Instrument analysis and maintenance guidance 1

Output	Method to confirm the output
Capability of staff of the central laboratory to examine water quality using Atomic Absorption Spectrophotometer	Can staff examine water quality by Flame AAS analysis?
	Can staff examine water quality by NO_2 Flame AAS analysis?
	Can staff examine water quality by Hydride Vapor Generation AAS analysis?
	Can staff examine water quality by AAS for Hg analysis?
Capability of staff of the central laboratory to provide fundamental maintenance to Atomic Absorption Spectrophotometer	Can staff adjust and maintain optical system of AAS ?
	Can staff adjust and maintain hydride vapor generation unit of AAS ?
	Can staff adequately clean quartz cell of AAS?
	Can staff replace the lump of AAS ?

C. Instrument analysis and maintenance guidance 2

Output	Method to confirm the output
Capability of staff of the central laboratory to examine water quality using gas chromatograph and ion chromatograph	Can staff examine water quality by solvent extraction gas chromatograph for chlorinated phenols?
	Can staff examine water quality by purge & trap gas chromatograph for volatile organic compounds?
	Can staff examine water quality by ion chromatograph for anion species?
	Can staff examine water quality by ion chromatograph for Cr(VI) ion?
Capability of staff of the central laboratory to provide fundamental maintenance to gas chromatograph and ion chromatograph	Can staff replace the column of gas chromatograph ?
	Can staff replace the septum of gas chromatograph
	Can staff avoid contamination of purge & trap device of gas chromatograph?
	Can staff replace the column of ion chromatograph
	Can staff maintain pump unit of ion chromatograph
	Can staff maintain the detector of ion chromatograph?

D. Instrument analysis and maintenance guidance 3

Output	Method to confirm the output
Capability of staff of the central laboratory to examine water quality using spectrophotometer, oil detector, total Nitrogen and Phosphorus detector, TOC meter	Can staff examine water quality by spectrophotometer?
	Can staff examine water quality by oil detector?
	Can staff examine water quality by total Nitrogen and Phosphorus?
	Can staff examine water quality by TOC meter?
Capability of staff of the central laboratory to provide fundamental maintenance to spectrophotometer, oil detector, total Nitrogen and Phosphorus detector, TOC meter	Can staff operate and maintain spectrophotometer?
	Can staff operate and maintain oil detector?
	Can staff operate and maintain total Nitrogen and Phosphorus detector?
	Can staff operate and maintain TOC meter?

E. Database management guidance

Output	Method to confirm the output
Capability of the staff at the central laboratory to use facility and software for database management	Can staff design and build database using database software (Access) ?
	Can staff design and build database using GIS software (ArcVIEW) ?
	Can staff import spatial map information to GIS using scanner?
	Can staff import spatial map information to GIS using digitizer?
	Can staff output map information and database data?

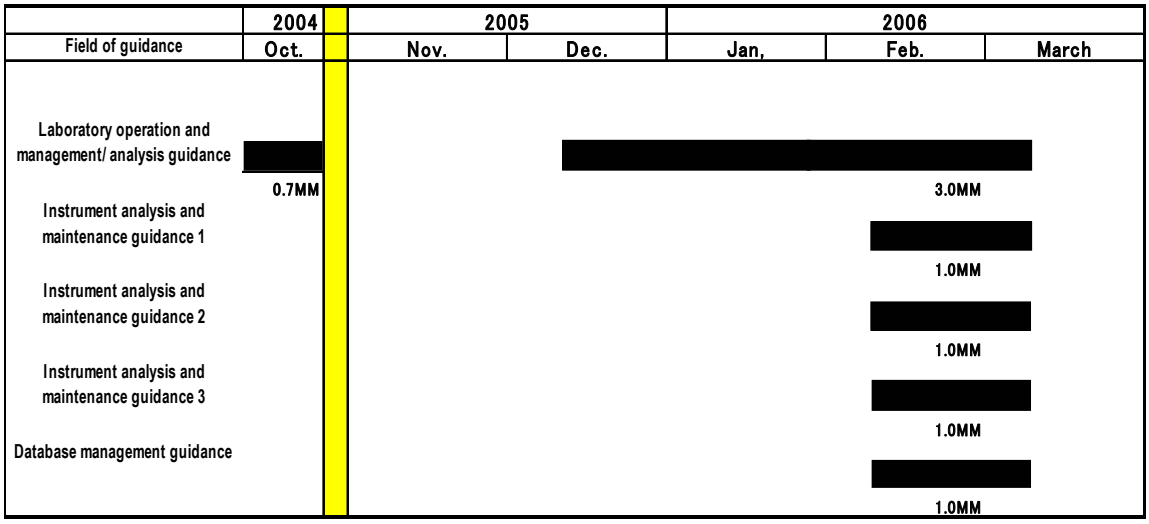
(5) Resources

The technical support is planned to be direct assistance by Japanese consultants. The objective of the technical support is to provide guidance on basic laboratory management, instrument analysis and maintenance at the initial stage. In Bangladesh, there are organizations specialized in water quality analysis such as ITN-BUET, ICDDR,B, BCSIR, and DOE, which can be mobilized as a resource for assistance. However, the technical support consists of providing knowledge and skills to facilitate the start up phase of a new organization based on the functions and roles of the central laboratory and guidance for analysis and maintenance of equipment, rather than providing general skills in water quality examination. In this regard, it is more efficient and effective, especially in view of the short period for the support, to mobilize Japanese consultants who are well aware of the basic design of the facility and equipment. However, this does not exclude the possibility of cooperation with those organizations. In fact, it is recommended to have close communication with those organizations for cooperation in training during the technical cooperation project.

As for data management, though the software to be used is general, guidance shall be not only for simple database training but also for database design and building with special emphasis on water quality management, and GIS system to show the coordinate position of the sampling point. It is not possible to find adequate resources in Bangladesh. Therefore, a Japanese consultant will be mobilized.

(6) Implementation schedule of technical support

Technical support will be implemented according to the following schedule.



Completion of construction of the central laboratory and subsequent installation and commissioning of the analytical instruments is expected at the end of January to early February of 2006. Therefore, the duration of technical support and guidance using the instruments and facilities at

the central laboratory is very limited. The technical support plan took such conditions as well as staff of the laboratory into account, and intensive technical transfer in a short period was considered.

(7) Output of technical support

The output of technical support after completion is as follows.

- Completion report (for the Government of Bangladesh, and the Government of Japan)
- Progress report of technical support (Interim report of guidance on laboratory operation and management/analysis, after completion of support for workshops and completion of guidance to zonal laboratories)
- Operation and management guideline of the central laboratory
- Operation and management guideline of the zonal laboratories
- Technical manuals for analysis using major instruments
- Maintenance manuals for major instruments
- Checklists of practical examination
- Questionnaire feedback form (response from the recipients)

(8) Operational budget for techncial support

21,141 Thousand Yen (No local subcontract)

(9) Responsibility of implementing agency of the recipient government

In order to achieve the goal of the technical support, DPHE shall have the responsibility to set up WQMSC (Water Quality Monitoring & Surveillance Circle) as a responsible body, to recruit staff to the central laboratory and zonal laboratories at Jhenaidah and Noakhali, and to secure the budget for manpower and operation in a sustainable way.

Chapter 3 Project Evaluation and Recommendations

Chapter 3. Project Evaluation and Recommendations

3-1 Project Effect

Effects of the overall project in respect to the project goal of strengthening the drinking water quality examination system are summarized below.

(1) Direct Effect

- ♦ A central laboratory is constructed, two zonal laboratories (Jhenaidah, Noakhali) are renovated, and equipment is procured for the laboratories.
- ♦ An implementation system for water quality examination is established.
- ♦ A regulatory and fund system for water quality examination is established.
- ♦ Technical competence of the implementing agency for water quality examination is improved.

※Underlined section: Outcome to be completed under the Grant Aid project

(2) Indirect Effect

- ♦ By managing water quality analysis results, it will be possible to reflect the results in policies such as arsenic mitigation measures.
- ♦ Situation of safe drinking water for the people of Bangladesh will be improved.

Improvement to the current situation through the implementation of the overall project plan is summarized in the table below.

Table 3-1 Improvement to the current situation through implementation of the Grant Aid project

Current Situation and Issues	Measures (Grant Aid Project)	Effect / Degree of Improvement
Considering that 25% of the 10 million wells supplying drinking water to 95% of the population in Bangladesh have arsenic levels exceeding the national water quality standard (0.05mg/L), an accurate water quality examination system is urgently needed. Bangladesh lacks a water quality examination system. From an institutional aspect, there is no responsible organization nor a regulatory and fund system for water quality examination. From an operational aspect, there is a shortage of water quality analysis facilities, equipment and personnel; improper equipment maintenance and chemical procurement; lack of quality control and management of water quality data; and no reflection of analysis results in policy.	・ Construct a central laboratory and procure equipment to make up the shortage of water quality analysis facilities and equipment. ・ Renovate and procure equipment for two zonal laboratories (Jhenaidah, Noakhali) to upgrade and expand water quality examination at the zonal laboratories ・ Technical support to train laboratory staff by providing basic guidance for laboratory management and data management and operation and maintenance of analytical equipment	・ Along with construction of the central laboratory and procurement of equipment, basic framework of the roles and functions to be performed by the central laboratory will be established. - Set up of Equipment Maintenance Section - Support for the procurement of chemicals - Expansion of water quality parameters to be analyzed - Introduction of accuracy control - Establishment of training program - Establishment of data management system - Establish base for conducting research to support policy/measures ・ The organization responsible for all water quality examination is clarified, water quality examination is implemented systematically and the number of samples analyzed increases. Conditions are set to enable the reflection of analysis results in policy/measures.

3-2 Recommendations

In order to ensure sustainability of the effects of the overall project, LGD and DPHE need to address the following main issues:

(1) Establishment of Laboratory Management System and Staff Assignment

The project goal is to strengthen the water quality examination system throughout the entire country of Bangladesh. Therefore, it is necessary to assign staff and promptly set up a management system for not only the central laboratory and two zonal laboratories targeted in the Grant Aid project, but all eleven zonal laboratories. To create posts on a revenue basis, it is necessary to go through procedures separate from the PCP. Since the process requires about one year, appropriate steps should be taken ahead of time. Furthermore, securing capable staff will have a direct effect on strengthening of the management system and success of the project. Therefore, recruitment of staff with the required qualifications and experience should be started in advance.

(2) Establishment of Revolving Fund System for Laboratory Management

The revolving fund system is a scheme to use revenue collected as water quality analysis fees for management of the laboratories. To set up the system, after approval by the MLGRD&C, comments are sought from the Ministry of Finance and the Ministry of Justice and permission is obtained from the Cabinet, followed by approval of the minister of MLGRD&C. The draft is currently under examination in DPHE. As DPHE has experience with existing revolving fund systems for two other activities and marketability of the water quality analysis fees has been investigated, the draft can be said to be feasible. Creation of the revolving fund system is key to sustainable operation of the laboratories and, together with establishment of the water quality examination system described below, is essential for implementation of the project. DPHE must take steps to set up the system as quickly as possible.

(3) Establishment of Drinking Water Quality Examination System

At present, the zonal laboratories do not have an annual program for conducting water quality examination. They simply analyze samples brought in on a day-to-day-basis. This unsystematic approach to implementing water quality examination must be improved. The new circle in DPHE, with the central laboratory as the responsible organization, needs to develop short-term and medium- and long- term water quality examination programs, and establish an implementation system to ensure continued water quality analysis by the zonal laboratories. For that purpose, DPHE must conduct inventory studies on drinking water sources and arrange data on the type of water source such as wells (i.e. deep wells, shallow wells, dug wells, etc.) and PSF, their quantity, supplied population and so on.

It is also necessary for DPHE to collect information on the sites and quantity of new wells to be constructed by DPHE and other donor organizations. Moreover, by obtaining information managed by NAMIC, DPHE can organize current well information, which can be used to select sites that require water quality monitoring and to examine institutional arrangements for the water quality analysis cost for construction of new wells. DPHE is currently estimating the required annual cost for laboratory operation based on past experience. From the estimated annual operating cost and set unit cost of water quality parameters to be analyzed, it is possible to determine the minimum number of samples that need to be analyzed each year to sustain laboratory operation. Therefore, DPHE will be able to develop a systematic plan for water quality examination. DPHE needs to exchange opinions and obtain consensus with outside organizations and donors by holding workshops on the overall plan for establishing the water quality examination system, and selection criteria for drinking water sources. Examining and establishing the water quality examination system in such a way is a major task of the new circle in DPHE.

The technical support under Grant Aid will assist in solving a portion of these issues. However, input by technical support under Grant Aid and the technical skills that DPHE can acquire in a short period are limited. Therefore, in addition to technical support under Grant Aid, long-term experts and technical cooperation are also necessary to ensure sustainability of the project. The aim of the long-term experts is to support continued operation of water quality examination in Bangladesh, while the technical cooperation project shall assist in capacity building of DPHE staff for establishment and carrying out of the roles and functions of the central laboratory.

Appendices

1. Member List of the Study Team

2. Study Schedule

3. List of Parties Concerned in the Recipient Country

4. Minutes of Discussions

5. References

1. Member List of the Study Team

1. Member List of the Study Team

（1）Study Team for Basic Design（Field Study 1）

	Member	Duty	Organization
1	Mr. Takashi Sakamoto	Team Leader	Resident Representative JICA Bangladesh Office
2	Ms. Junko Uno	Planning Management	First Project Management Division Grant Aid Management Dept., JICA
3	Mr. Toshiyuki Matsumoto	Chief of Consultants / Donor Coordination	Manager, Overseas Operations Dept. Kokusai Kogyo Co., Ltd.
4	Mr. Munehiro Fukuda	Operation & Management Planning / Water Quality Analysis 1	Executive Director Sowa Consultants Inc.

（2）Study Team for Basic Design（Field Study 2）

	Member	Duty	Organization
1	Mr. Toshiyuki Matsumoto	Chief of Consultants / Donor Coordination	Manager, Overseas Operations Dept. Kokusai Kogyo Co., Ltd.
2	Mr. Munehiro Fukuda	Operation & Management Planning / Water Quality Analysis 1	Kokusai Kogyo Co., Ltd.
3	Mr. Takeshi Higo	Equipment Planning / Water Quality Analysis 2	Kokusai Kogyo Co., Ltd.
4	Mr. Naofumi Sato	Facility Planning	Kokusai Kogyo Co., Ltd.
5	Mr. Takeshi Nakano	Procurement Planning / Cost Estimation	Kokusai Kogyo Co., Ltd.

（3）Study Team for Basic Design（Explanation of Summary of Basic Design）

	Member	Duty	Organization
1	Mr. Takashi Sakamoto	Team Leader	Resident Representative JICA Bangladesh Office
2	Ms. Junko Uno	Planning Management	First Project Management Division Grant Aid Management Dept., JICA
3	Mr. Toshiyuki Matsumoto	Chief of Consultants / Donor Coordination	Manager, Overseas Operations Dept. Kokusai Kogyo Co., Ltd.
4	Mr. Munehiro Fukuda	Operation & Management Planning / Water Quality Analysis 1	Executive Director Sowa Consultants Inc.

2. Study Schedule

No.	Date		Matsumoto	Fukuda	Stay
6	Mar-5	Fri	Data collection, examination of facility and equipment plan		Dhaka
7	Mar-6	Sat	Examination of soil conditions		
8	Mar-7	Sun	Discuss w/ DPHE		
9	Mar-8	Mon	Discuss w/ DPHE, Visit to Tongi and AAN		
10	Mar-9	Tue	Discuss w/ local consultant	Visit to DOE & AEC Lab.	Jessore
			Visit to private Lab., Move to Jessore		
11	Mar-10	Wed	Visit to Jhenaidah and AAN Labs. Move to Dhaka		Dhaka
12	Mar-11	Thr	Move to Nohakali, Visit to DANIDA and Lab. Move to Dhaka		
13	Mar-12	Fri	Data arrangement		
14	Mar-13	Sat	Data arrangement		
15	Mar-14	Sun	GOB-UNICEF Project World Bank	NGO Forum Soil Resource Development Inst.	
			Visit to WHO		
16	Mar-15	Mon	Visit to UNICEF, ADB, DOE, UNDP, JICA		
17	Mar-16	Tue	Discuss w/ DPHE & BAMWSP, Visit to APSU, JICA Discuss w/ Expert		
18	Mar-17	Wed	Dhaka (13:10, TG322)→Bangkok (16:25) (23:40, NH916)		On plane
19	Mar-18	Thr	Narita(7:30)		

BAMWSP: Bangladesh Arsenic Mitigation Water Supply Project
ERD: Economic Relations Division, Ministry of Finance
LGD: Local Government Division, Ministry of Local Government, Rural Development and Cooperatives (MLGRD&C)
DPHE: Department of Public Health Engineering, MLGRD&C
ITN-BUET: International Training Network, Bangladesh University of Engineering and Technology
AAN: Asia Arsenic Network
GOB: Government of Bangladesh
DOE: Department of Environment
AEC: Atomic Energy Centre
ADB: Asian Development Bank
APSU: Arsenic Policy Support Unit

2. Study schedule

（1）Study Team for Basic Design（1st Field Study）

No.	Date	Time • Place of Visit	Remarks	Place of Stay
1	Feb-29	9:15 JICA Office 11:00 BAMWSP 14:30 ERD 15:30 LGD 17:45 Embassy of Japan	Meeting (schedule, policies, etc.) Information gathering and exchange of views Courtesy call, explanation of items to be borne by the recipient country Courtesy call, discussion on cooperation policies and items to be borne by the recipient country Courtesy call, explanation of policies	Dhaka
2	Mar-1	9:30 DPHE	Discussion（confirmation of contents of request, budget measures, etc.）	
3	Mar-2	10:00 Mohakhali、Tejgaon	Visit to candidate sites for construction of the central laboratory	
4	Mar-3	9:30 World Bank 11:00 DPHE 13:00 ITN-BUET 13:30 LGD 16:00 DANIDA	Information gathering and exchange of views Discussion （confirmation of the minutes of discussion (M/D)） Information gathering and exchange of views Discussion（confirmation of the M/D） Participation in core donor meeting on arsenic, introduction of study, exchange of views on the project	
5	Mar-4	13:00 ERD 16:00 Embassy of Japan	Signing of the M/D Report of study results and discussion on future policy	

From March 5, 2004, the itinerary of the consultants shall be indicated.

（2）Study Team for Basic Design（Field Study 2）

	Date		Matsumoto	Fukuda	Higo	Sato	Nakano
1	5-Apr-04			Leave for Dhaka	Leave for Dhaka		Leave for Dhaka
2	6-Apr-04			Arrive at Dhaka Visit to JICA	Arrive at Dhaka Visit to JICA		Arrive at Dhaka Visit to JICA
3	7-Apr-04			Study of analytycal method and equipment	Study on chemical procurement		Quatation collection
4	8-Apr-04			Study of analytycal method and equipment	Study on chemical procurement		Quatation collection
5	9-Apr-04			Study of analytycal method and equipment	Study on chemical procurement		Quatation collection
6	10-Apr-04	Sat	Leave for Dhaka	Study of analytycal method and equipment	Study on chemical procurement	Leave for Dhaka	Quatation collection
7	11-Apr-04	Sun	Arrive at Dhaka Visit to private lab. Site survey at Mohakhali	Visit to DOE Visit to local equipment suppliers	Visit to local chemical supliers	Arrive at Dhaka Visit to private lab. Site survey at Mohakhali	Quatation collection
8	12-Apr-04	Mon	Discussion w / DPHE	Discussion w / DPHE	Discussion w / DPHE	Discussion w / DPHE Discussion w /local consultant	Discussion w / DPHE
9	13-Apr-04	Tue	Discussion w / DPHE Discussion w / BAMWSP	Discussion w / DPHE Discussion w / BAMWSP	Discussion w / DPHE	Discussion w / DPHE Site survey w /local consultant	Discussion w / DPHE Site survey w /local consultant
10	14-Apr-04	Wed	Discussion w / DPHE	Discussion w / DPHE	Study on equipment procurement	Design of the building for central lab.	Quatation collection
11	15-Apr-04	Thu	Discussion w / DPHE Visit to JICA Visit to AAN	Discussion w / DPHE Visit to JICA Visit to AAN	Discussion w / DPHE Visit to JICA Visit to AAN	Design of the building for central lab. Meeting w /JICA	Quatation collection
12	16-Apr-04	Fri	Discussion w / World Bank mission	Discussion w / World Bank mission	Data arrangement	Design of the building for central lab.	Quatation collection
13	17-Apr-04	Sat	Design of building for central lab. Visiting at Human Resources Development in Reproductive Health Maternal & Child Health	Discussion w / DPHE Discussion w / BAMWSP/World bank mission	Study on equipment procurement	Design of building for central lab. Visiting at Human Resources Development in Reproductive Health Maternal & Child Health	Design of building for central lab. Visiting at Human Resources Development in Reproductive Health Maternal & Child Health
14	18-Apr-04	Sun	Leave for JPN	Discussion w / DPHE	Study on equipment procurement	Discussion w / DPHE Site survey w /local consultant	Quatation collection
15	19-Apr-04	Mon	Arrive at JPN	Move to Noakali Site survey at Noakali Lab.	Study on equipment procurement	Move to Noakali Site survey at Noakali Lab.	Quatation collection
16	20-Apr-04	Tue		Move to Comila Site survey at Comila Lab. Discussion w /DPHE	Study on equipment procurement	Move to Comila Site survey at Comila Lab. Discussion w /DPHE	Quatation collection
17	21-Apr-04	Wed		Discussion w irh DPHE Discussion w / APSU	Move to Jhenaidha Visit to Jhenaidha Lab.	Move to Jhenaidha Visit to Jhenaidha Lab.	Leave for JPN
18	22-Apr-04	Thu		Discussion w / DPHE Discussion w / BAMWSP	Move to Dhaka	Move to Dhaka	Arrive at JPN
19	23-Apr-04	Fri		Data arrangement	Data arrangement	survey for material price	
20	24-Apr-04	Sat		Data arrangement	Data arrangement	Leave for JPN	
21	25-Apr-04	Sun		Participation to DPHE w orkshop	Visit to Private Lab.	Arrive at JPN	
22	26-Apr-04			Discussion w / DPHE	Study on equipment procurement		
23	27-Apr-04			Signing of Technical Note w / DPHE Visit to Jica	Signing of Technical Note w / DPHE Visit to Jica		
24	28-Apr-04			Data arrangement	Data arrangement		
25	29-Apr-04			Visit to EOJ	Visit to EOJ		
26	30-Apr-04			Leave for JPN	Leave for JPN		
27	1-May-04			Arrive at JPN	Arrive at JPN		

（3）Study Team for Basic Design（Explanation of Draft of Basic Design）

No.	Date	Time • Place of Visit		Remarks	Stay
1	Jun-12	11:55	Arrive at Dhaka		
		14:30	DPHE	Submission D/F Report, Discussion	
2	Jun-13	9:30	JICA Office	Discussion	
		11:30	Embassy of Japan	Courtesy call, Report to D/F report	
		14:00	LGD	Courtesy call, Report to D/F report	
		15:00	ERD	Courtesy call, Report to D/F report	
		17:30	JICA Office	Discussion	
3	Jun-14	9:30	JICA Office	Work	
		14:00	DPHE	Discussion about D/F report	Dhaka
4	Jun-15	9:30	DPHE	Discussion about D/F report	
5	Jun-16	9:30	JICA Office	Revision of D/F Report, preparation of minutes of discussion (M/D)	
		12:30	LGD	Report of M/D, Discussion	
6	Jun-17	10:00	ERD	Signing of M/D	
		14:00	JICA Office	Discussion	
		16:00	Embassy of Japan	Report of study results and discussion on future policy	

3. List of Parties Concerned in the Recipient Country

3. List of Parties Concerned in the Recipient Country

（1）Study Team for Basic Design（Field Survey 1）

Economic Relations Division, Ministry of Finance

Mr. Mahmudul Huq Bhuiyan	Deputy Secretary

Ministry of Local Government, Rural Development and Cooperatives

Md. Abdullah	Deputy Chief

Local Government Division

Mr. M. Sharful Alam	Director General

Department of Public Health Engineering

Mr. Md. Khurshed Alam	Chief Engineer
Mr. Amanullah Al Mahmood	Superintending Engineer, Planning Circle
Mr. Iftishamol Huq	Assistant Chief Engineer
Mr. Md. Siddique Amis Talukder	Sr. Chemist, Rajshahi Zonal Laboratory
Mr. Hiroshi Jigami	Long-term Expert (Arsenic Mitigation Advisor to DPHE)
Mr. Md. Rashidul Huque	Executive Engineer, GOB-UNICEF PROJECT
Mr. Panna Lal Chowdhury	Senior Chemist Comilla lab.
Mr. Aya Imtiazul Haque	DPHE-Danida

Bangladesh Arsenic Mitigation Water Supply Project (BAMWSP)

Mr. Khoda Baksh	Project Director
Mr. J.T.A. Chowdhury	Consultant, Project Management Unit

Arsenic Policy Support Unit, DPHE

Guy Howard	International Specialist

The World Bank

Mr. Tanveer Ahsan	Urban Specialist, Water and Sanitation Program
Mr. Shafiul Azam Ahmed	Water & Sanitation Specialist, Water and Sanitation Program

Asian Development Bank

Mr. Md. Rafiqul Islam	Project Implementation Officer

ITN-BUET

Mr.Sk,Abu Jafar Shamsuddin	Center Manager
Dr. A.B.M.Badruzzaman	Professor and Environmental Consultant

Soil Resource Development Institute

Mr. Mainul Ahsan	Principal Scientific Officer

FAO

Mr. Alex Heikens	Associate Professional Officer

CIDA

Ms. Aylvia Islam	Senior Development Adviser
Ms. Elene Uarabeda	Program Coordinator, OCETA

World Health Organization

Mr. Han A. Heijnen	Environmental Health Advisor
Mr. Roy K. Boerschke	Senior Advisor

UNICEF

Mr. Sahiqul Islam	Team leader, Arsenic Unit

DANIDA

Mr. Carel P.M. de Groot	Sector Program Coordinator
Mr. Alok Majumder	Program Officer

Australian Agency for International Development (AusAID)

Ms. Rifat Shahpar Khan	Senior Program Officer

Asia Arsenic Network

Mr. Kazuyuki Kawahara	Resident Representative in Dhaka
Ms. Sachie Tsushima	Deputy Director of the Executive Office
Mr. Ryuji Ogata	Resident Representative in Jessore
Mr. MD. Shamin Uddin	Environmental Chemist
Mr. Tarun Kanti Hore	Accountant & Office Administrator

NGO FORUM

Mr. S. M. Shahidullah	Chemist Drinking Water Supply & Sanitation

Embassy of Japan in Bangladesh

Mr. Masahiko Kiya	Counselor
Mr. Yoichi Matsumoto	First Secretary
Mr. Yasukuni Kimura	Second Secretary

JICA Bangladesh Office

Mr. Zulfiker Ali	Staff
Mr. Takuya Sugawara	Staff
Mr. Md. Mokirul Islam	Staff

（2）Study Team for Basic Design（Field Survey 2）

Department of Public Health Engineering

Mr. Md. Khurshed Alam	Chief Engineer
Mr. Amanullah Al Mahmood	Superintending Engineer, Planning Circle
Mr. Hiroshi Jigami	Long-term Expert (Arsenic Mitigation Advisor to DPHE)
Mr. Md. Siddique Amis Talukder	Sr. Chemist, Rajshahi Zonal Laboratory
Mr.Md Abdus Sattar Mia	Sr. Chemist, Khuluna Zonal Laboratory
Mr.Md Serajul Haque	Jr. Chemist, Khuluna Zonal Laboratory
Mr. Panna Lal Chowdhury	Sr. Chemist Comilla Zonal laboratory
Mr. Md Mostaque	Jr. Chemist Comilla Zonal laboratory
Mr. Md Fakar Uddin	Sr. Chemist, Mymensign Zonal Laboratory
Mr. Md Anisur Rahman Khan	Jr. Chemist, Mymensign Zonal Laboratory
Mr. Md.Nazmul Haque	Executive Engineer DPHE Noakhali Division

Bangladesh Arsenic Mitigation Water Supply Project (BAMWSP)

Mr. J.T.A. Chowdhury	Consultant, Project Management Unit

Department of Environment

Ms. B.U.H. Mst Akhtaruzzahan	Sr. Chemist, Dhaka division

Arsenic Policy Support Unit, DPHE

Mr. Guy Howard	International Specialist

The World Bank

Ms. Karin Kemper	Task Manager/BAMWSP
Ms. Amal Talbi	Water Resource Management Specialist
Mr. Albert Tuinhof	Groundwater management advisory team member

Asia Arsenic Network

Mr. Kazuyuki Kawahara	Resident Representative in Dhaka

Embassy of Japan in Bangladesh

Mr. Masahiko Kiya	Counselor
Mr. Yoichi Matsumoto	First Secretary

JICA Bangladesh Office

Mr. Zulfiker Ali	Staff
Mr. Takuya Sugawara	Staff

（3）Study Team for Basic Design（Explanation of Draft of Basic Design）

Economic Relations Division, Ministry of Finance

Mr. Iqbal mahmood	Deputy Secretary

Local Government Division

Mr. M. Sharful Alam	Director General

Department of Public Health Engineering

Mr. Md. Khurshed Alam	Chief Engineer
Mr. Amanullah Al Mahmood	Superintending Engineer, Planning Circle
Mr. Hiroshi Jigami	Long-term Expert (Arsenic Mitigation Advisor to DPHE)
Mr.Akm Ibrahm	Executive Engineer in charge of BAMWSP
Mr.Monwar Ali	Executive Engineer Planning Division

Bangladesh Arsenic Mitigation Water Supply Project (BAMWSP)

Mr. J.T.A. Chowdhury	Consultant, Project Management Unit

DANIDA

Mr. Carel P.M. de Groot	Sector Program Coordinator

Asia Arsenic Network

Mr. Kazuyuki Kawahara	Resident Representative in Dhaka
Ms. Asako Takahashi	Resident Representative in Jessore

Embassy of Japan in Bangladesh

Mr. Matsushiro Horiguchi	Ambassador
Mr. Masahiko Kiya	Counselor
Mr. Yoichi Matsumoto	First Secretary
Mr. Yasukuni Kimura	Second Secretary

JICA Bangladesh Office

Mr. Mitsuyoshi Kawasaki	Deputy Director
Mr. Zulfiker Ali	Staff
Mr. Takuya Sugawara	Staff
Mr. Md. Mokirul Islam	Staff

4. Minutes of Discussions

MINUTES OF DISCUSSIONS
ON THE BASIC DESIGN STUDY (FIRST FIELD SURVEY) ON THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH

In response to a request from the Government of the People's Republic of Bangladesh (hereinafter referred to as "Bangladesh"), the Government of Japan has decided to conduct a Basic Design Study on the Project on Strengthening of Water Examination System (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Bangladesh the Basic Design Study Team (hereinafter referred to as "the Team"), headed by Mr. Takashi Sakamoto, Resident Representative, Bangladesh Office, JICA, and is scheduled to stay in the country from February 28 to March 17, 2004.

The Team held discussions with the officials concerned of the Government of Bangladesh, and conducted a field survey at the project sites.

In the course of discussions and field survey, both parties confirmed the main items described on the attached sheets.

Dhaka, 4 March, 2004

Takashi Sakamoto
Leader
Basic Design Study Team
Japan International Cooperation Agency
Japan

Mahmudul Huq Bhuiyan
Deputy Secretary
Economic Relations Division
Ministry of Finance
The People's Republic of Bangladesh

4.3.2004

Syed Mamunul Alam
Senior Assistant Chief
Ministry of Local Government,
Rural Development & Cooperatives
The People's Republic of Bangladesh

Amanullah Al Mahmood
Superintending Engineer
Department of Public Health Engineering
Ministry of Local Government,
Rural Development & Cooperatives
The People's Republic of Bangladesh

ATTACHMENT

1. Objective of the Project

The objective of the Project is to establish the Central Laboratory in Dhaka and to improve the facilities of the two zonal laboratories in order to strengthen the overall water examination system with special emphasis on arsenic analysis and promote arsenic mitigation activities in Bangladesh through procurement of materials and equipment necessary for laboratories and construction of the Central Laboratory.

2. Project Sites

The Project sites requested by the Bangladeshi side are as follows which are shown in annex-1.

-The Central Laboratory, to be established in Dhaka City at Mohakhali DPHE land
-Jhenaidah Zonal Laboratory
-Noakhali Zonal Laboratory

3. Sponsoring Ministry and Implementing Agency

The sponsoring ministry for the Project is the Ministry of Local Government, Rural Development & Cooperatives: MLGRD&C (Local Government Division: LGD).
The implementing agency of the Project is Department of Public Health Engineering (DPHE).
In terms of executing proper operation and maintenance of the equipment and facilities as well as enhancing the effectiveness of the Project, LGD/DPHE is responsible for coordination with the relevant ministries and agencies such as Economic Relations Division (ERD).
The organization chart of DPHE is shown in annex-2.

4. Items Requested by the Government of Bangladesh

After discussions, the Team and the Bangladeshi side confirmed the items described in annex-3 as component of request by the Government of Bangladesh at this moment in time.
The Team proceeds with further study in 1st and 2nd field surveys based on this mutual understanding as annex-3, and final components of the request from the Government of Bangladesh will be confirmed during 2nd field survey scheduled in April 2004.
Both sides fully understood that the appropriateness of the request shall be assessed according to the further studies and analysis in Japan and the final components of the Project shall be decided after the assessment.

5. Japan's Grant Aid System

(1) The Bangladeshi side has understood Japan's Grant Aid system explained by the Team as described in annex-4.

(2) The Bangladeshi side will take necessary measures, as described in annex-4 for smooth implementation of the Project, on condition that the Grant Aid Assistance by the Government of Japan is extended to the Project.

6. Schedule of the Study

(1) The consultants of the Team will proceed to carry out further studies in Bangladesh until March 16, 2004.

(2) After analyzing the result of the study, JICA will dispatch the Basic Design Study Team (2nd Field Survey Team) to Bangladesh in April 2004, to conduct further investigation.

(3) Based on the Minutes of Discussions and technical examination of the study results, JICA will prepare a draft report in English and dispatch a mission to Bangladesh in order to explain its contents around June 2004.

(4) If the contents of the draft report are accepted in principle by the Bangladeshi side, JICA will complete the final report and send it to the Bangladeshi side around August 2004.

7. Other Relevant Issues

The following issues were discussed and confirmed by both sides.

(1) Policy for strengthening of the water examination system

The Bangladeshi side explained the importance of strengthening of the water examination system in accordance with the draft National Arsenic Mitigation Policy that is under examination for the Cabinet approval and which states necessity of the followings;

--- Capacity building for water quality monitoring and surveillance of exiting safe tube wells and the proposed interventions

--- Establishment of a network of well equipped laboratories with arsenic measurement capacity at appropriate levels

(2) Necessity and appropriateness on implementation of the Project

The Team explained that based on the result of this study, the Japanese side shall analyze necessity and appropriateness on implementation of the Project and JICA will dispatch the 2nd Field Survey Team only when the Project implementation is judged as necessary and appropriate.

(3) Functions of the Central Laboratory

Both sides confirmed the functions of the Central Laboratory to be established are as follows.

--- to coordinate and manage all zonal laboratories of DPHE as the center of laboratory

--- to train and develop human resources in the zonal laboratories

--- to manage the zonal laboratories in terms of quality assurance and quality control (QA/QC)

--- to provide technical support for zonal laboratories in terms of maintenance of equipment.

--- to establish and manage water quality analysis data at all level

--- to analyze water samples from rural areas where zonal laboratories can not cover
--- to give support for research which will be utilized to make policies and actions for securing supply of safe drinking water

(4) Staffing plan for the laboratories

The Bangladeshi side assured the Team all the necessary staff and its budget for the new Central Laboratory and the two existing laboratories (Jhenaidah and Noakhali) were to be assigned under revenue establishment of DPHE in time before completion of the Project. LGD (DPHE) shall submit necessary PCP (Project Concept Paper) in June 2004 to the Planning Commission for approval after getting the draft report of the Project scheduled in early June 2004 and promote the documents be approved at the earliest, not later than September 2004. If actual proceeding cannot satisfy the due schedule, the Japanese side will re-consider the appropriateness of implementation of the Project.

Both sides agreed that the number and qualification of staff for the Central Laboratory shall be assessed in the 2nd Field Survey scheduled in April 2004.

(5) Budgetary arrangement for operation and maintenance

The Bangladeshi side assured the Team to allocate sufficient budget necessary for the operation and maintenance for the new Central Laboratory and existing zonal laboratories in time before completion of the Project. LGD (DPHE) shall submit necessary PCP in June 2004 to the Planning Commission for approval after getting the draft report of the Project scheduled in early June 2004 and promote the documents be approved at the earliest, not later than September 2004. If actual proceeding cannot satisfy the due schedule, the Japanese side will re-consider the appropriateness of implementation of the Project. Also as for operation cost of laboratories, the Bangladeshi side explained that the plan to introduce revolving fund system using water analysis fee is under examination for approval by the competent authorities and once it is approved it will help greatly for sustainability of the laboratories.

Both sides agreed that the amount of budget for operation and maintenance shall be assessed in the 2nd Field Survey scheduled in April 2004.

(6) Capacity building

The Bangladeshi side requested the technical guidance ("Soft Component") by the Japanese side for operation and maintenance of the equipment to be included in the Project in order to ensure the prompt set up of the laboratory.

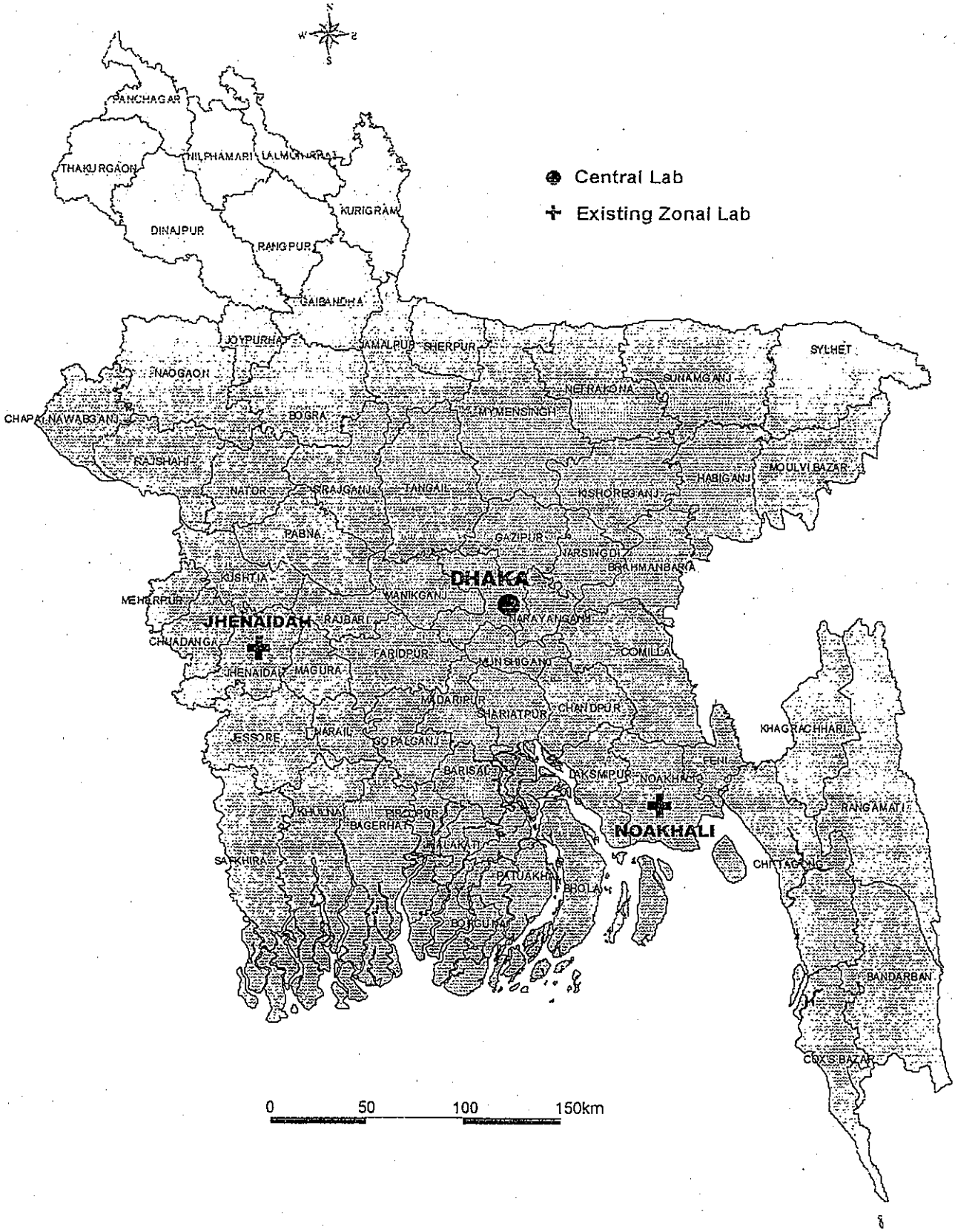
In Addition, the Bangladeshi side fully understood the importance of the staff training and requested the Japanese side to consider technical cooperation. Both sides agreed that technical cooperation for enhancing capacity towards water quality examination especially arsenic mitigation activity was indispensable to secure sustainability of the Project and discussion of the issue shall be proceeded to.

(7) Data management system of the Central Laboratory

Both sides agreed that the data management system shall be established between DPHE headquarters and existing zonal laboratories by Bangladesh Arsenic Mitigation Water Supply Project

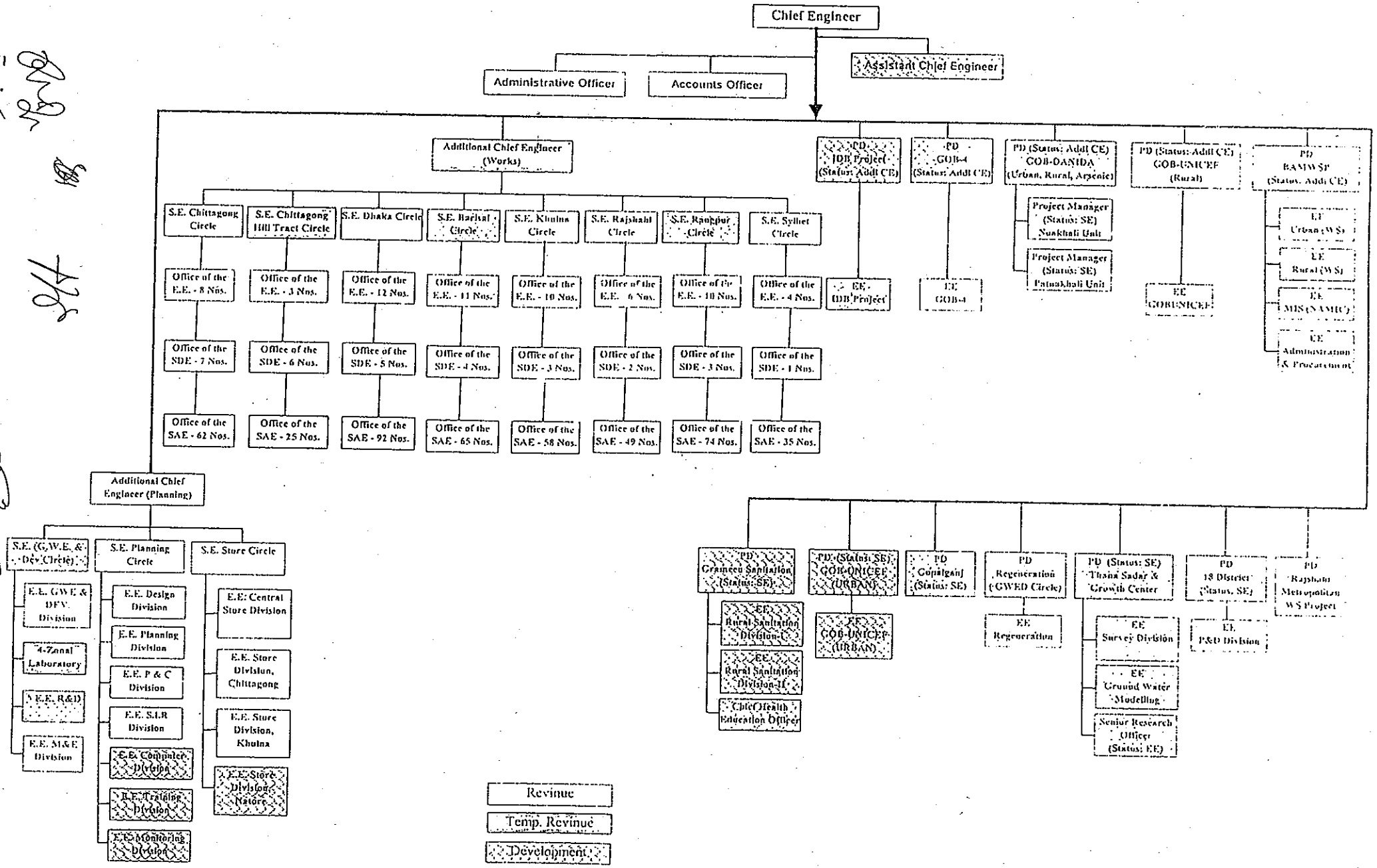
(BAMWSP) as LIMS (Laboratory Information Management System) before set up of the Central Laboratory. Since the LIMS will be transferred to the Central Laboratory in future, equipment plan for the Central Laboratory will be assessed in consideration of the equipment by the LIMS.

annex-1



Project Sites Map

Organogram : Department of Public Health Engineering (DPHE)



annex-2

annex-3

Contents of the request by the Government of Bangladesh

1. Establishment of the Central Laboratory in Dhaka
   Construction of a laboratory building
   Procurement of necessary equipment and materials

2. Upgrading the existing two laboratories (Jhenaidah and Noakhali)
   Procurement of necessary equipment and materials
   Internal repair of the existing facilities, only when it is necessary

3. Technical support in capacity building for newly recruited staff in the Central Laboratory as well as the staff of zonal laboratories in order to operate and maintain equipment properly

JAPAN'S GRANT AID

1. Japan's Grant Aid System

(1) Grant Aid Procedures

1) Japan's Grant Aid Program is executed through the following procedures.

- Application (Request made by a recipient country)
- Study (Basic Design Study conducted by JICA)
- Appraisal & Approval (Appraisal by the Government of Japan and Approval by the Cabinet)
- Determination of the implementation
  (The Notes exchanged between the Governments of Japan and the recipient country)
- Implementation (Implementation of the Project)

2) Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study), using Japanese consulting firms.

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Programme, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes signed by the Governments of Japan and the recipient country.

Finally, for the implementation of the project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

(2) Basic Design Study

1) Contents of the Study

The aim of the Basic Design Study (hereinafter referred to as "the Study"), conducted by JICA on a requested project (hereinafter referred to as "the Project"), is to provide a basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Study are as follows:

i) Confirmation of the background, objectives and benefits of the Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation;
ii) Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic points of view;
iii) Confirmation of items agreed on by both parties concerning the basic concept of the Project;
iv) Preparation of a basic design of the Project; and
v) Estimation of costs of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even through they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

2) Selection of Consultants

For the smooth implementation of the Study, JICA uses a registered consulting firm. JICA selects a firm based on proposals submitted by interested firms. The firm selected carries out a Basic Design Study and writes a report, based upon terms of reference set by JICA.

The consultant firm used for the Study is recommended by JICA to the recipient country to also work in the Project's implementation after the Exchange of Notes, in order to maintain technical consistency and also to avoid any undue delay in implementation should the selection process be prepared.

(3) Japan's Grant Aid Scheme

1) What is Grant Aid?

The Grant Aid Program provides a recipient country with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. Grant Aid is not supplied through the donation of materials as such.

2) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

3) "The period of the Grant" means the one fiscal year which the Cabinet approves the project for. Within the fiscal year, all procedure such as exchanging of the Notes, concluding contracts with consulting firms and contractors and final payment to them must be completed.
However, in case of delays in delivery, installation or construction due to unforeseen factors such as weather, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

4) Under the Grant, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However, the prime contractors, namely consulting, contracting and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

5) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability of Japanese taxpayers.

6) Undertakings required to the Government of the recipient country

In the implementation of the Grant Aid project, the recipient country is required to undertake such necessary measures as the followings:

i) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction;

ii) To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the site;

iii) To secure buildings prior to the procurement in case the installation of the equipment;

iv) To ensure all the expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid;

v) To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts;

vi) To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contracts such as facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work;

vii) "Proper Use"
The recipient country is required to maintain and use the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign the necessary staff for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

viii) "Re-export"
The products purchased under the Grant Aid shall not be re-exported from the recipient country.

ix) Banking Arrangement (B/A)

a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in an authorized foreign exchange bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the verified contracts.

b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to Pay (A/P) issued by the Government of recipient country or its designated authority.

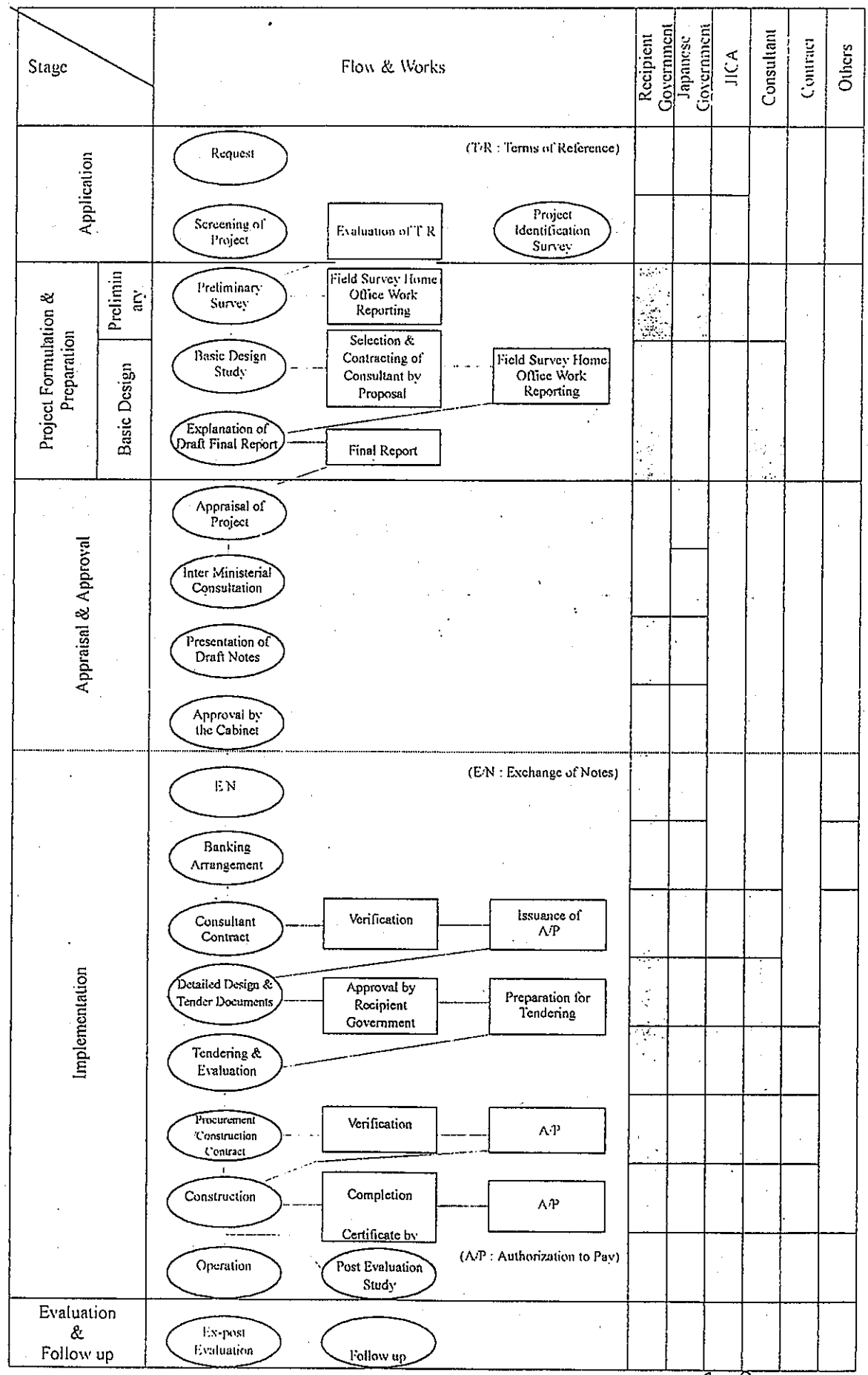
2. Grant Aid Procedure

(1) Flowchart of Japan's Grant Aid Procedures
Refer to Attachment 1.

(2) Major Undertaking to be taken by Each Government
Refer to Attachment 2.

Attachment I

FLOW CHART OF JAPAN's GRANT AID PROCEDURES



Attachment-2

Major Undertakings to be taken by Each Government (Construction)

No	Items	To be covered by	
		Grant Aid	Recipient Country
1	To secure land		●
2	To clear, level and reclaim the site when needed		●
3	To construct gates and fences in and around the site		●
4	To construct the parking lot	●	
5	To construct roads		
	1) Within the site	●	
	2) Outside the site		●
6	To construct the building	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities		
	1)Electricity		
	a.The distributing line to the site		●
	b.The drop wiring and internal wiring within the site	●	
	c.The main circuit breaker and transformer	●	
	2)Water Supply		
	a.The city water distribution main to the site		●
	b.The supply system within the site (receiving and/or elevated tanks)	●	
	3)Drainage		
	a.The city drainage main (for storm, sewer and others) to the site		●
	b.The drainage system (for toilet sewer, ordinary waste, storm drainage and others) within the sit	●	
	4)Gas Supply		
	a.The city gas main to the site		●
	b.The gas supply system within the site	●	
	5)Telephone System		
	a.The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b.The MDF and the extension after the frame/panel	●	
	6)Furniture and Equipment		
	a.General furniture		●
	b.Project equipment	●	
8	To bear the following commissions to a bank of Japan for the banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
9	To ensure prompt unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine(Air) transportation of the products from Japan to the recipient country	●	
	2) Tax exemption and customs clearance of the products at the port of disembarkation		●

	3) Internal transportation from the port of disembarkation to the project site	(●)	(●)
10	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
11	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts		●
12	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid		●
13	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities as well as for the transportation and installation of the equipment		●

Major Undertakings to be taken by Each Government (Equipment)

NO	Items	To be covered by Grant Aid	To be covered by Recipient
1	To bear the following commissions to a bank of Japan for the banking services based upon the B/A		
1) Advising commission of A/P			●
2) Payment commission			●
2	To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country		
1) Marine(Air) transportation of the products from Japan to the recipient country		●	
2) Tax exemption and custom clearance of the products at the port of disembarkation			●
3) Internal transportation from the port of disembarkation to the project		(●)	(●)
3	To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
4	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract		●
5	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid		●
6	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for the transportation and installation of the equipment		●

MINUTES OF DISCUSSIONS
ON THE BASIC DESIGN STUDY
ON THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH
(EXPLANATION OF THE DRAFT REPORT)

In March and April 2004, Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Basic Design Study Teams on the Project on Strengthening of Water Examination System (hereinafter referred to as "the Project") to the People's Republic of Bangladesh (hereinafter referred to as "Bangladesh"), and through discussion, field survey in Bangladesh and technical examination of the results in Japan, JICA prepared a draft report of the study.

In order to explain and to consult with Bangladesh on the components of the draft report, JICA sent to Bangladesh the Draft Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Takashi Sakamoto, Resident Representative, JICA Bangladesh Office, and is scheduled to stay in the country from June 12 to 18, 2004.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Dhaka, 17 June, 2004

Takashi Sakamoto
Leader
Basic Design Study Team
Japan International Cooperation Agency
Japan

Iqbal Mahmood
Deputy Secretary
Economic Relations Division
Ministry of Finance
The People's Republic of Bangladesh

Syed Mamunul Alam
Senior Assistant Chief
Local Government Division
Ministry of Local Government,
Rural Development & Cooperatives
The People's Republic of Bangladesh

Amanullah Al Mahmood
Superintending Engineer
Department of Public Health Engineering
Ministry of Local Government,
Rural Development & Cooperatives
The People's Republic of Bangladesh

ATTACHMENT

1. Components of the Draft Report

The Government of Bangladesh agreed and accepted in principle the components of the draft report explained by the Team.

2. Minutes of Discussions (4 March, 2004)

Both sides read and confirmed again all the contents of the previous Minutes of Discussions, on the basic design study of 4 March 2004.

3. Japan's Grant Aid System

The Bangladeshi side has understood Japan's Grant Aid System and the necessary measures to be taken by the Government of Bangladesh as explained by the Team and described in annex-4 of the Minutes of Discussions signed by both parties on 4 March, 2004.

4. Schedule of the Study

JICA will complete the final report in accordance with the items confirmed and send it to Bangladesh around August 2004.

5. Other Relevant Issues

The following issues were discussed and confirmed by both sides.

(1) Components of the Project

Both sides agreed that the Project would be composed of the following components when the Japanese Government finally decides to implement the Project.

- Construction of the new Central Laboratory at Mohakhali, Dhaka
- Repair work for Jhenaidah Zonal Laboratory and Noakhali Zonal Laboratory
- Procurement of equipment and materials for the Central Laboratory, Jhenaidah Zonal Laboratory and Noakhali Zonal Laboratory listed in annex-1
- Technical support in the field of laboratory management and water quality analysis, operation and maintenance of the main equipment and basic operation of water quality data management system ("Soft Component").

(2) Staffing plan for the laboratories

Both sides confirmed that Department of Public Health and Engineering (DPHE) shall set up the Water Quality Monitoring and Surveillance Circle (WQMSC), which is responsible for drinking

water quality monitoring and surveillance, and allocate thirty nine staff for the Central Laboratory and nine staff for all eleven zonal laboratories respectively. As for qualification of staff for the laboratories, the Japanese side requested the Bangladeshi side to consider relevant laboratory experience at recruitment of personnel.

The Bangladeshi side assured the Team of creation of all necessary posts under revenue establishment of DPHE and allocation of personnel to the posts for the new Central Laboratory and the two existing zonal laboratories (Jhenaidah and Noakhali) by September 2005 at latest.

The Bangladeshi side also assured that (i) necessary staff shall be allocated to the vacant posts of four existing zonal laboratories (Khulna, Rajshahi, Mymensingh and Comilla), and that (ii) creation of nine posts under revenue establishment and allocation of personnel to the posts for the new five zonal laboratories (Rangpur, Barisal, Sylhet, Bogra and Tongi) respectively, which are to be constructed under BAMWSP, by September 2005 at latest in order to strengthen their functions and thus to ensure the overall water examination system works effectively.

(3) Budgetary arrangement for implementation of the Project and annual operation and maintenance

Both side confirmed that the Bangladeshi side shall make necessary budgetary arrangement to cover required amount of cost for the Project implementation shown in annex-2 in time.

Furthermore, the Bangladeshi side assured the Team to allocate sufficient budget necessary for annual operation and maintenance for the new Central Laboratory and the eleven zonal laboratories.

Both sides agreed that a revolving fund system using water analysis fee for management of the laboratories is indispensable in order for proper management of the laboratories. The Bangladeshi side assured the system would be introduced as soon as possible after consultation with concerned organizations of Bangladesh. The Japanese side expressed that the Government of Japan might have difficulty to implement the Project and to consider further assistance to the laboratories if such system would not be introduced before the completion of the Project at latest.

(4) Approval of the Project Concept Paper (PCP)

In order to secure necessary budget and human resources for the Project, LGD (DPHE) shall submit necessary PCP in early July 2004 to the Planning Commission for approval in accordance with the draft report of the Project and promote the documents be approved at the earliest, not later than September 2004.

(5) Regulatory framework and drinking water quality examination programme in national level

Both sides agreed the importance of introduction of regulation to enforce water quality monitoring and surveillance for existing and new drinking water sources. Such regulation shall show clear criteria of priority of the sources which quality to be examined, as it is not possible to cover all the drinking water sources in the nation at one time. Based on the regulation, drinking water quality examination programme in national level shall be formulated. The regulation and programme shall be shared with other organizations concerning water quality examinations to coordinate activities. DPHE agreed to conduct workshops for establishment and share the system around October 2004 and the Japanese side will support the activity through the soft component under the Project.

(6) Other responsibility of the Bangladeshi side

The Bangladeshi side assured to take necessary measures for items described in annex-3 during implementation of the Project in due time.

(7) Project Management Unit for implementation

Both side agreed the necessity of setting up a Project Management Unit (PMU) as soon as the PCP approved in DPHE for smooth implementation of the Project. The PMU will be composed of the staff from DPHE, headed by the Superintending Engineer of WQMSC.

List of Main Equipment

No.	Name	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
A-01 Chemical and Instrumental Analysis for Industrial Wastewater						
A-01-01	Atomic absorption spectrophotometer	HVG	1			1
A-01-02	Atomic absorption spectrophotometer	Heavy metals	1			1
A-01-03	Atomic absorption spectrophotometer	AL, Ba, Na	1			1
A-01-04	Atomic absorption spectrophotometer	All elements			1	1
A-02	Atomic absorption spectrophotometer for Hg analysis		1			1
A-03-01	Ion chromatograph	Anion	1			1
A-03-02	Ion chromatograph	Sexivalent chrome	1			1
A-04-01	Gas chromatograph	Solvent extraction	1			1
A-04-02	Gas chromatograph	With verge & trap	1			1
A-05	Flow injection analyzer	Total P, Total N	1			1
A-06	UV-VIS spectrophotometer		2		1	3
A-07	Infrared spectrophotometer		1			1
A-08	pH meter		1	1	1	3
A-09	ORP meter		1	1	1	3
A-10	Ion meter	With selective electrodes	5	5	5	15
A-11	DO meter	Benchtop	1	1	1	2
A-12	Turbidity meter		1		1	2
A-13	TDS/EC/Salinity meter	Portable		1	1	2
A-14	COD meter	Benchtop	1	1	1	3
A-15	TOC analyzer		1			1
A-16	Microwave digestion apparatus		1			1
A-17	Pure water apparatus		1	1	1	3
A-18	Precision balance		2	1	1	4
A-19	Table for balance		2	1	1	4
A-20-01	Draft chamber with treatment	With acidic gas emission	1			1
A-20-02	Draft chamber with treatment	With solvent adsorption device	1			1
A-20-03	Draft chamber without treatment	Without acidic gas emission and solvent adsorption device		1		1
A-21-01	Clean bench	Fixed type	1			1
A-21-02	Clean bench	Desktop type		1	1	2
A-22	Autoclave	Microorganisms, 47L	1	1	1	3
A-23	Incubator	BOD and microorganisms	2	1		3
A-24	dry-heat sterilizer	Microorganisms, 150L	1			1
A-25	Dehydrator	SS, TDS	2	1	1	4
A-26	Refrigerator for reagent		3			3
A-27	Dehumidifier	15-20m2	5		1	6
A-28	Rotary evapolator	For waste solvent recycling V type	1			1
A-29	Pipet washer	Ultrasonic wave type	1			1
A-30	Shaker	Phenol chloride (for separatory funnel)	1			1
A-31	Muffle furnace		1			1
A-32	Water bath		3			3
A-33	Hot Plate		3	1	1	5
A-34	Magnetic Stirrer		3	1	1	5
A-35	Blender		1			1
A-36	Stirrer		1			1
A-37	Shaker	For single test tube	3	1	1	5
A-38	Centrifuge		1			1

No.	Name	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
A-39	End-point detection apparatus		1			1
A-40	Microscope and light source		1			1
A-41	Optical Counting Equipment		1			1
A-42-01	Temperature-Monitoring Devices		1			1
A-42-02	Thermometer	0-100°C and others	5	4	4	13
A-42-03	Thermometer		3			3
A-43	Platinum sticks		3			3
A-44	Gas flow meter	For GC flow confirmation/detergent	3			3
A-45	Ice machine		1			1
A-46	Ultrasonic cleaner		1			1
A-47	Vacuum pump	Desktop compact type		1	1	2
A-48	Automatic dispenser	10 and 20ml	3			3
A-49	Desiccator		1			1
A-50	Balance	up to 3000g	1		1	2
A-51	Membrane filtration unit	0.45microm filter paper			1	1
A-52	UPS	5KVA			1	
A-53	Stabilizer				1	
A-54	Waste water treatment device		1			1
A-55	Strage cabin		2	1	1	4
A-56	Srying rack		2	1	1	4
A-57	Potable water quality sensor		12			12
A-58	Potable water quality test kit		12			12
A-59-01	Work table	1.5x4.2m	1			1
A-59-02	Work table	1.5x3.0m	1	1		2
A-60-01	Side work table	0.75x1.5m	12		1	13
A-60-02	Side work table	0.75x3.0m	2			2
B-01-01	Beaker	50ml	40	10	10	60
B-01-02	Beaker	100ml	20			20
B-01-03	Beaker	200ml	20	20	20	60
B-01-04	Beaker	300ml	20	20	20	60
B-01-05	Beaker	500ml	20	5	5	30
B-01-06	Beaker	1000ml	5	5	5	15
B-01-07	Beaker	2000ml	5	2	2	9
B-02-01	Conical beaker	50ml		5	5	10
B-02-02	Conical beaker	100ml	20	20	20	60
B-02-03	Conical beaker	200ml	20			20
B-02-04	Conical beaker	300ml	20	20	20	60
B-02-05	Conical beaker	500ml	10	6	6	22
B-02-06	Conical beaker	1000ml	5	5	5	15
B-03-01	Odor flasks	200ml		11	11	22
B-03-02	Odor flasks	300ml		6	6	12
B-03-03	Odor flasks	500ml	50			50
B-03-04	Odor flasks	1000ml		4	4	8
B-04-01	Round bottom flask	200ml	10			10
B-04-02	Round bottom flask	500ml	10	6	6	22
B-04-03	Round bottom flask	1000ml	5	5	5	15
B-04-04	Round bottom flask	2000ml		3	3	6
B-05-01	Erlemyer flask	50ml	20			20
B-05-02	Erlemyer flask	100ml	20			20

No.	Name	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
B-05-03	Erlemyer flask	200ml	20			20
B-05-04	Erlemyer flask	300ml	20	5	5	30
B-05-05	Erlemyer flask	500ml	10	5	5	20
B-05-06	Erlemyer flask	1000ml	5	3	3	11
B-06-01	Volumetric flask, TS stopper	25ml	100			100
B-06-02	Volumetric flask, TS stopper	50ml	100	11	11	122
B-06-03	Volumetric flask, TS stopper	100ml	20	16	16	52
B-06-04	Volumetric flask, TS stopper	200ml	20			20
B-06-05	Volumetric flask, TS stopper	250ml	20	16	16	52
B-06-06	Volumetric flask, TS stopper	500ml	10	6	6	22
B-06-07	Volumetric flask, TS stopper	1000ml	5	5	5	15
B-06-08	Volumetric flask, TS stopper	2000ml	5			5
B-06-09	Volumetric flask, TS stopper	3000ml	5			5
B-06-10	Volumetric flask, TS stopper	5000ml	5			5
B-07-01	Kjeldahl flask	100ml	5			5
B-07-02	Kjeldahl flask	300ml	5			5
B-07-03	Kjeldahl flask	500ml	5			5
B-08-01	Measuring pipette	1ml	10	6	6	22
B-08-02	Measuring pipette	2ml	10			10
B-08-03	Measuring pipette	5ml	10	6	6	22
B-08-04	Measuring pipette	10ml	10	6	6	22
B-08-05	Measuring pipette	20ml	10			10
B-08-06	Measuring pipette	25ml	10	5	5	20
B-08-07	Measuring pipette	50ml	5	5	5	15
B-09-01	Volumetric pipette	1ml	20			20
B-09-02	Volumetric pipette	2ml	20			20
B-09-03	Volumetric pipette	5ml	20	5	5	30
B-09-04	Volumetric pipette	10ml	20	5	5	30
B-09-05	Volumetric pipette	20ml	20			20
B-09-06	Volumetric pipette	25ml	20	3	3	26
B-09-07	Volumetric pipette	50ml	10	3	3	16
B-09-08	Volumetric pipette	100ml	10			10
B-10-01	Komagome pipette	1ml	10			10
B-10-02	Komagome pipette	3ml	10			10
B-10-03	Komagome pipette	5ml	10			10
B-10-04	Komagome pipette	10ml	10			10
B-10-05	Komagome pipette	20ml	5			5
B-11	Rubber blower		20			20
B-12-01	Cylinder, Graduated	25ml	10			10
B-12-02	Cylinder, Graduated	50ml	10	6	6	22
B-12-03	Cylinder, Graduated	100ml	10	8	8	26
B-12-04	Cylinder, Graduated	200ml	10			10
B-12-05	Cylinder, Graduated	250ml	10	6	6	22
B-12-06	Cylinder, Graduated	300ml	10			10
B-12-07	Cylinder, Graduated	500ml	10	6	6	22
B-12-08	Cylinder, Graduated	1000ml	5	5	5	15
B-13-01	Test tube	12mm dia. x 120mm(H), plastic coated	100			100
B-13-02	Test tube	15mm dia. x 120mm(H), plastic coated	100			100
B-14-01	Reagent bottle, Narrow mouth, plane	50ml	5	5	5	15
B-14-02	Reagent bottle, Narrow mouth, plane	100ml	10	10	10	30

No.	Name	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
B-14-03	Reagent bottle, Narrow mouth, plane	250ml	10	10	10	30
B-14-04	Reagent bottle, Narrow mouth, plane	500ml	5	5	5	15
B-14-05	Reagent bottle, Narrow mouth, plane	1000ml	5	5	5	15
B-14-06	Reagent bottle, Narrow mouth, amber	50ml	10	10	10	30
B-14-07	Reagent bottle, Narrow mouth, amber	100ml	10	10	10	30
B-14-08	Reagent bottle, Narrow mouth, amber	250ml	10	11	11	32
B-14-09	Reagent bottle, Narrow mouth, amber	500ml	5	5	5	15
B-14-10	Reagent bottle, Narrow mouth, amber	1000ml	5	5	5	15
B-14-11	Reagent bottle, Wide mouth, plane	250ml	10			10
B-14-12	Reagent bottle, Wide mouth, plane	500ml	5			5
B-14-13	Reagent bottle, Wide mouth, plane	1000ml	5			5
B-14-14	Reagent bottle, Wide mouth, amber	250ml	10			10
B-14-15	Reagent bottle, Wide mouth, amber	500ml	5			5
B-14-16	Reagent bottle, Wide mouth, amber	1000ml	5			5
B-15-01	Burette	10ml, plane	5			5
B-15-02	Burette	25ml, plane	5			5
B-15-03	Burette	50ml, plane	5	5	5	15
B-15-04	Burette	10ml, amber	5			5
B-15-05	Burette	25ml, amber	5			5
B-15-06	Burette	50ml, amber	5			5
B-16-01	Separatory funnel	200ml	10			10
B-16-02	Separatory funnel	500ml	10	3	3	16
B-16-03	Separatory funnel	1000ml	5			5
B-16-04	Separatory funnel	2000ml	5			5
B-17-01	Funnel for filtering, Plain	45mm dia.	10			10
B-17-02	Funnel for filtering, Plain	60mm dia.	10			10
B-17-03	Funnel for filtering, Plain	90mm dia.	10	3	3	16
B-17-04	Funnel for filtering, Plain	105mm dia.		3	3	6
B-17-05	Funnel for filtering, Plain	120mm dia.	10			10
B-18-01	Dropping bottle, Plane	60ml	5			5
B-18-02	Dropping bottle, Plane	120ml	5			5
B-18-03	Dropping bottle, Plane	250ml	5			5
B-18-04	Dropping bottle, Amber	60ml	5			5
B-18-05	Dropping bottle, Amber	120ml	5			5
B-18-06	Dropping bottle, Amber	250ml	5			5
B-19-01	Weighing bottle	40mm dia. x 30mm(H)	10			10
B-19-02	Weighing bottle	40mm dia. x 40mm(H)	10			10
B-19-03	Weighing bottle	40mm dia. x 50mm(H)	10			10
B-19-04	Weighing bottle	50mm dia. x 30mm(H)	10			10
B-19-05	Weighing bottle	50mm dia. x 40mm(H)	10			10
B-19-06	Weighing bottle	50mm dia. x 50mm(H)	10			10
B-19-07	Weighing bottle	24ml (30 ϕ mm x 50(H)mm)		3	3	6
B-19-08	Weighing bottle	58ml (60 ϕ mm x 40(H)mm)		3	3	6
B-20-01	Petri dish	60mm dia.		16	16	32
B-20-02	Petri dish	90mm dia.	20			20
B-20-03	Petri dish	100mm dia.	50	16	16	82
B-20-04	Petri dish	120mm dia.	20			20
B-21-01	Watch glass	60mm dia.	20			20
B-21-02	Watch glass	80mm dia.		5	5	10
B-21-03	Watch glass	120mm dia.	20			20

No.	Name	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
B-22-01	Evaporating dish, Porcelain	90mm dia.	20			20
B-22-02	Evaporating dish, Porcelain	120mm dia.	20			20
B-23-01	Color comparison tube, TS stopper 100ml	50ml, 24/25	10			10
B-23-02	Color comparison tube, TS stopper 100ml	100ml, 24/25	10			10
B-24-01	Desiccators with plate	240mm dia.	3	3	3	9
B-24-02	Desiccators with plate	300mm dia.	3			3
B-24-03	Dessicator with vacuum	180mm, with flange & lid		3	3	6
B-25-01	Glass tube	8mm dia.	5			5
B-25-02	Glass tube	10mm dia.	5			5
B-26-01	Washing bottle	250ml	10			10
B-26-02	Washing bottle	500ml	5			5
B-26-03	Wash bottle (plastic)	250ml		5	5	10
B-26-04	Wash bottle (plastic)	500ml		5	5	10
B-27	BOD bottle	100ml	100			100
B-28-01	Centrifugal tubes	10ml	20			20
B-28-02	Centrifugal tubes	15ml	20			20
B-28-03	Centrifugal tubes	50ml	10			10
B-28-04	Centrifugal tubes	100ml	50			50
B-29-01	Filtering bottle	3L	3			3
B-29-02	Filtering bottle	5L	3			3
B-30-01	Condenser Liebig	300mm	10			10
B-30-02	Condenser Liebig	200mm		3	3	6
B-31	Filtration apparatus	47mm diameter	3			3
B-32-01	Auto buret, plane	25ml	3	2	2	7
B-32-02	Auto buret, amber	25ml	3	2	2	7
B-33	Sample bottle, amber	Glass with a screw cap lined with TFE	50			50
B-34	Chromatographic column	100mm × 10mm ID, with TFE stopcock with reagent	5			5
B-35	Reaction flask	15 to 25mL with standard tapered joint	10			10
B-36-01	Tall beaker	100ml	10			10
B-36-02	Tall beaker	200ml	10			10
B-37	Aspirator bottle	5000ml		3	3	6
B-38-01	Bottle with screawcap	25ml		5	5	10
B-38-02	Bottle with screawcap	50ml		5	5	10
B-38-03	Bottle with screawcap	250ml		5	5	10
B-38-04	Bottle with screawcap	500ml		5	5	10
B-38-05	Bottle with screawcap	1000ml		3	3	6
B-39	BDH crucible with sintered disk, grade 40	50ml		3	3	6
B-40	Buchner funnel with sintered disk	80ml		3	3	6
B-41	Mortar with pestle (porcelain)	Volume 400cm (300 ϕ mm)		3	3	6
B-42	Alchol lamp			5	5	10
B-43	Filter paper Whatmann grade 1	9cm dia.		5		5
B-44	Pasture pipette	250pcs pack		3	3	6
B-45	Pipette filler (rubber made)	10ml		5	5	10
B-46	Chemical gloves			3	3	6
B-47	Heat resistance glove			3	3	6
B-48	Glassware dry stand	24 holds		3	3	6
B-49	Safety glass	UV proof and chemical resistance		3	3	6
B-50	Millipore filter paper, size 47 ϕ mm	0.45U		3	3	6
B-51	Glass-fiber filter disks		3			3
B-52	Membrane filter	For micro-organisms test, 47mm diameter	3			3

No.	Name	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
B-53	Membrane filter	47mm diameter, particle holding 0.1 μm	3			3
B-54	Filter funnels	55mm diameter filter paper	3			3
B-55	Filter paper for phase separation		3			3
B-56	Ion-exchange column	With ion exchange resin	5			5
B-57	Soxhlet extraction apparatus	150mL	1			1
B-58	Filter paper		3			3
B-59-01	Gas dispersion tube	1.2m long, 6mm diameter	3			3
B-59-02	Gas dispersion tube	1.2m long, 7mm diameter	3			3
B-60-01	Syringes	0.5mL	3			3
B-60-02	Syringes	1.0mL	3			3
B-60-03	Syringes	5.0mL	3			3
B-60-04	Syringes	25.0mL	3			3
B-61-01	Microsyringes	10-iL	3			3
B-61-02	Microsyringes	25-iL	3			3
B-61-03	Microsyringes	100-iL	3			3
B-62-01	Gastight syringe	10-iL	3			3
B-62-02	Gastight syringe	25-iL	3			3
B-62-03	Gastight syringe	100-iL	3			3
B-63	Kuderna-Danish apparatus		3			3
B-64	Concentrator tube		50			50
B-65	Vials		50			50
B-66	Boiling chips		1			1
B-67-01	Sample bottle	General water quality elements	1,000			1,000
B-67-02	Sample bottle	For heavy metal	1,000			1,000
B-67-03	Sample bottle	For micro-organisms test	500			500
B-67-04	Sample bottle	Effluvium	500			500
B-68	Dilution bottle		100			100
B-69	Fermentation Tubes and Vials		100			100
B-70-01	Micro pipetter	1-5ml	3		1	4
B-70-02	Micro pipetter	2-10ml	3		1	4
B-71	Crucible, made by Alumina		5			5
B-72	Crucible tong	300ml	2			2
B-73	Combustion Tube, Alumina made		5			5
C-01	pH standard solution 4.01		20			20
C-02	pH standard solution 6.86		20			20
C-03	(NH2)2・H2SO4		2			2
C-04	(CH2)6N4		20			20
C-05	KH2PO4		2			2
C-06	K2HPO4		8			8
C-07	Na2HPO4・7H2O		2			2
C-08	NH4Cl		4			4
C-09	MgSO4・7H2O		2			2
C-10	CaCl2		2			2
C-11	FeCl3・6H2O		2			2
C-12	sodium hydroxide		2			2
C-13	Na2SO3		2			2
C-14	glucose		4			4
C-15	glutamic acid		4			4
C-16	K2Cr2O7		2			2

No.	Name	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
C-17	Ag2SO4		2			2
C-18	H2SO4		10			10
C-19	1,10-phenanthroline monohydrate		4			4
C-20	FeSO4·7H2O		2			2
C-21	Fe(NH4)2(SO4)2·6H2O		2			2
C-22	HgSO4, crystals or powder		2			2
C-23	HOOCC6H4COOK		4			4
C-24	K2S2O8		8			8
C-25	NH4OH		6			6
C-26	H3PO4		4			4
C-27	Sulfanilamide		2			2
C-28	N-(1-naphthyl)ethylenediamine dihydrochloride	NED	2			2
C-29	CuSO4·5H2O		3			3
C-30	Copperized cadmium granules		3			3
C-31	KNO3.		3			3
C-32	NaOH		8			8
C-33	NH3	1000mg/L	2			2
C-34	CH3COOH		2			2
C-35	NaCl		6			6
C-36	1,2-cyclohexylenediaminetetraacetic acid	CDTA	3			3
C-37	F	1000mg/L	2			2
C-38	KOH		2			2
C-39	CN	1000mg/L	2			2
C-40	KCl		2			2
C-41	Ascorbic acid		3			3
C-42	Na2H2		2			2
C-43	Na2S-9H2O		2			2
C-44	K2SO4		2			2
C-45	Na2S2O3·5H2O		6			6
C-46	1,1-Dichloroethylene in methanol	packed in pierceable ampules	2			2
C-47	1,2-Dichloroethylene in methanol	packed in pierceable ampules	3			3
C-48	Tetrachloroethylene in methanol	packed in pierceable ampules	3			3
C-49	Trichloroethylene in methanol	packed in pierceable ampules	3			3
C-50	Cloroform in methanol	packed in pierceable ampules	3			3
C-51	Benzene in methanol	packed in pierceable ampules	3			3
C-52	Na2SO4		4			4
C-53	Acetone		2			2
C-54	Methanol		10			10
C-55	Methylene chloride		2			2
C-56	K2CO3		2			2
C-57	a-bromopentafluorotoluene		2			2
C-58	1,4,7,10,13,16-hexaoxacyclooctadecane		2			2
C-59	2-propanol		2			2
C-60	Hexane		2			2
C-61	Toluene		2			2
C-62	Silica gel		6			6
C-63	Sodium carbonate		2			2
C-64	Standard solutions	1000mg/L	2			2
C-65	Standard solutions	1000mg/L	2			2
C-66	H2SO4		4			4

No.	Name	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
C-67	(NH4)6Mo7O24·4H2O		2			2
C-68	C8H4K2O12Sb2·3H2O		2			2
C-69	KH2PO4		2			2
C-70	Standard solutions	1000mg/L	2			2
C-71	HNO3, conc.		6			6
C-72	Aluminum	1000mg/L	2			2
C-73	Ammonium acetate		2			2
C-74	8-hydroxyquinoline		2			2
C-75	Reagent grade		2			2
C-76	Hydroxylamine hydrochloride		2			2
C-77	Barium	1000mg/L	2			2
C-78	Curcumin		2			2
C-79	Oxalic acid		2			2
C-80	Ethyl alcohol		2			2
C-81	Hydrochloric acid, conc		10			10
C-82	CL2	1000mg/L	2			2
C-83	SO4	1000mg/L	2			2
C-84	CaCO3		2			2
C-85	Lanthanum oxide		8			8
C-86	Hydrogen peroxide	30%	2			2
C-87	Ca	1000mg/L	2			2
C-88	Mg	1000mg/L	2			2
C-89	Phenol		2			2
C-90	KBrO3		2			2
C-91	KBr		2			2
C-92	starch powder		2			2
C-93	KH2PO4		6			6
C-94	4-aminoantipyrine		2			2
C-95	K3Fe(CN)6		2			2
C-96	CHCL3		2			2
C-97	anhydrous Na2SO4, granular		2			2
C-98	Potassium bi-iodate anydrous		2			2
C-99	Phenylarsine oxide		2			2
C-100	anhyrous NaC2H3O2		2			2
C-101	Tryptose		4			4
C-102	Lactose		4			4
C-103	Sodium lauryl sulfate		2			2
C-104	Nitogen gas		2			2
C-105	Ethyl acetate		2			2
C-106	NaHCO3		4			4
C-107	1,1,2-trichloro-1,2,2-trifluoro ethane		2			2
C-108	Isooctane		2			2
C-109	Hexadecane		3			3
C-110	Benzene		2			2
C-111	NaBH4		2			2
C-112	KI, crystals		4			4
C-113	conc H2SO4		2			2
C-114	K2S2O8		2			2
C-115	HClO4, conc		2			2
C-116	HCl conc		4			4

No.	Name	Specification	Quantity			
			Dakha	Jhenaidah	Noakhali	Total
C-117	As	1000mg/L	2			2
C-118	Se	1000mg/L	2			2
C-119	Cd	1000mg/L	2			2
C-120	Cr	1000mg/L	2			2
C-121	(NH4)2SO4		2			2
C-122	1,5-diphenylcarbazide		2			2
C-123	HPLC-grade methanol		2			2
C-124	K2Cr2O7 standard grade		2			2
C-125	Cu	1000mg/L	2			2
C-126	Fe	1000mg/L	2			2
C-127	Pb	1000mg/L	2			2
C-128	Mn	1000mg/L	2			2
C-129	KMnO4		2			2
C-130	NH2OH·H2SO4		2			2
C-131	SnCl2		2			2
C-132	Ni	1000mg/L	2			2
C-133	Sn	1000mg/L	2			2
C-134	Zn	1000mg/L	2			2
C-135	Ag	1000mg/L	2			2
C-136	Na	1000mg/L	2			2
C-137	Na2CO3		2			2
[illegible]						
D-01	4WD passenger vehicle	For manamement of zonal laboratories	2			2
D-02	Microbus	For training	1			1
D-03	Pick-up truck	To tranport samples and material	1			1
[illegible]						
E-01	Projector		1			1
E-02	Opaque projector		1			1
E-03	Screen		2			2
E-04	Laptop PC		1			1
E-05	Digital video camera		1			1
E-06	Printer		1			1
E-07	Photocopy machine		1			1
[illegible]						
F-01	PC for server		1			1
F-02	PC		10			10
F-03	Printer		1			1
F-04	Scanner		1			1
F-05	Digitaizer		1			1
F-06	Software		1			1

Costs to be borne by the Bangladeshi Side

annex-2

Unit: TK

Item		Cost (Sep.2004-Jun.2005)	Deadline	Cost (Jul.2005-Mar.2006)	Deadline
Costs related to construction of central laboratory	Leveling of ground	360,000	Sep.2004	0	—
	Construction permit	50,000	Dec.2004	0	—
	Installation of electricity	200,000	Feb.2005	200,000	Nov.2005
	Connection of water supply, telephone line, etc.	50,000	Feb.2005	50,000	Aug.2005
	Installation of fence and outer wall	30,000 (temporary)	Feb.2005	140,000 (permanent)	Feb.2006
	Purchase of general furniture	0	—	1,800,000	Dec.2005
Costs related to renovation of zonal laboratories	Relocation of facilities for renovation work	0	—	100,000	Aug.2005
	Connection of electricity, water supply, telephone line, etc.	0	—	300,000	Jul.2005
	Purchase of general furniture	0	—	400,000	Dec.2005
Operation & Maintenance (for 6 months)		0	—	6,044,000	Nov.2005
Customs duty, B/A set up fee		4,125,000	Sep.2004	6,000,000	Jul.2005
Total		4,815,000	—	15,034,000	—

* Contingency is not included in the cost.

annex-3

Items to be managed by the Bangladeshi side during implementation of the Project

(1)All necessary procedures described in annex-4 of the Minutes of Discussion signed by the Bangladeshi side and the Japanese side on 4 March 2004.

(2) Land leveling of the site for the Central Laboratory by September 2004

(3) Provision of space to store equipment and materials near the Central Laboratory

(4) Acquisition of construction permission for the Central Laboratory

(5) Preparation of utilities such electricity, water service, sewage, gas and telephone, for the Central Laboratory, Jhenaidah Zonal Laboratory and Noakhali Zonal Laboratory

(6) Construction of fences and outer walls surrounding the Central Laboratory

(7) Procurement of general furniture for the Central Laboratory, Jhenaidah Zonal Laboratory and Noakhali Zonal Laboratory

(8) To remove temporarily the existing equipment and material during renovation of Jhenaidah Zonal Laboratory and Noakhali Zonal Laboratory and replace them as requiring

(9) To secure offices for staff in Jhenaidah Zonal Laboratory and Noakhali Zonal Laboratory

(10) Introduction and improvement of regulatory framework for drinking water examination in national level

(11) To secure the Water Quality Monitoring and Surveillance Circle in DPHE

(12) Establishment of revolving fund system to secure budget for laboratory management and operation before completion of the Project

(13) To secure budget for laboratory management and operation until the revolving fund system can provide full cost

(14) To secure posts for staff of the Central Laboratory, Jhenaidah Zonal Laboratory and Noakhali Zonal Laboratory on a revenue basis and recruitment of staff by September, 2005 at latest

(15) To secure the posts for staff for the other nine zonal laboratories on a revenue basis and recruitment of staff by September, 2005 at latest

5. References

5-1 Technical Note

5-2 Result of Soil Test (SPT)

5-1 Technical Note

Technical Note

Following items were discussed and agreed by DPHE and the Basic Design Team.

1 Building / facility

1.1 Central laboratory

As attached drawings.**(attachment 1 and 2)**

1.2 Zonal laboratories in Jhenaida and Noakhali.

Renovation work to make the laboratories as attached drawings. **(attachment 3 and 4)**

2 Equipment

Major equipment as attached list.**(attachment 5)**

3 Operation and maintenance

3.1 Staffing

Organization chart and staffing plan for the central laboratory and zonal laboratories as attached list. Mandate of each division is as attached.**(attachment 6, 7 and 8)**

3.2 Operation and maintenance

Budget required for the operation and maintenance will be further studied by the Team and will be reported in end of May or early June.

4 Undertaking of Bangladeshi side

Undertaking required by the Government of Bangladesh for the Japan's Grant Aid system is agreed and confirmed as Minutes of Discussions signed on March 4th, 2004. Further detail was agreed for following items.

- The existing building, facilities, stocked material and any others things currently occupying the project site of the central laboratory shall be removed and make a vacant lot. Additional space around the site shall be secured for the stock area of construction materials. Dead line for the above shall be before the commencement of detailed design work (currently assumed at September, 2004).
- The above land clearance schedule shall be prepared and submitted to BD2 study team **(attachment 9).**

- The facility/equipment shall be moved and the room shall be cleared for the renovation work at the zonal laboratories in Jhenaida and Noakhali. .
- New manpower setup (Water Quality Monitoring & Surveillance Circle and zonal laboratories in Jhenaida and Noakhali) shall be established under revenue budget with the staff as agreed upon in item 3.1.
- Necessary items including office furniture and chemical shall be secured.
- Any permit and clearance required by the law of the Bangladesh for the central laboratory as well as for renovation of zonal laboratory shall be obtained before July, 2004.

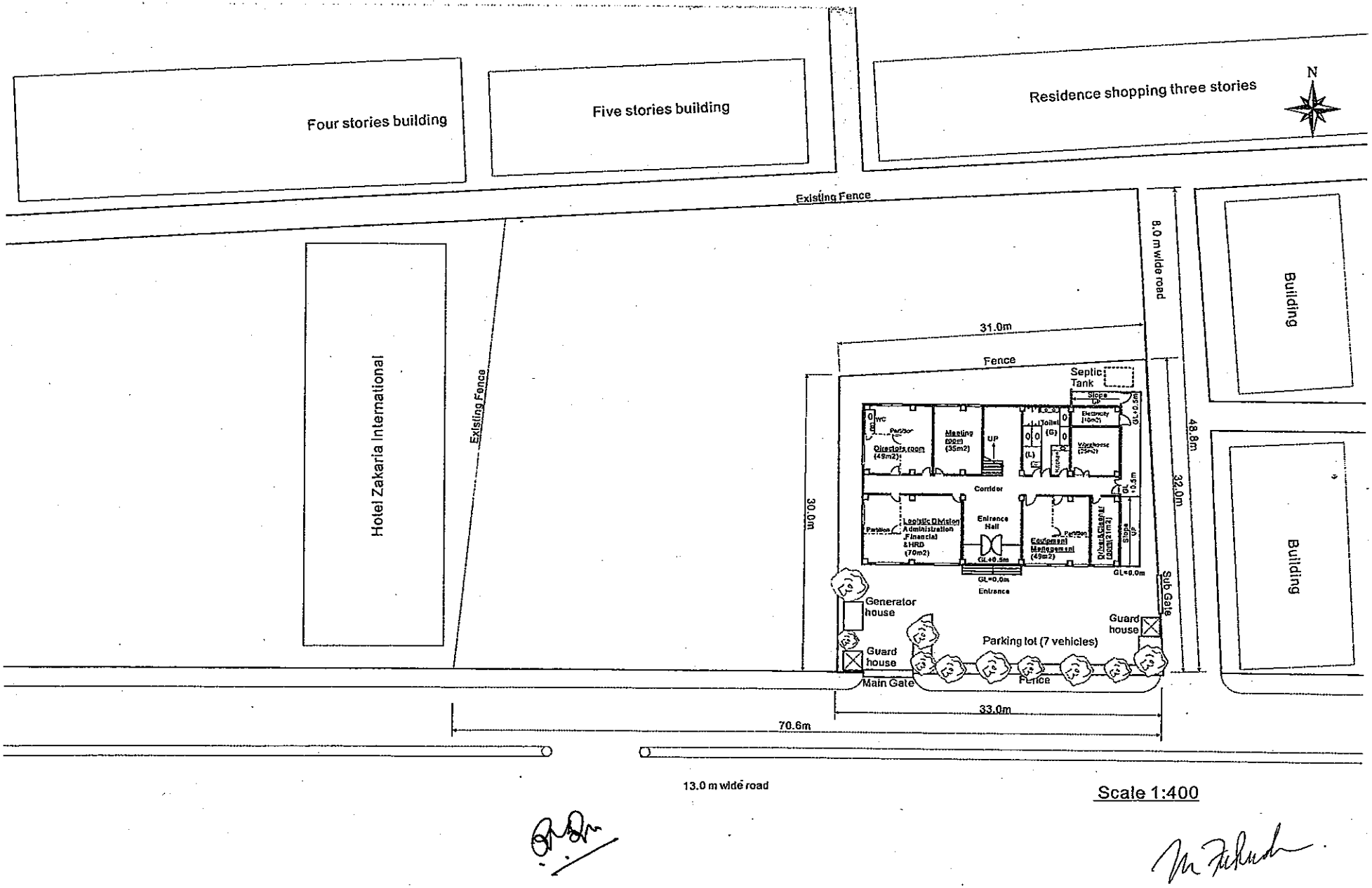
5. A function of central laboratory as stated in the Minutes of Discussions (Attachment 7. (3)) signed on March 4, 2004, "to analyze water sample from rural areas where zonal laboratories can not cover" shall be corrected as "to analyze water sample from rural areas which zonal laboratories can not cover in terms of parameter".

6. The final components of the Project (basic design of the building and equipment) shall be assessed in Japan and shall be decided after the assessment.

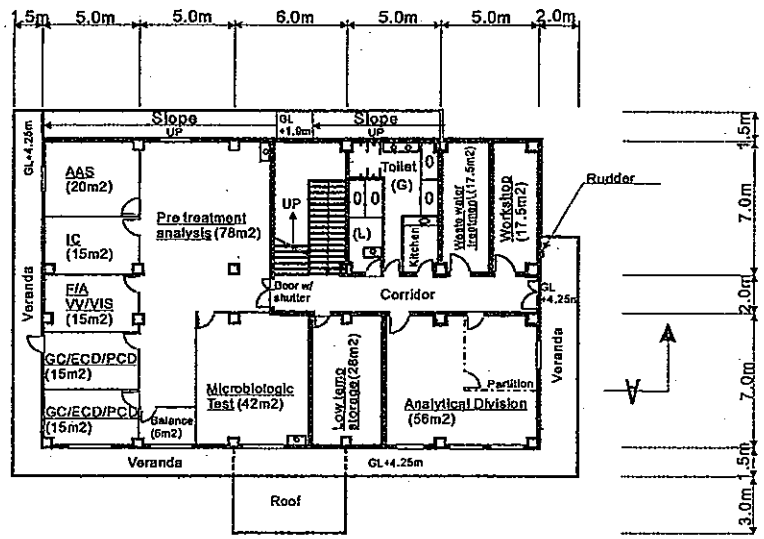
Date: May 27th, 2004

Amanullah Al Mahmood
Superintending Engineer
Department of Public Health Engineering
Ministry of Local Government Rural Development & Cooperatives
The People's Republic of Bangladesh

Munehiro Fukuda
Operation & maintenance/Water Quality Analysis 1
Basic Design Study Team
Japan International Cooperation Agency
Japan


Four stories building
Five stories building
Residence shopping three stories
N
Existing Fence
Hotel Zakaria International
Existing Fence
8.0 m wide road
Building
Building
31.0m
Fence
Septic Tank
48.8m
32.0m
30.0m
Corridor
Entrance Hall
Entrance
Generator house
Guard house
Guard house
Sub Gate
Parking lot (7 vehicles)
Main Gate
Fence
33.0m
70.6m
13.0 m wide road

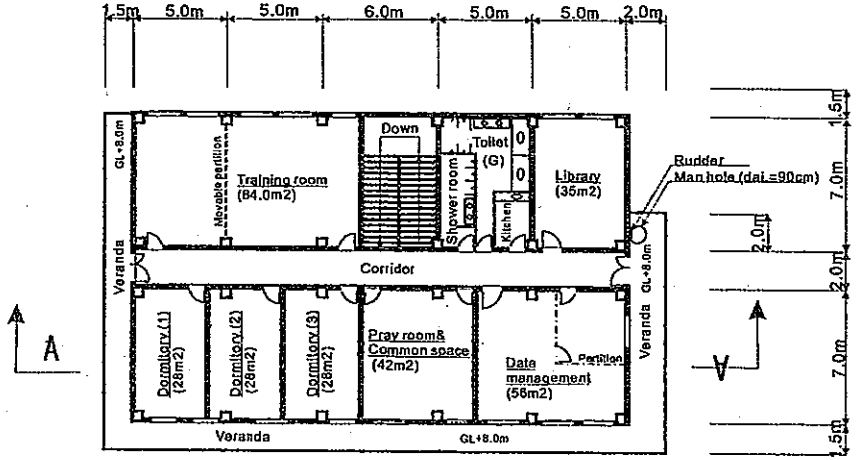
Scale 1:400



A

Plan of 1st Floor

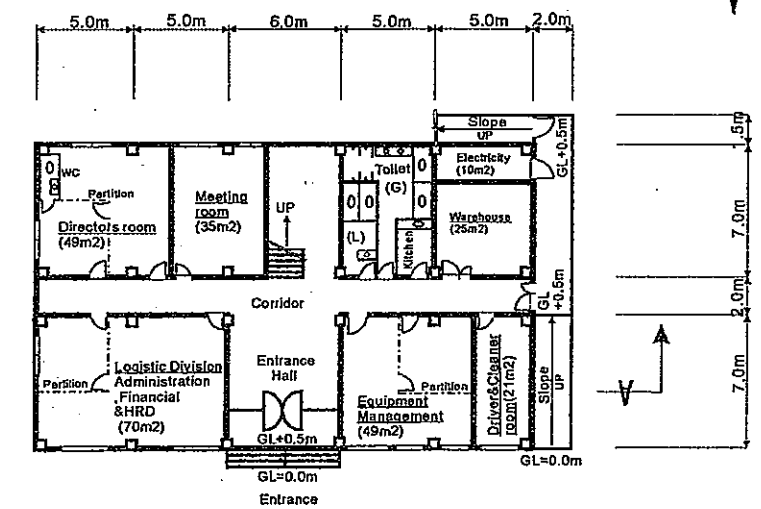
S=1:40



A

Plan of 2rd Floor

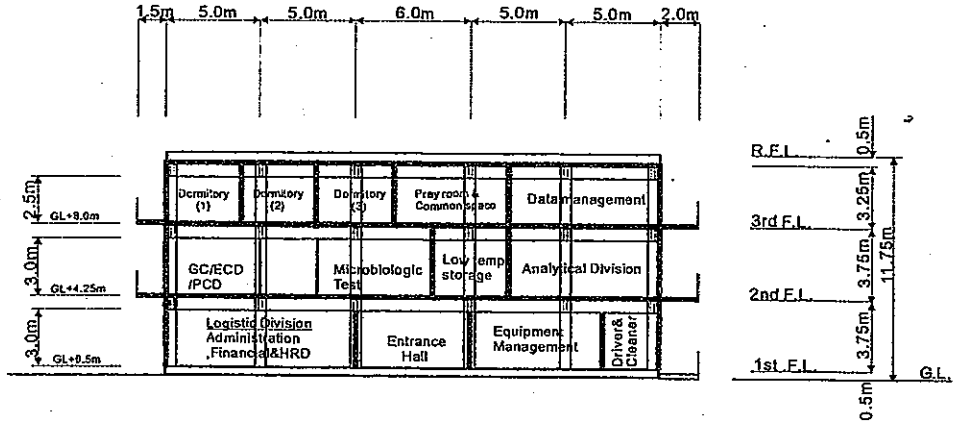
S=1:40



A

Plan of Ground Floor

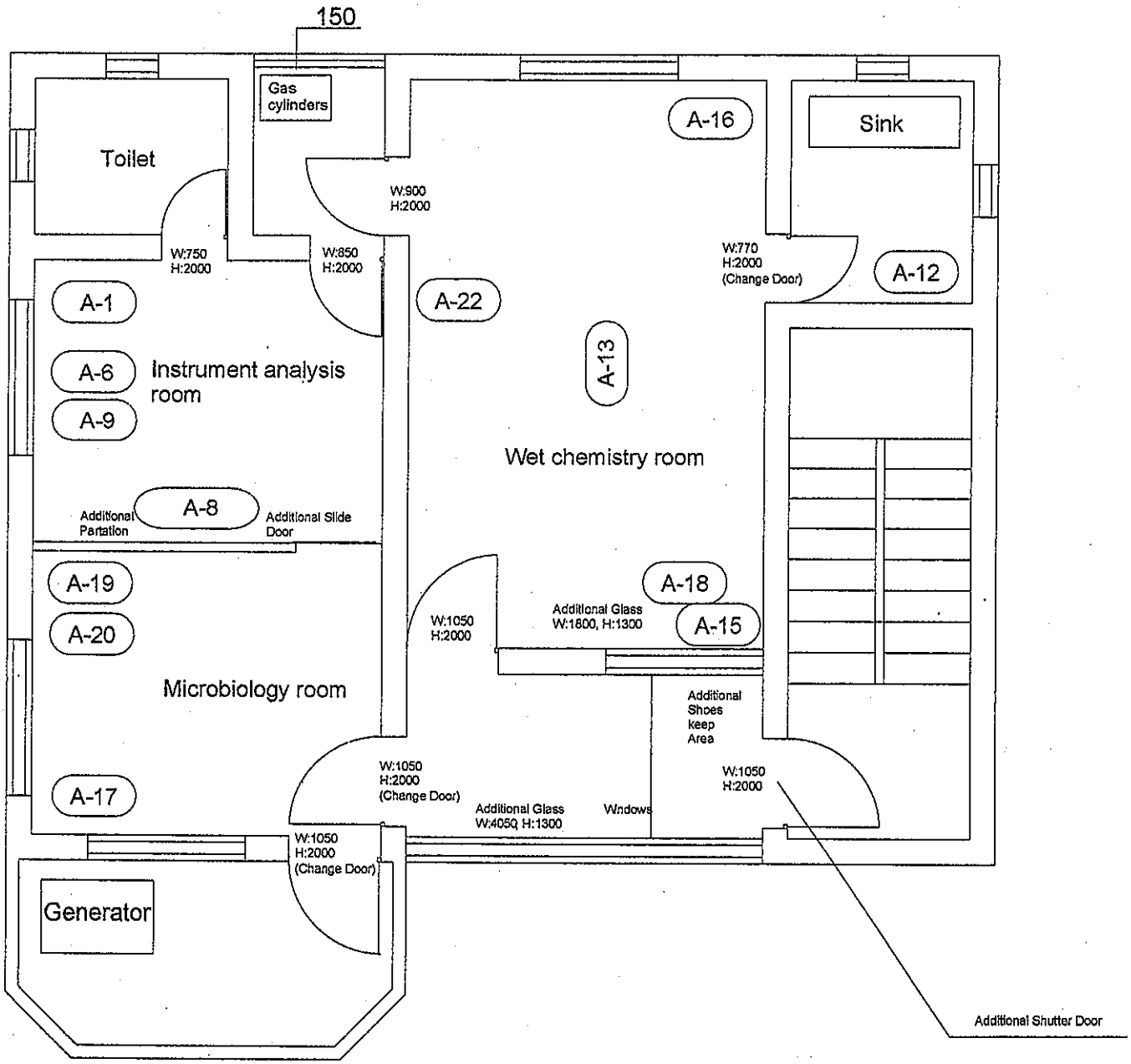
N



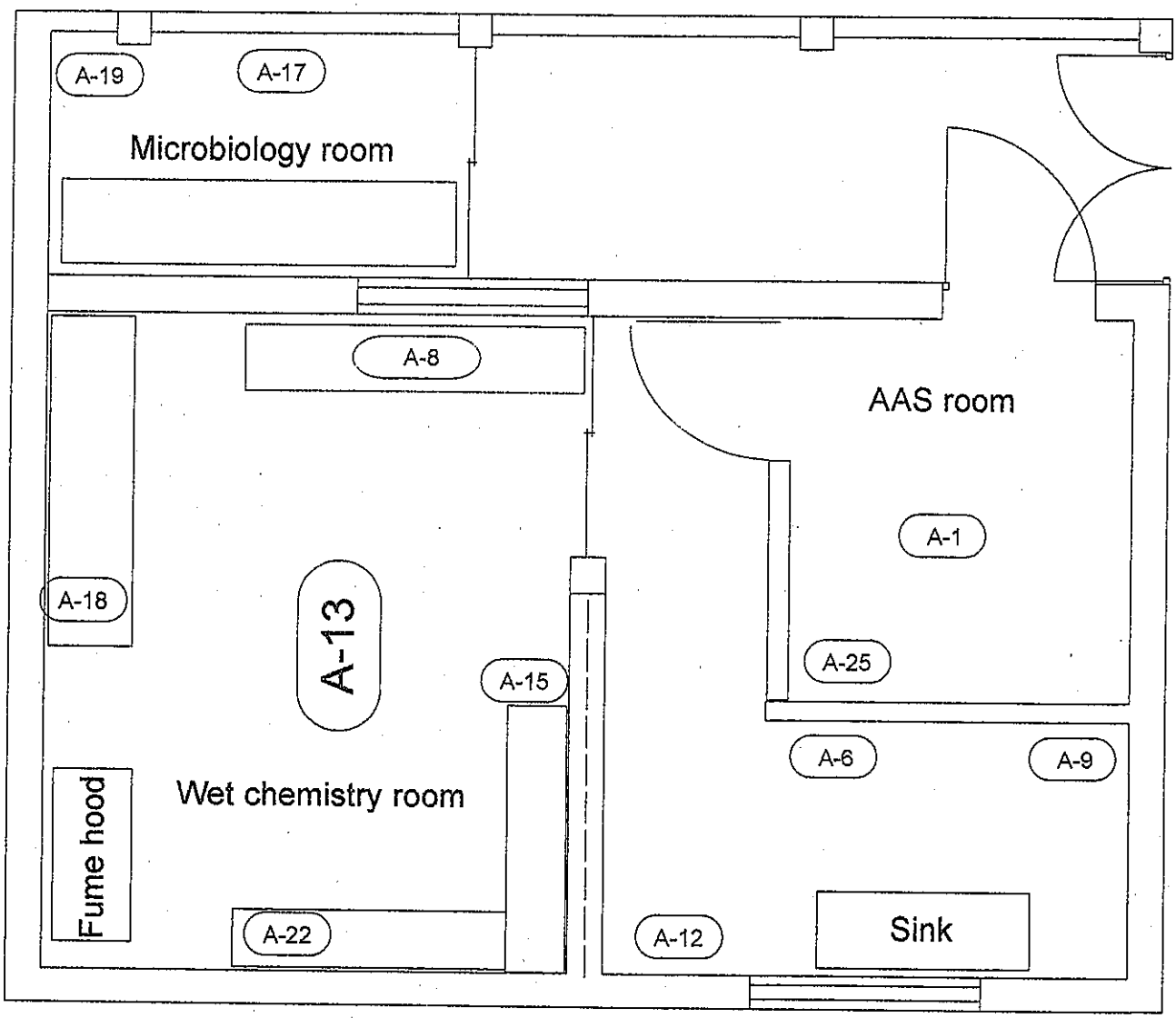
A-A Section

S=1:40

2



Jhenaida Laboratory

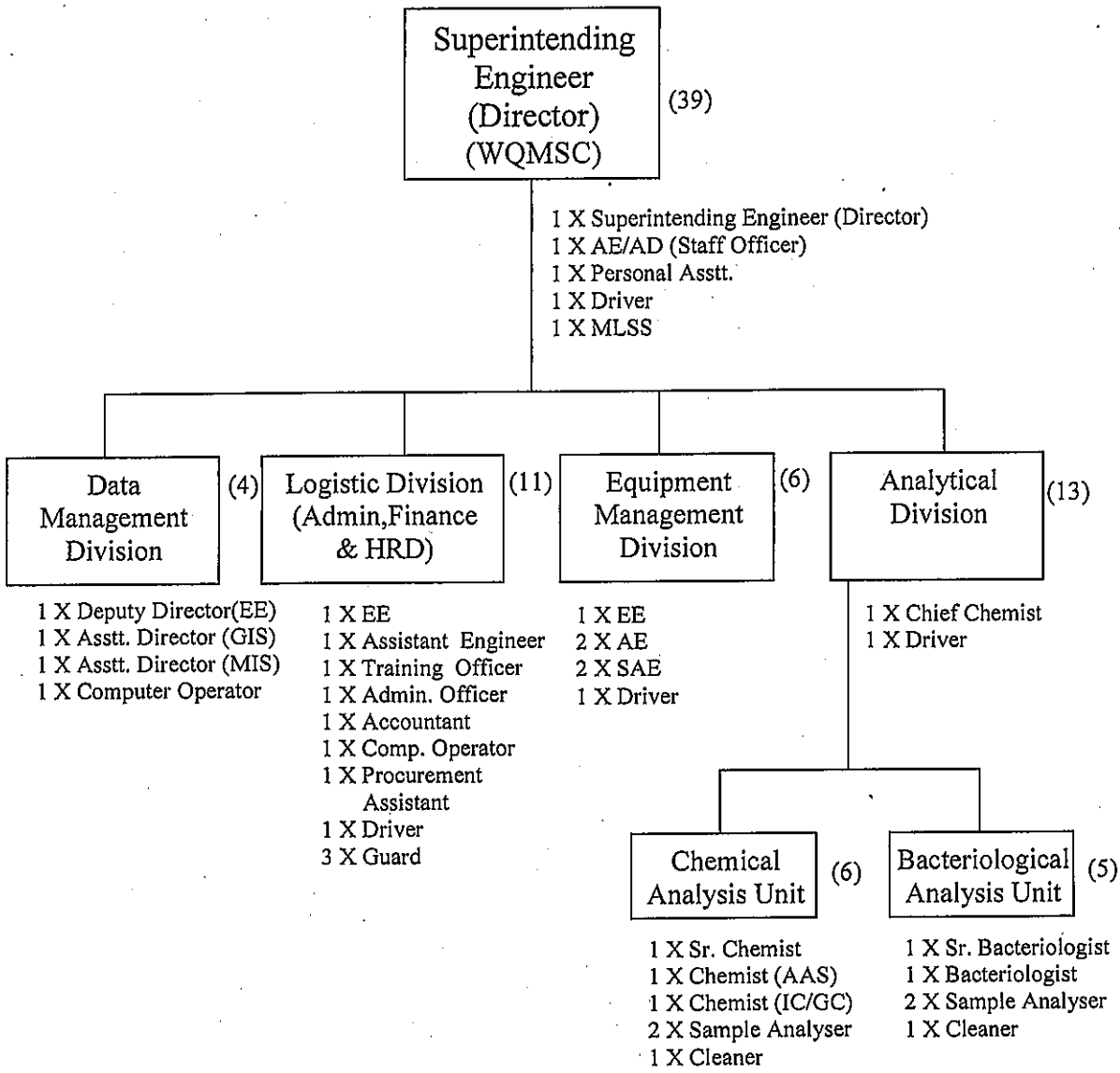


Noakhali Laboratory

List of major equipment

No.	Item	Number of procurement			
		Central	Jhenaida	Noakhali	Total
A. Laboratory apparatus					
A-1	Atomic absorption spectrophotometer	3	0	1	4
A-2	Atomic absorption spectrophotometer for Hg analysis	1	0	0	1
A-3	Ion chromatograph	2	0	0	2
A-4	Gas chromatograph with purge & trap device	2	0	0	2
A-5	Flow injection analyzer	2	0	0	2
A-6	UV-VIS spectrophotometer	2	1	1	4
A-7	Infrared spectrophotometer	1	0	0	1
A-8	Ion meter with selective electrode	8	8	7	23
A-9	Turbidity meter	1	1	0	2
A-10	TOC analyzer	1	0	0	1
A-11	Microwave digestion apparatus	1	0	0	1
A-12	Pure water apparatus	1	1	1	3
A-13	Work table	2	1	1	4
A-14	Side work table	14	0	0	14
A-15	Balance table	2	1	1	4
A-16	Draft chamber with treatment for acid fume and solvent	2	0	0	2
	Draft chamber without treatment	0	1	0	1
A-17	Bio clean bench (installation type)	1	0	0	1
	Bio clean bench (desktop type)	0	1	1	2
A-18	Precision balance	2	1	1	4
A-19	Autoclave	1	1	1	3
A-20	Incubator	2	1	0	3
A-21	Hot-air sterilizer	1	0	0	1
A-22	Drying oven	2	1	1	4
A-23	Refrigerator for reagent	3	0	0	3
A-24	Portable toxicity test kit	1	0	0	1
A-25	Dehumidifier	5	0	1	6
A-26	Rotary evaporator	1	0	0	1
A-27	Pipette washer	1	0	0	1
A-28	Shaker	1	0	0	1
A-29	Others	1	1	1	3
A-30	Grassware	1	1	1	3
A-31	Reagents	1	0	0	1
B. Vehicle					
B-1	4WD	2	0	0	2
B-2	Micro bus	1	0	0	1
B-3	Pickup truck	1	0	0	1
C. Training equipment					
C-1	Projector	1	0	0	1
C-2	Opaque projector	1	0	0	1
C-3	Screen	2	0	0	2
C-4	Laptop PC	1	0	0	1
C-5	Digital camera	1	0	0	1
C-6	Portable water quality testing sensor	12	0	0	12
C-7	Portable water quality testing kit	12	0	0	12
C-8	Printer	1	0	0	1
C-9	Photocopy machine	1	0	0	1
D. Data management equipment for water quality results					
D-1	Server PC	1	0	0	1
D-2	Desktop PC	10	0	0	10
D-3	Printer	1	0	0	1
D-4	Scanner	1	0	0	1
D-11	Digitizer	1	0	0	1
D-12	Software	1	0	0	1

DPHE Central Laboratory



WQMSC : Water Quality Monitoring & Surveillance Circle.

Proposed manpower set up for Zonal Laboratory at Jhinaidah

Sl No.	Description of the posts	No of Post
01	Senior Chemist	1
02.	Junior Chemist	1
03.	Sample analyzer	2
04.	Computer operator	1
05.	Sample collector	2
06	Driver	1
07.	Cleaner(Full time)/MLSS	1
	Total:	**9**

Proposed manpower set up for Zonal Laboratory at Noakhali

Sl No.	Description of the posts	No of Post
01	Senior Chemist	1
02.	Junior Chemist	1
03.	Sample analyzer	2
04.	Computer operator	1
05.	Sample collector	2
06	Driver	1
07.	Cleaner(Full time)/MLSS	1
	Total:	**9**

DPHE Central Laboratory

Responsibilities of Manpower setup

Superintending Engineer(Director)

- Overall management of laboratories of DPHE
- Coordination within & outside DPHE
- Planning for ISO-17025
- Communication & awareness building

Data Management Division

- Management of LIMS
- Data acquisition and storage
- Management & processing of data
- Publication of reports, maps etc.

Logistic Division

- Assist SE (Director) in Administration & Financial management
- Coordinate HRD functions
- Procurement, storage and supply of chemicals and others

Equipment Management Division

- Maintenance and Repair Management of equipment and Spares for all DPHE labs.
- Assist SE/Chief Chemist in the procurement of Equipments and Spares

Analytical Division

- Water Quality monitoring & surveillance
- Chemical analysis of samples
- Bacteriological analysis of samples
- Management of QA/QC programme for all Labs of DPHE
- On the Job Training for all laboratory personnel
- Carryout / Assist in Applied Research/Study

Project site clearance schedule

	204								
	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
Notify movement of staff			→						
Movement of staff				→	→				
Relocaion of equipment / Demolish of temporary structure						→			
Land clearance						→			
Preparatry works for implementation							·····	·····	····· →

5-2 Result of Soil Test (SPT)

KOKUSAI KOGYO CO., Ltd.
5 Sanban-Cho, Chiyoda-ku, Tokyo, 102-0075 Japan

Report

on

Standard Penetration Test (Soil Test) for the Project on Strengthening of Water Examination System in the People's Republic of Bangladesh

April - 2004

BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD.
House No.10, Road No.135, Gulshan-1, Dhaka-1212, Bangladesh

Report on Standard Penetration Test (Soil Test) for the Project on Strengthening of Water Examination System in the People's Republic of Bangladesh

Table of Contents

1 INTRODUCTION

M/S Kokusai Kogyo Co., Ltd. entrusted M/S Bangladesh Engineering & Technological Services (BETS) Ltd. with the assignment for completing all the Standard. Penetration Test of the site for construction of Laboratory Building at Mohakhali in connection with the Project on Strengthening of Water Examination System in the People's Republic of Bangladesh. A contract to this effect was signed on the 15th day of April 2004 between the two parties for doing the soil test. The purposes of the investigations were for the safety as well as economy in design for the foundation structure of the proposed building.

This report contains information on scope of works, methodology of field investigation & laboratory investigations, discussion on physical and engineering properties, of sub-soil, evaluation at test data, analysis of bearing capacity, charts and graphs representing field and laboratory test results along with conclusion and recommendation.

2 SCOPE OF WORK

The scope of works includes all works such as mobilization preparation of equipment, soil test reporting etc. Specific scope of work involves performing Standard Penetration Test at *5* (five) points for designing the foundation of 3 (three) storied RCC building at Mohakhali DPHE land in the Dhaka City of Bangladesh.

Some additional but related investigations have been performed to obtain information relating to foundation condition commensurate with the magnitude and type of structure involved with the project. The soil investigations both in the field and in the laboratory were carried out in detail to evaluate the physical, mechanical and geotechnical properties of the soil. The followings are the detailed lists of investigations done.

A Field Investigations

(i) Number of boring 5 (five) nos. to a depth of 12m (1 meter more than the average depth where SPT has been found to be more than 25.)

(ii) SPT execution - 44 (forty four) nos. at interval of 1.00/1 .5m

(iii) Collection of 44 (forty four) nos. disturbed samples and 7 (seven) nos. undisturbed samples.

(iv) Ground water level observation - 5 (five) nos.

B Laboratory Investigations

(i)	Grain size analysis	-	15 Nos.
(ii)	Atterberg limit test	-	5 Nos.
(iii)	Sp. gravity test	-	4 Nos.
(iv)	Moisture content test	-	7 Nos.
(v)	Unconfined compression test	-	7 Nos.
(vi)	Direct shear test	-	9 Nos.
(vii)	Consolidation test	-	5 Nos.

The test results, analysis, discussions and recommendations which are presented in this report is valid only for the locations where the actual investigation have been carried out.

C Reporting Related to the Study are

Two (2) copies of report and one (1) set of digital data in English shall be submitted to the Client. The report shall include the following

- Columnar section including description of the faces of sample and "N" values
- Time and date of the beginning and completion of the test
- Weather conditions
- Observation of the test ground
- Change of the ground surface around the loading plate due to application of load
- Any unusual conditions observed during the test
- Photograph of sites and activities
- The result of calculation of the bearing power by using "N" values; etc.

3 METHODOLOGY

3.1 Field Works

The methodology of conducting field investigation is discussed below:

Location of bore hole

The locations of *5* bore holes were shown in the ground by the representative of the client. These were marked by pegs for subsequent identification during field work (shown in photograph).

Exploratory boring drilling

Drilling was executed by the method of wash boring. A hole was started by driving vertically a 4 inches dia steel casing into the ground to some depth and than the formation inside the casing was broken up by the repeated drops of a chopping bit attach to the lower end of the drilling pipe. The upper end of the same was fitted to swivel head through which water was forced at high pressure through pressure pipe. Forced water emerges at high velocity through the pores of the chopping bit and returns to the surface, carrying with it the broken-up soils. In this way drilling is advanced upto a level of 6 inches above the depth, where SPT has to be executed.

Standard Penetration Tests (SPT)

The Standard Penetration Tests (SPT) were performed in all the bore holes. The test were executed by using a thick walled split spoon sampler of 35mm internal and 50.8 mm outer dia and a 65 kg hammer falling freely from a constant height of 75 cm interval. The SPT value (N value) were taken as the; summation of the number of blows required in 2^{nd} and 3^{rd} 15 cm of penetration of sampler. The N-values are shown on the bore hole logs against the respective interval of tests.

The Standard Penetration Tests provide a fair knowledge on the density and consistency of the soil layer encountered and in addition yield disturbed/ semi-disturbed soil samples from within the split sampler used during the tests.

Disturbed sample collection

The disturbed samples were collected with the help of split spoon sampler used during Standard Penetration Tests. The collected samples were classified in-situ and were preserved in water tight polyethylene bags with proper identification marks for onward transmission to the laboratory for further analysis. The disturbed samples were also used to reconstruct depth wise stratification of bore holes depending on its classifications.

Undisturbed soil sample collection

Undisturbed soil samples were collected whenever feasible from the cohesive layers with the help of thin walled Shelby tubes 76 mm dia thin walled Shelby tubes are penetrated into the undisturbed soil formation at the bottom of the bore hole by applying repaid but continuous force. The samples recovered within the Shelby tubes were wax sealed at both ends and transmitted to the laboratory with proper identification marks.

Recording of ground water table

The ground water table was recorded in each of the bore holes by rope/ sounding rod after 24 hours of completion of the drilling and sampling operation.

Correction of field SPT values

If the soil is very fine or silty saturated sand and the measured penetration resistance is greater than 15, then the field "N" value should be adjusted by

$N = 15 + ½ (N'-15)$ Where, N = Corrected SPT and N' = Field SPT

3.2 Laboratory Tests

Different types of laboratory tests were performed in the laboratory to evaluate the physical and engineering properties of the sub-soil formation to facilitate determination of soil bearing capacities and to recommend foundation type and magnitude. Grain Size Analysis, Atterberg Limits and Sp. Gravity Tests were performed to ascertain the detail composition of the soil and to evaluate the physical parameters of the formation. These tests also help in classifying the soils properly for geological and geotechnical interpretation. Unconfined Compression, Density and Shear tests were done to evaluate the shear characteristics of the soils, which directly help in bearing capacity calculations. Consolidation tests provide data on consolidation behaviour of the sub-soil formation. The laboratory tests were performed as per AASHTO/ASTM Standard.

3.3 Description of Soil Composition

The following terms are generally used in reports for description of soil composition;

Trace	:	1 to 10%
Little	:	10 to 20%
Some	:	20 to 35%
Sandy	:	35 to 50% sand
Clayey	:	35 to 50% clay
Silty	:	35 to 50% silt

On the basis of N-Values the relative density/ consistency of soil formation may be said to vary as, very loose, loose, medium, dense, and very dense for non-cohesive soil and very soft, soft, medium stiff, very stiff and hard for cohesive soil (after K Tarzaghi and R.B. Peck). Based on N-values other very useful soil parameters may be obtained from the correlation charts given by different research workers. Two such useful correlation for cohesive and non-cohesive soils after Prof. K. Terzaghi are given below:

For cohesionless soil

SPT N Value	Approx. Ø	Density Index	Description	Density T/cu m
0-4	25-30	0	Very Loose	1.12-1.60
4	27-32	15	Loose	1.44-1.84
10	30-35	35	Medium	1.76-2.08
30	35-40	65	Dense	1.76-2.24
50	34-43	85	Very Dense	2.08-2.40

For cohesive soil

SPT (N) Value	qu t/sq m	Density t/cu m	Consistency
0	2		Very Soft
2	2.5	1.60-1.92	Soft
4	5.0	1.76-2.08	Medium
8	10.0	1.76-2.08	Stiff
16	20.0	1.92-2.24	Very Stiff
32	40.0	1.92-2.24	Hard

3.4 Evaluation of Bearing Capacity of Soil

The bearing capacity of the shallow foundation particularly for top layer of cohesive soil may be estimated from the SPT values, as suggested by Terzaghi, according to following Table.

Bearing Capacity of the shallow foundation, TSF (F.S.=3.0)

SPT range	Consistency	Allowable Bearing Capacity	
		Continuous Footing	Isolated Column Footing
0 – 2	Very soft	0.00 - 0.225	0.00 - 0.30
2 – 4	Soft	0.225 - 0.45	0.30 - 0.60
4 – 8	Medium	0.45 - 0.90	0.60 - 1.20
8 – 15	Stiff	0.90 - 1.80	1.20 - 2.40
15- 30	Very stiff	1.80 - 3.60	2.40 - 4.80
>30	Hard	> 3.60	>4.80

4. TIME, DATE AND WEATHER CONDITION DURING FIELD WORKS

The field works of soil boring, sample collections etc were done during the 2 days of 17th and 18th April 2004. The field work started at 9 am in the morning and continued upto 5 pm in the evening. The weather was hot and dry with sunshine during the whole working period. The temperature and humidity of the 2 working days were as follows:-

Sl	Date	Temperature		Humidity	
		Day time	Night time	Morning	Evening
1	17 th April 2004	35 ^{0}	28 ^{0}	75 %	67 %
2	18 th April 2004	34 ^{0}	28 ^{0}	73%	67 %

5. PHYSICAL AND ENGINEERING PROPERTIES OF SOIL

5.1 Physical Properties

Stratification of soil

The top formation of soil extending to the depth of about 5.0 m to 6.90 m is predominated by cohesive soil consisting of reddish brown silty clay. Below this and upto the depth of investigation, layers of soil are non-cohesive in nature consisting of loose to dense sandy silt.

Consistency/Compactness

The layers of cohesive soil predominates in a medium to stiff consistency. The subsequent deep layers of non-cohesive soil usually have been observed in a loose to dense silty sand.

Natural moisture content, Unit weight & specific gravity

Natural moister content the top layer of cohesive soil varied from 19.65%-25.71%. Dry unit weight of the same soil varied from 1.18 t/m^3 to 1.88 t/m^3. Specific gravity of the investigated soil varied from 2.64 to 2.682

5.2 Engineering Properties

Cohesion

The values of cohesion, as reported from the performance of unconfined compression strength tests, vary from 0.01kg/cm^2 to 0.10 to kg/cm^2.

Compressibility

The top formation of cohesive soil usually has been observed moderately compressible in nature, as the values of compression index vary from 0.175 to 0.225 and the corresponding value of the natural void ratio vary from 0.54 to 0.675.

Angle of internal friction

The values of the angle of internal friction, as obtained from the performance of Direct Shear Tests varied from 25^0 to 34^0.

7 LABORATORY RESULTS FOR DIFFERENT BORE HOLES

Allowable bearing capacity of sub-soil, skin friction and end bearing capacity of piles /(ultimate) at whole depth using Standard Penetration Test (SPT) values and laboratory test results

Depth in Meter (M)	Standard Penetration resistance SPT/ Correct SPT	Unit weight in gm/ cm^2	Angle of internal friction cohesion of sub-soil. TSF	Allowable Bearing Capacity	Ultimate pile Bearing Capacity	
				Square Footing in TSF	Skin friction in TSF	End bearing capacity in TSF
BH No.-1						
1.5	11(11)	1.90	0^0 (0.83)	1.51	0.52	6.19

Depth in Meter (M)	Standard Penetration resistance SPT/ Correct SPT	Unit weight in gm/ cm^2	Angle of internal friction cohesion of sub-soil. TSF	Allowable Bearing Capacity	Ultimate pile Bearing Capacity	
				Square Footing in TSF	Skin friction in TSF	End bearing capacity in TSF
3.0	10(10)	1.88	0^0 (0.75)	1.40	0.45	5.53
4.5	11(11)	1.90	0^0 (0.83)	1.59	0.52	6.25
6.0	10(10)	1.71	25^0 (0.06)	2.23	0.23	6.50
7.5	14(14)	1.75	25^0 (0.08)	-	0.27	8.39
9.0	28(22)	1.88	32^0 (0.02)	-	0.58	27.65
10.5	31(23)	1.92	32^0 (0.05)	-	0.62	31.49
12.0	33(24)	1.94	32^0 (0.10)	-	0.65	33.51
BH N0.-2						
1.5	12(12)	1.92	0^0 (0.88)	1.59	0.53	6.35
3.0	9(9)	1.88	0^0 (0.66)	1.24	0.41	4.94
4.5	10(10)	1.87	0^0 (0.75)	1.44	0.45	5.65
6.0	11(11)	1.90	0^0 (0.81)	1.64	0.52	6.27
7.5	14(14)	1.73	28^0 (0.04)	-	0.32	31.65
9.0	20(18)	1.80	28^0 (0.06)	-	0.34	36.58
10.5	27(21)	1.87	28^0 (0.95)	-	0.48	52.62
11.0	30(23)	1.90	34^0 (0.02)	-	0.72	38.45
12.0	33(24)	1.94	34^0 (0.07)		0.85	45.23
BH N0.-3						
1.5	12(12)	1.90	0^0 (0.82)	1.49	0.49	6.05
3.0	12(12)	1.92	0^0 (0.88)	1.64	0.53	6.44
4.5	12(12)	1.92	0^0 (0.88)	1.66	0.53	6.57
6.0	11(11)	1.75	12^0 (0.43)	1.90	0.49	6.10
7.5	13(13)	1.78	12^0 (0.52)	-	0.52	7.23
9.0	21(18)	1.80	27^0 (0.02)	-	0.54	15.61
10.5	21(18)	1.80	27^0 (0.02)	-	0.54	15.85
11.0	32(24)	1.93	31^0 (0.06)	-	0.61	26.29
12.0	32(24)	1.93	31^0 (0.06)		0.61	26.57
BH No.-4						
1.5	7(7)	1.80	0^0 (0.55)	1.01	0.32	3.89
3.0	13(13)	1.93	0^0 (0.98)	1.82	0.58	6.88
4.5	11(11)	1.91	0^0 (0.81)	1.55	0.49	6.15
6.0	10(10)	1.70	26^0 (0.03)	2.19	0.21	5.86
7.0	11(11)	1.72	26^0 (0.05)	-	0.32	9.63
8.0	14(14)	1.75	26^0 (0.08)	-	0.35	10.23

Depth in Meter (M)	Standard Penetration resistance SPT/ Correct SPT	Unit weight in gm/ cm^2	Angle of internal friction cohesion of sub-soil. TSF	Allowable Bearing Capacity	Ultimate pile Bearing Capacity	
				Square Footing in TSF	Skin friction in TSF	End bearing capacity in TSF
9.5	26(21)	1.85	30^0 (0.04)	-	0.38	13.33
10.00	30(23)	1.90	33^0 (0.08)	-	0.65	33.09
12.00	32(24)	1.93	33^0 (0.10)	-	0.68	35.15
BH N0.-5						
1.5	8(8)	1.85	0^0 (0.61)	1.11	0.35	4.25
3.0	12(12)	1.91	0^0 (0.89)	1.65	0.53	6.44
4.5	10(10)	1.90	0^0 (0.75)	1.45	0.45	5.55
6.0	12(12)	1.79	10^0 (0.55)	2.04	0.40	6.10
7.0	13(13)	1.82	10^0 (0.62)	-	0.44	6.91
8.0	15(15)	1.75	29^0 (0.02)	-	0.42	14.49
9.0	25(20)	1.85	29^0 (0.05)	-	0.45	15.84
10.0	29(22)	1.90	34^0 (0.01)	-	0.71	38.41
12.0	33(24)	1.93	34^0 (0.03)	-	0.83	44.51

8 CALCULATION OF BEARING CAPACITY USING "N" VALUE

Assumption 1: Let us assume that a 3 storied building imposes a weight of 20 ton/ sq. meter on the foundation. (Ref: Indian Practical Civil Engineer's Hand Book, P. N. Khanna, 14th Edition, 1995, Engineers Publishers, New Delhi – 110001)

Assumption 2: The depth of footing will be 2.5m

As per Terzaghi, the semi empirical equation for square footing of size B:-

$q_{ult} = 1.3CN_C + \gamma D_f N_q + 0.4 B \gamma N_r$

Where C = Cohesion of soil

N_C, Nq & N_r are dimensionless bearing capacity factor that depend on the angle of internal friction (∅) of soil

B = minimum width of foundation

D_f = assuming effective depth of foundation or surcharge depth to be 2.5m below the surface level

For ∅ = 0^0

Nc = 5.14, N_q = 1.0, N_r = 0

C = Cohesion of soil
= 0.78 t/sft
= (0.78 x 1000 x (1/1000) x 9.8)/ ((1/3.281) x (1/3.281)) kN/m^2
= 82.24 kN/m^2

$\therefore$ q_{ult} = $(1.3CN_c + \gamma D_f Nq + 0.4 B \gamma N_r)$ kN/m^2
= (1.3 x 82.29 x 5.14 + 17.3 x 2.5 x 1 + 0.4 x Bx γx0) kN/m^2
= 592.84 kN/m^2

$\therefore$ $q_{allowable} = q_{ult} / 3$ = (592.84/ 3) kN/m^2
= 197.61 kN/m^2
= 20.14 $t/m^2 > 20$ t/m^2

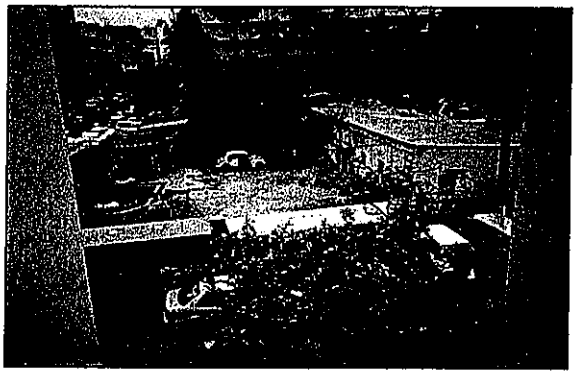
Hence the assumption of taking the depth of footing to be 2.5m is O.K.

9 CONCLUSION AND RECOMMENDATION

By analysing the field and laboratory test values it can be concluded that the over all strength parameter and bearing capacity of the site throughout the soil profiles are good. Hence shallow open footing foundation will be suitable form structural and economic consideration.

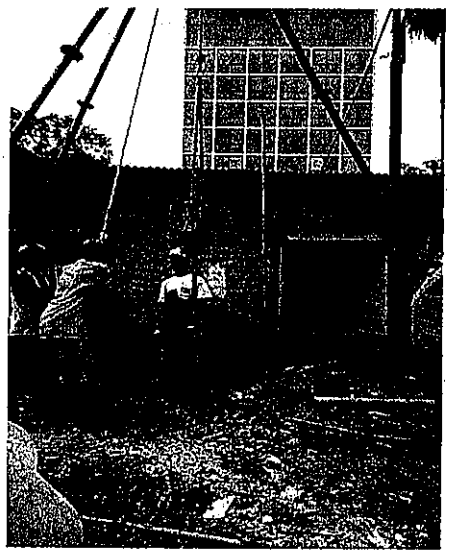
10 PHOTOGRAPHS

PHOTOGRAPHS



The Project Site

Boring work in progress



Determination of SPT valve.

Marking of location for Bore hole No.-5
(before boring)

Bore hole No.-1

Bore hole No.-2

Bore hole No.-3

Bore hole No.-4

Bore hole No.-5

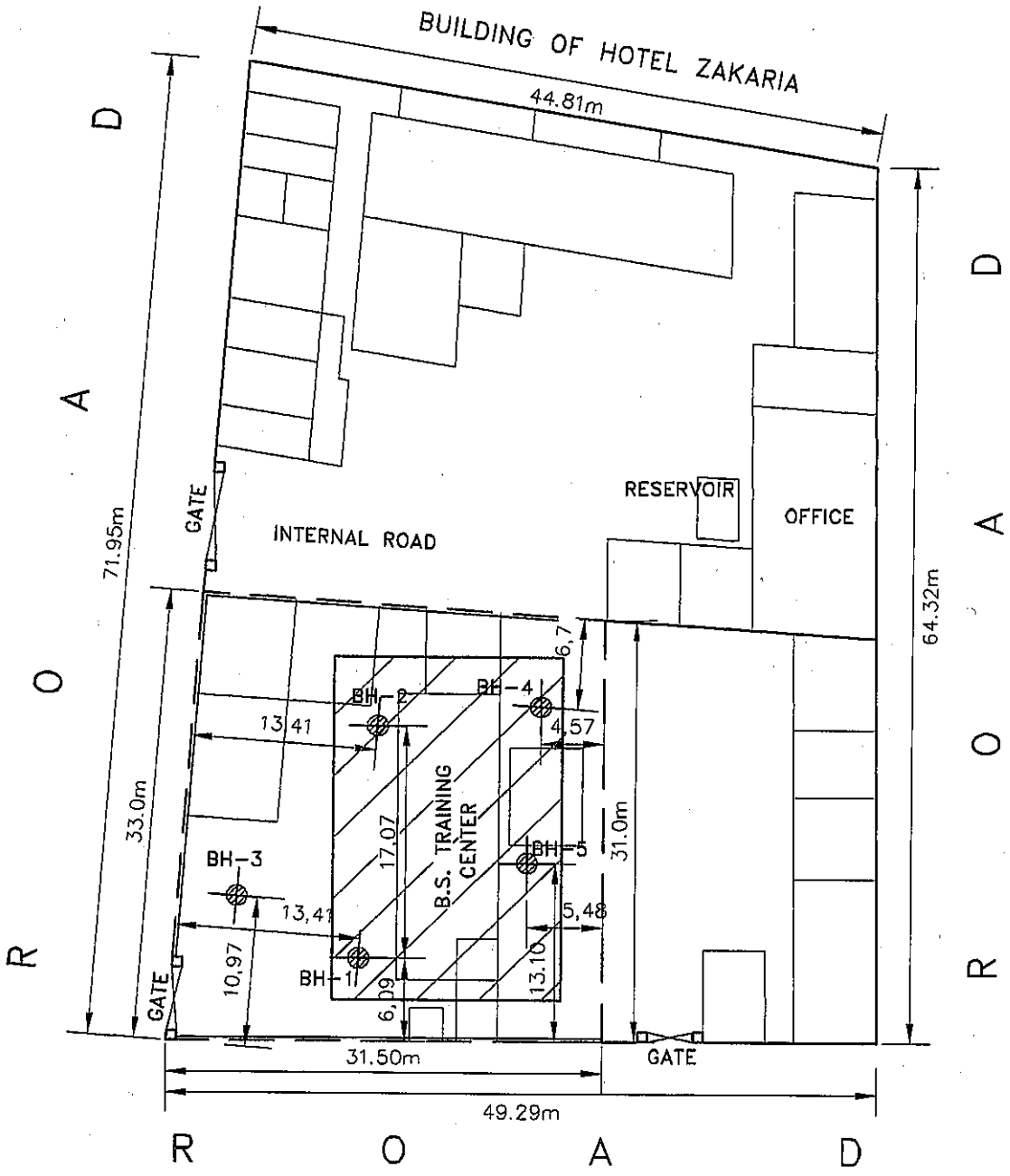
Extraction of soil sample from tube

Collection of soil sample

The soil sample in polythene bag

11 FIGURES

CLIENT : KOKUSAI KOGYO CO., LTD.	TITLE :
PROJECT : STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH.	SITE PLAN
LOCATION : 36–37 MOHAKHALI , DHAKA.	



LEGEND :

EXISTING SHED		PROPOSED PROJECT AREA	
BORING POINT		PROPOSED BUILDING LOCATION	

BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD.	FIGURE : 1

CLIENT : KOKUSAI KOGYO CO, LTD

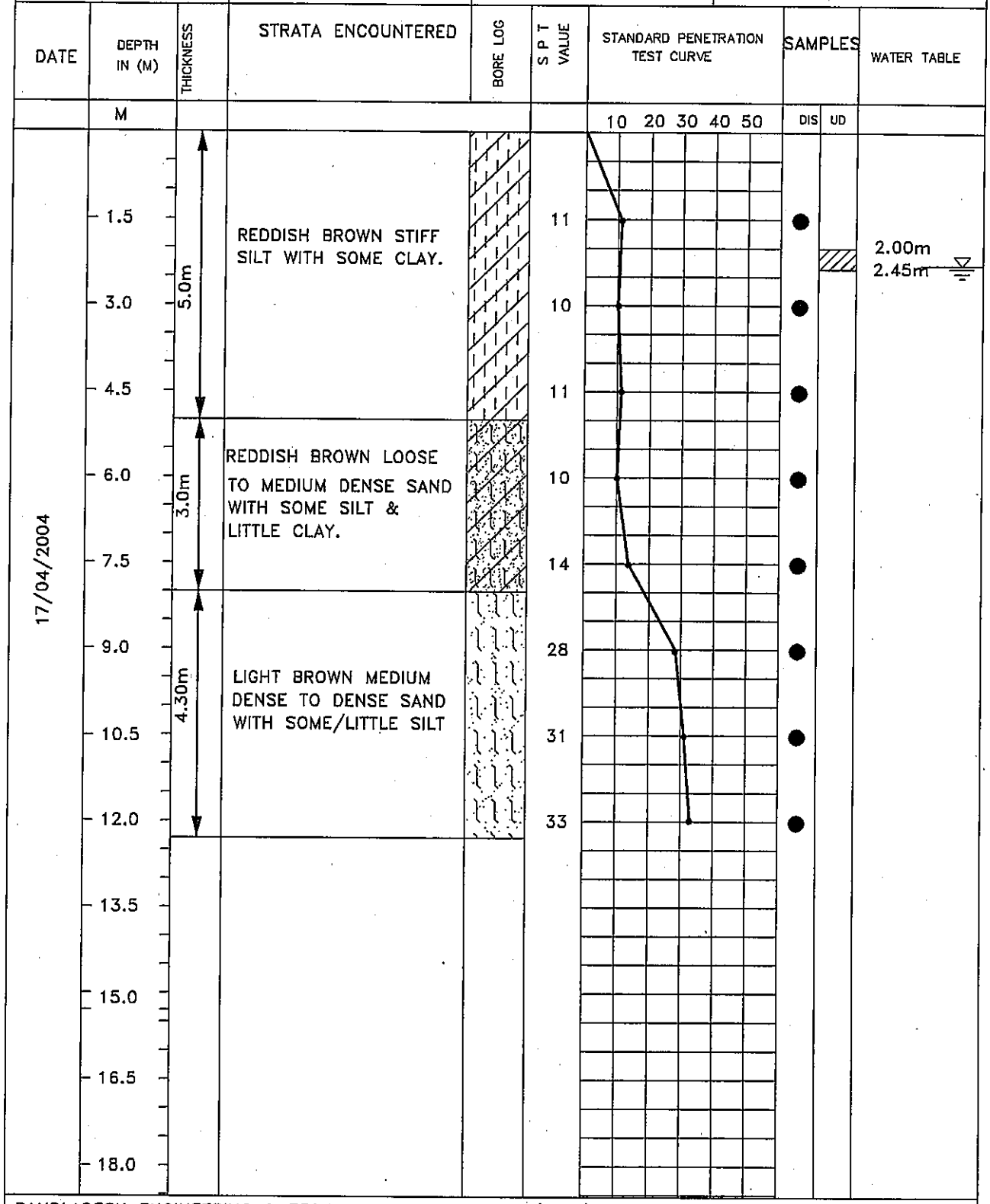
PROJECT : STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH

LOCATION : 36–37 MOHAKHALI, DHAKA.

TITEL

BORE LOG FOR BORE HOLE NO 1

BORING NO 1 | Method : Wash | W.L. 2.30m below from surface



BANDLADESH ENGINEERING & TECHNOLOGICAL SERVICES (BETS) LTD

FIGURE NO :2

CLIENT : KOKUSAI KOGYO CO, LTD

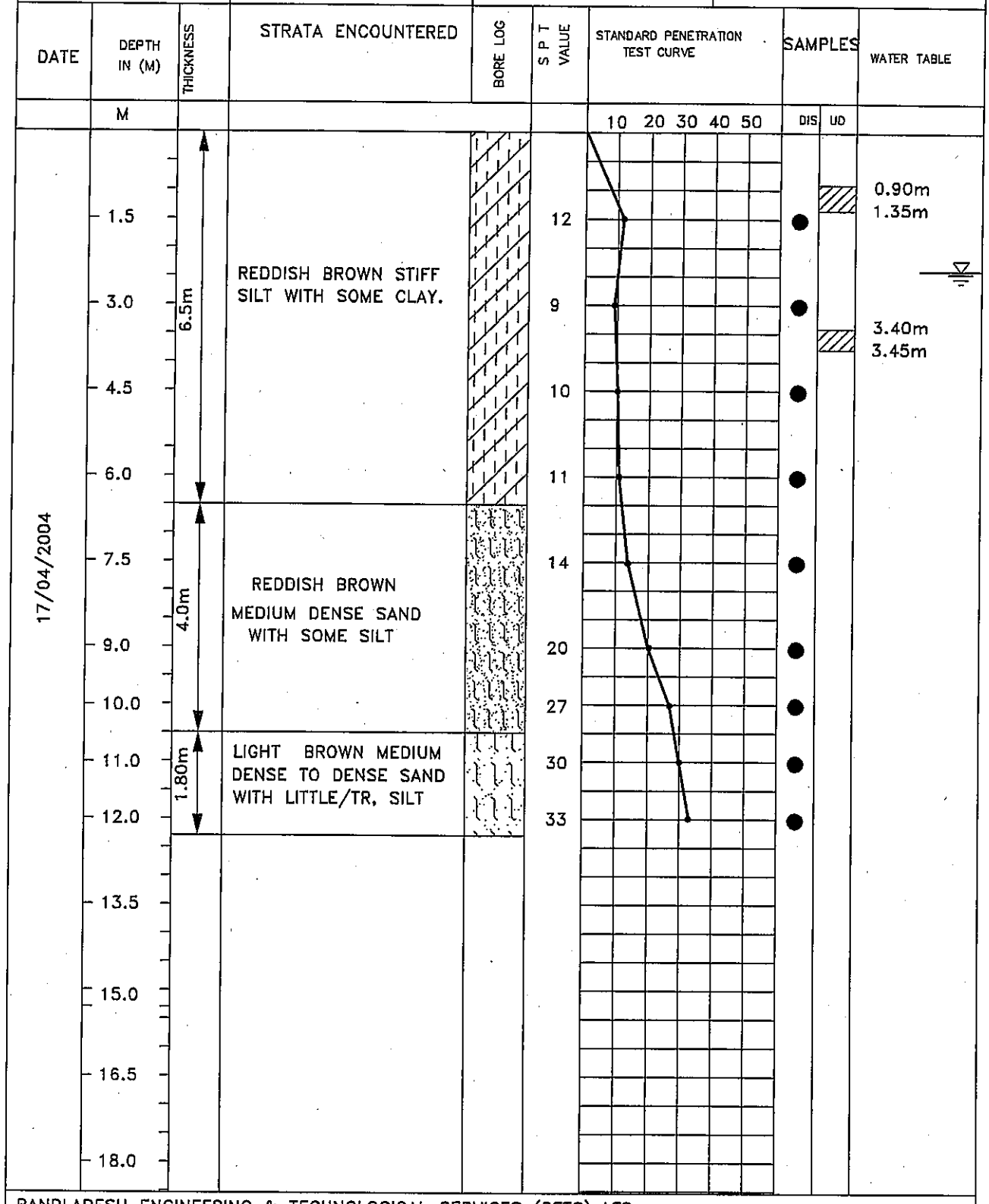
PROJECT : STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH

TITEL

BORE LOG FOR BORE HOLE NO 2

LOCATION : 36–37 MOHAKHALI, DHAKA.

BORING NO 2 | Method : Wash | W.L. 2.40m below from surface



BANDLADESH ENGINEERING & TECHNOLOGICAL SERVICES (BETS) LTD

FIGURE NO :3

CLIENT : KOKUSAI KOGYO CO, LTD

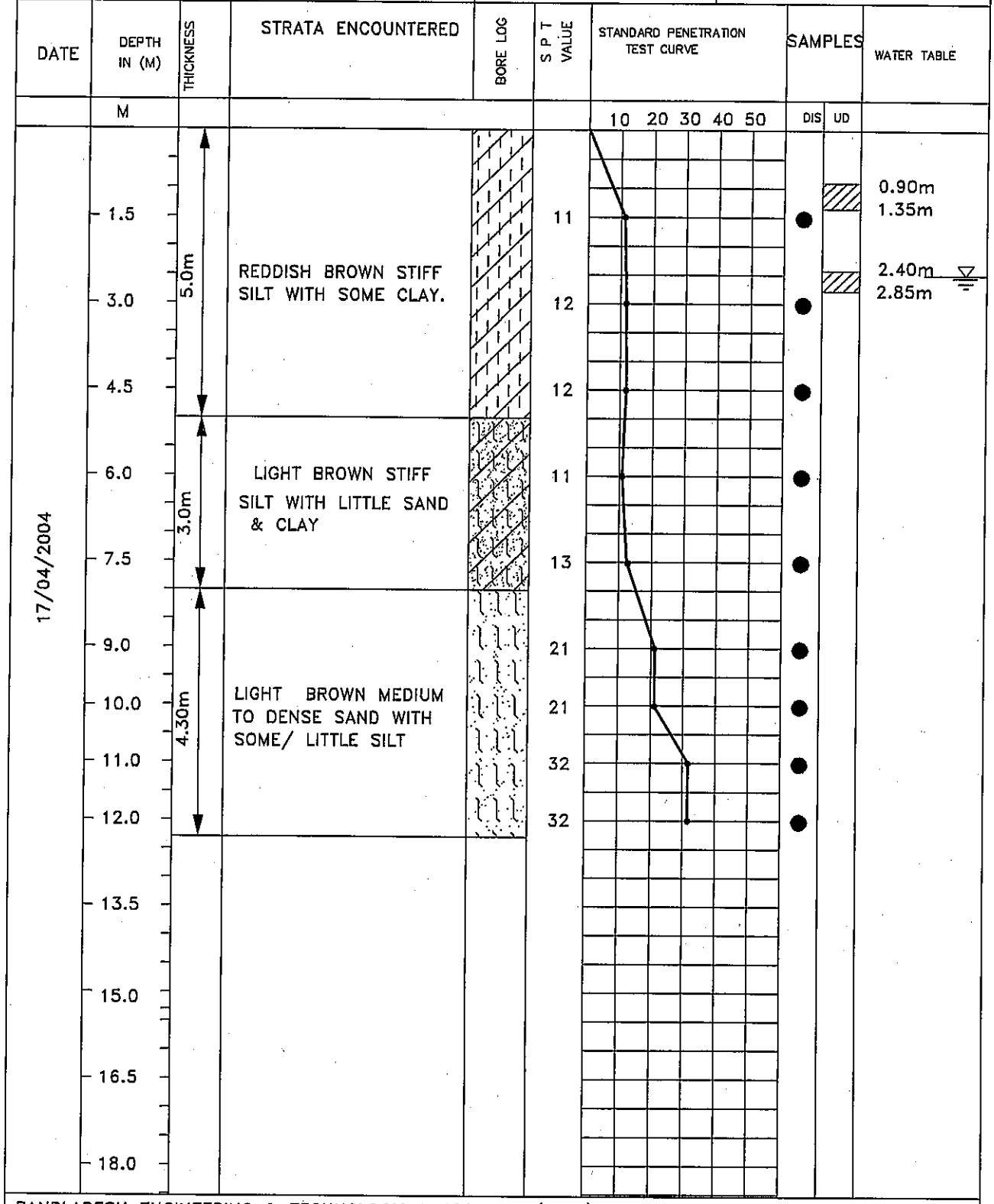
PROJECT : STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH

LOCATION : 36–37 MOHAKHALI, DHAKA.

TITEL

BORE LOG FOR BORE HOLE NO 3

BORING NO 3 | Method : Wash | W.L. 2.50m below from surface



BANDLADESH ENGINEERING & TECHNOLOGICAL SERVICES (BETS) LTD

FIGURE NO :4

CLIENT : KOKUSAI KOGYO CO, LTD

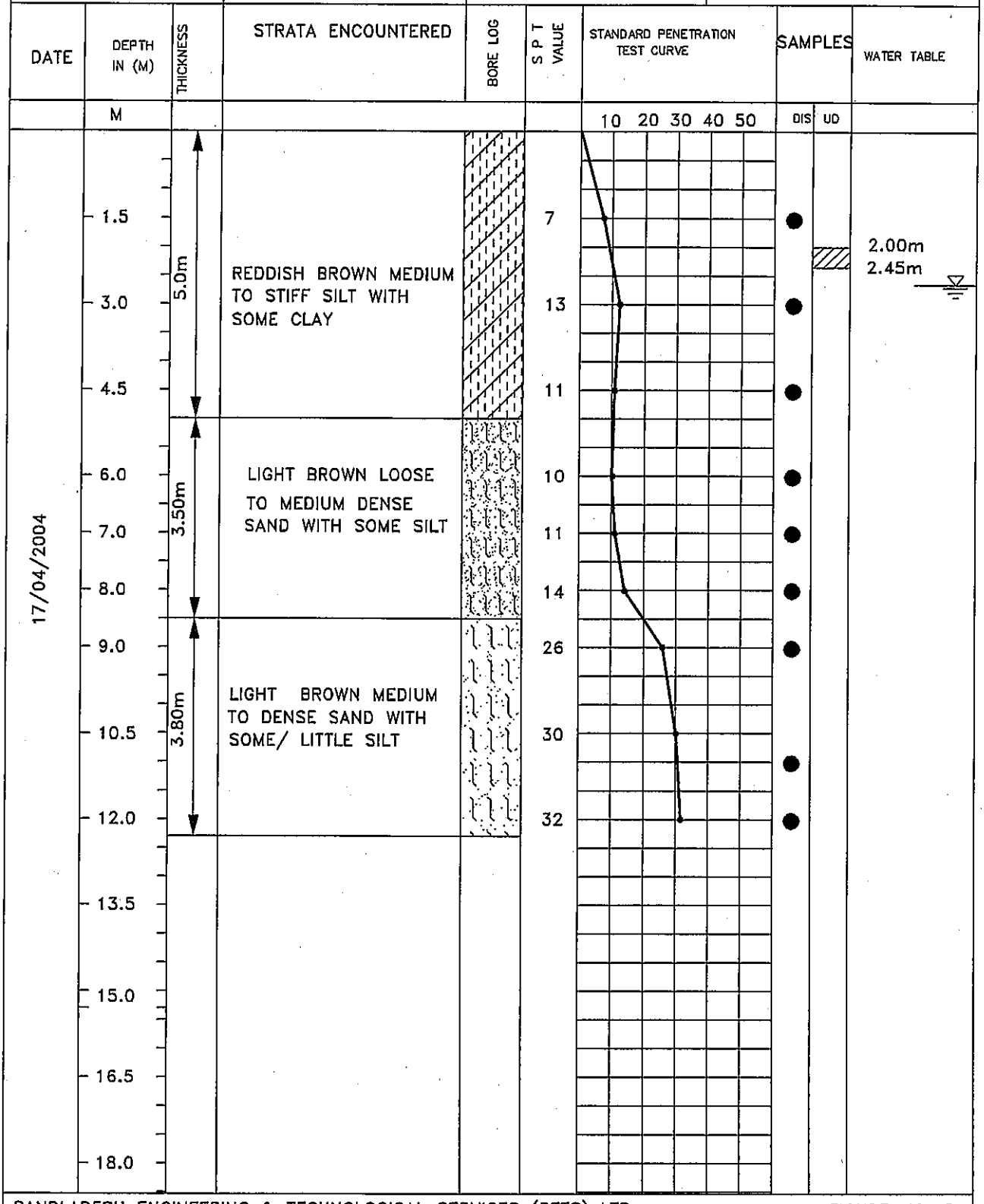
PROJECT : STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH

LOCATION : 36–37 MOHAKHALI, DHAKA.

TITEL

BORE LOG FOR BORE HOLE NO 4

BORING NO 4 | Method : Wash | W.L. 2.65m below from surface



BANDLADESH ENGINEERING & TECHNOLOGICAL SERVICES (BETS) LTD

FIGURE NO :5

CLIENT : KOKUSAI KOGYO CO, LTD

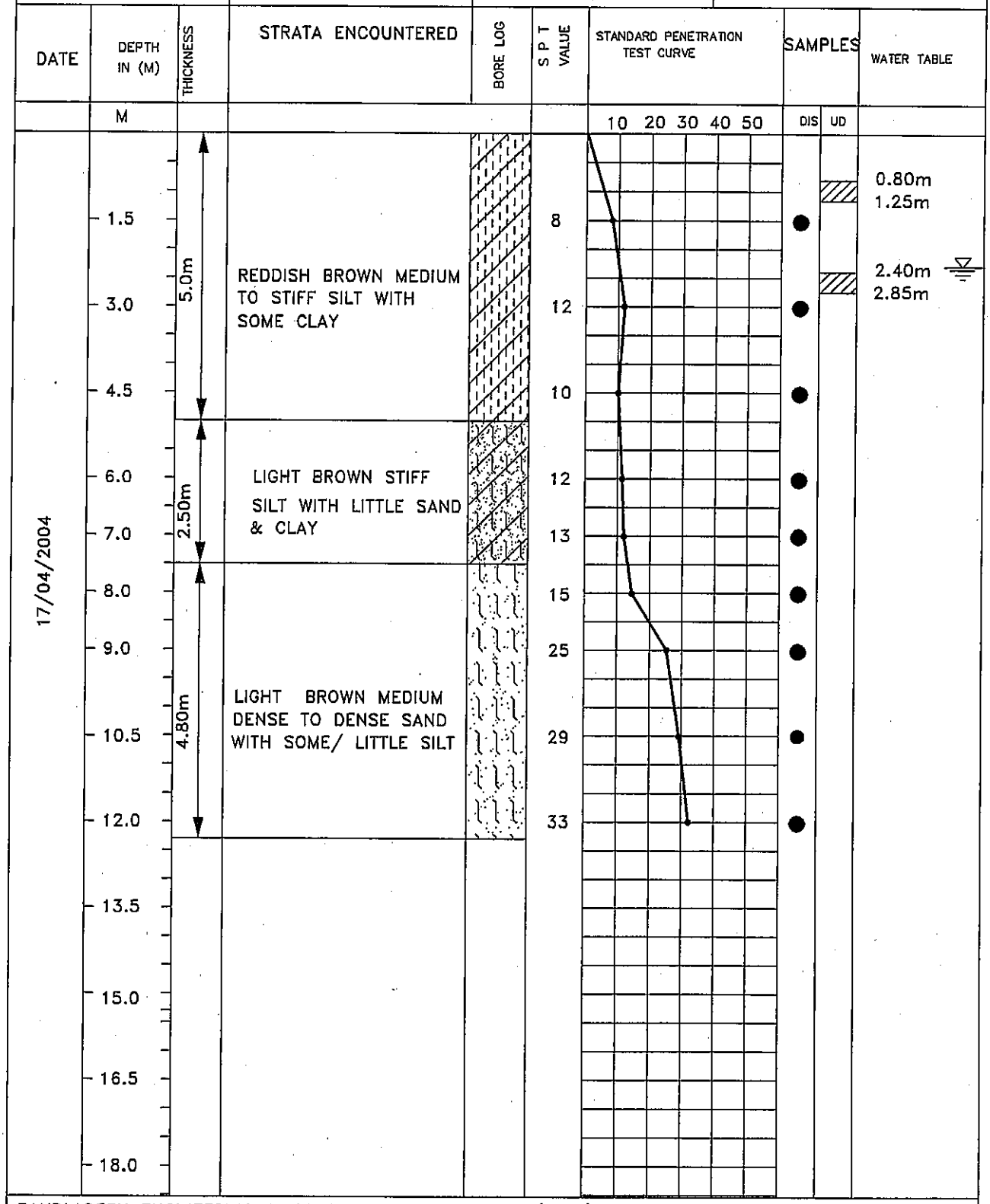
PROJECT : STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH

LOCATION : 36–37 MOHAKHALI, DHAKA.

TITEL

BORE LOG FOR BORE HOLE NO 5

BORING NO 5 | Method : Wash | W.L. 2.30m below from surface



BANDLADESH ENGINEERING & TECHNOLOGICAL SERVICES (BETS) LTD

FIGURE NO :6

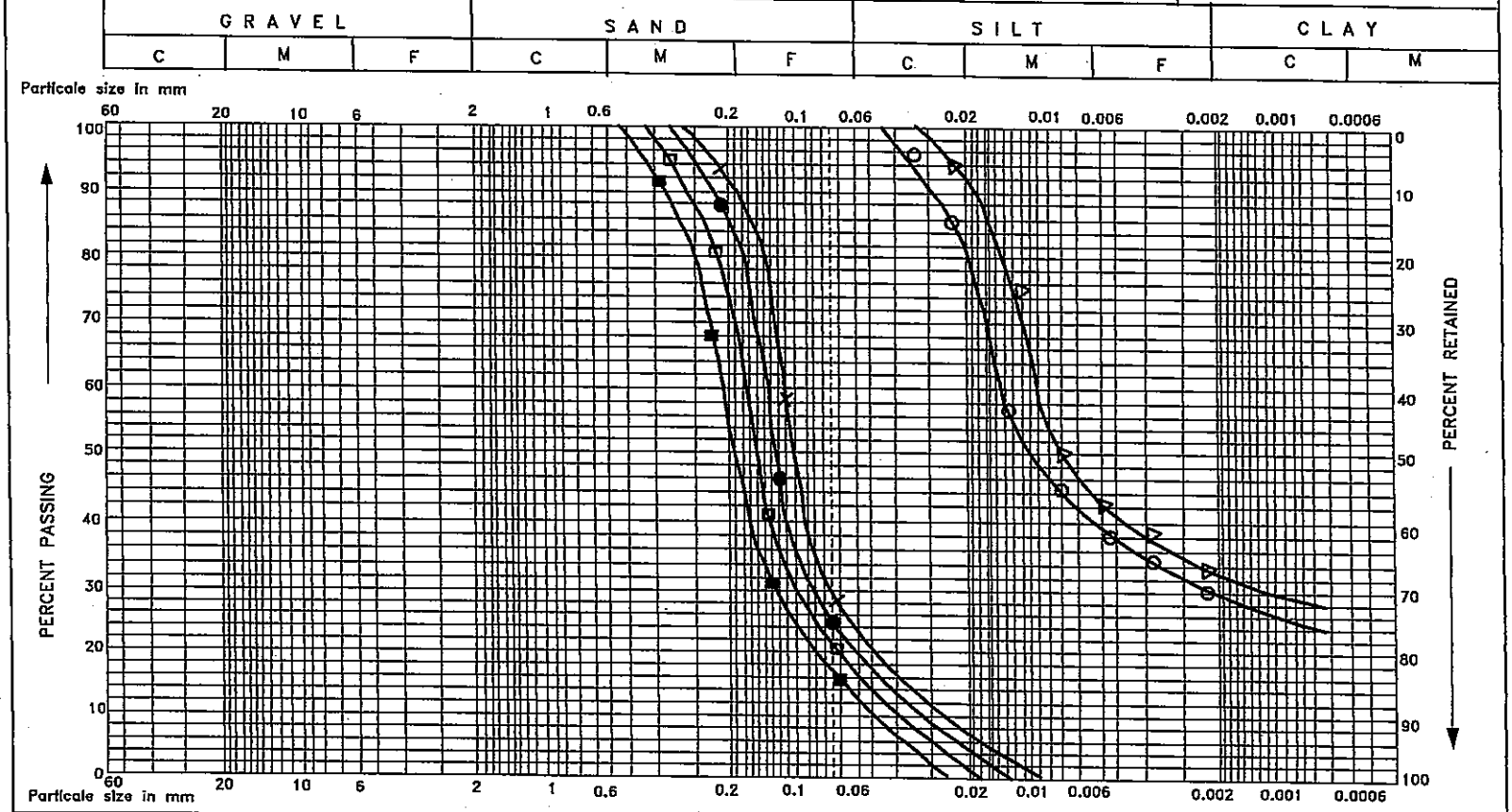
CLIENT : KOKUSAI KOGYO CO, LTD

PROJECT : STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH

LOCATION : 36–37 MOHAKHALI, DHAKA.

TITEL

GRAIN SIZE ANALYSIS



SYMBOL	BORE	SAMPLE	DEPTH IN R.L	DEPTH IN M.	CLASSIFICATION	SP. GR.	SAND %	SILT %	CLAY %	L.L	P.L	P.I
O—O	BH-1	D-2		3.0	SILT SOME CLAY		0	69	31	49	28	21
X—X	BH-1	D-5		7.5	SAND SOME SILT		72	28	0	—	—	—
■—■	BH-1	D-8		12.0	SAND LITTLE SILT		83	17	0	—	—	—
△—△	BH-2	D-1		1.5	SILT SOME CLAY		0	67	33	51	29	22
●—●	BH-2	D-6		9.0	SAND SOME SILT		75	25	0	—	—	—
□—□	BH-2	D-8		11.5	SAND SOME SILT		78	22	0	—	—	—

BANDLADESH ENGINEERING & TECHNOLOGICAL SERVICES (BETS) LTD

FIGURE NO : 7

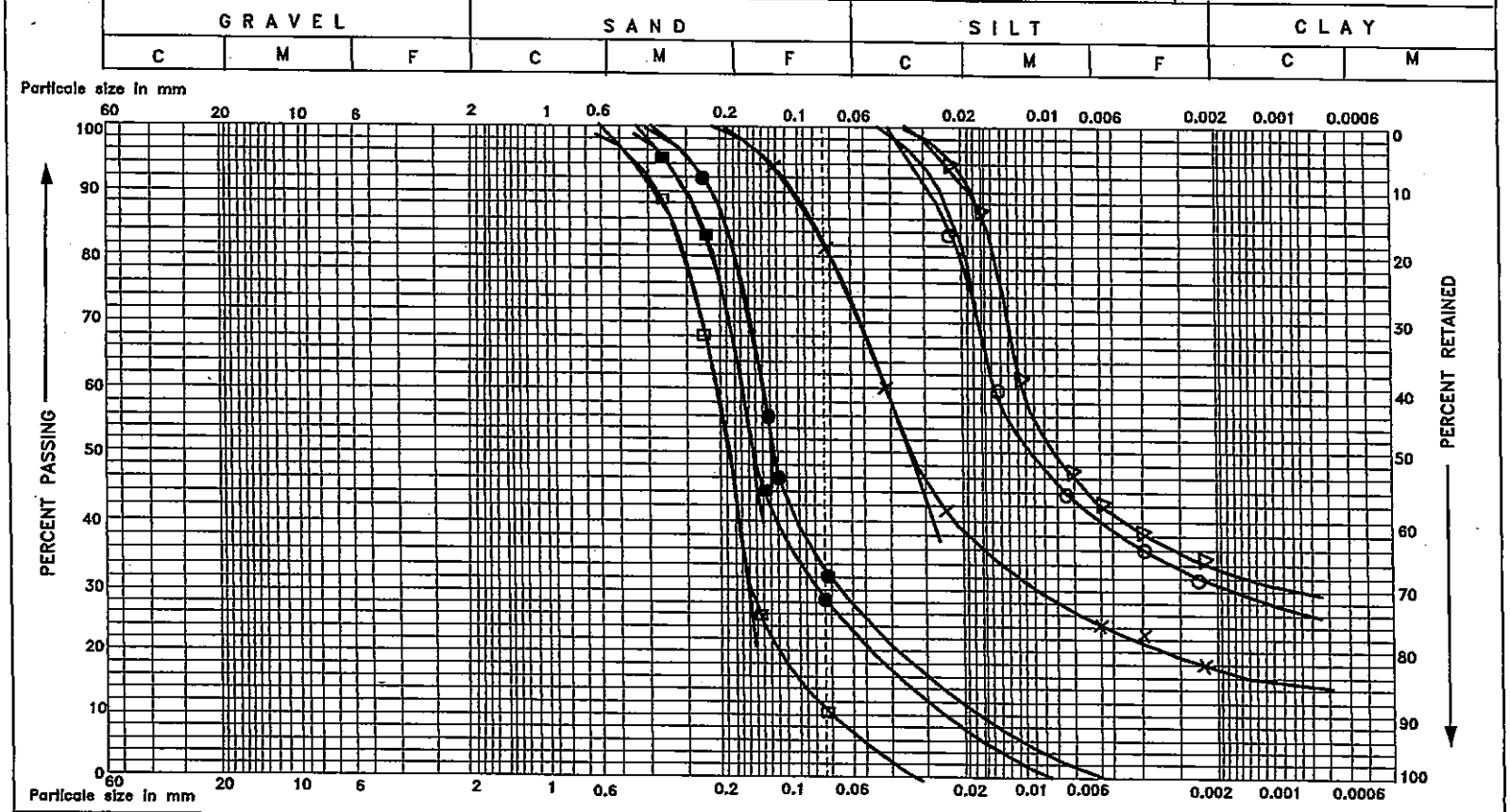
CLIENT : KOKUSAI KOGYO CO, LTD

PROJECT : STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH

LOCATION : 36–37 MOHAKHALI, DHAKA.

TITEL

GRAIN SIZE ANALYSIS



SYMBOL	BORE	SAMPLE	DEPTH IN R.L	DEPTH IN M.	CLASSIFICATION	SP. GR.	SAND %	SILT %	CLAY %	L.L	P.L	P.I
O—O	BH-3	D-2		3.0	SILT SOME CLAY		0	68	32	52	29	23
X—X	BH-3	D-4		6.0	SILT LITTLE SAND & CLAY		19	63	18	—	—	—
■—■	BH-3	D-7		10.0	SAND SOME SILT		71	29	0	—	—	—
△—△	BH-4	D-1		1.5	SILT SOME CLAY		0	66	34	47	27	20
●—●	BH-4	D-6		8.0	SAND SOME SILT		69	32	0	—	—	—
□—□	BH-4	D-8		12.0	SAND LITTLE SILT		88	12	0	—	—	—

BANDLADESH ENGINEERING & TECHNOLOGICAL SERVICES (BETS) LTD

FIGURE NO : 8

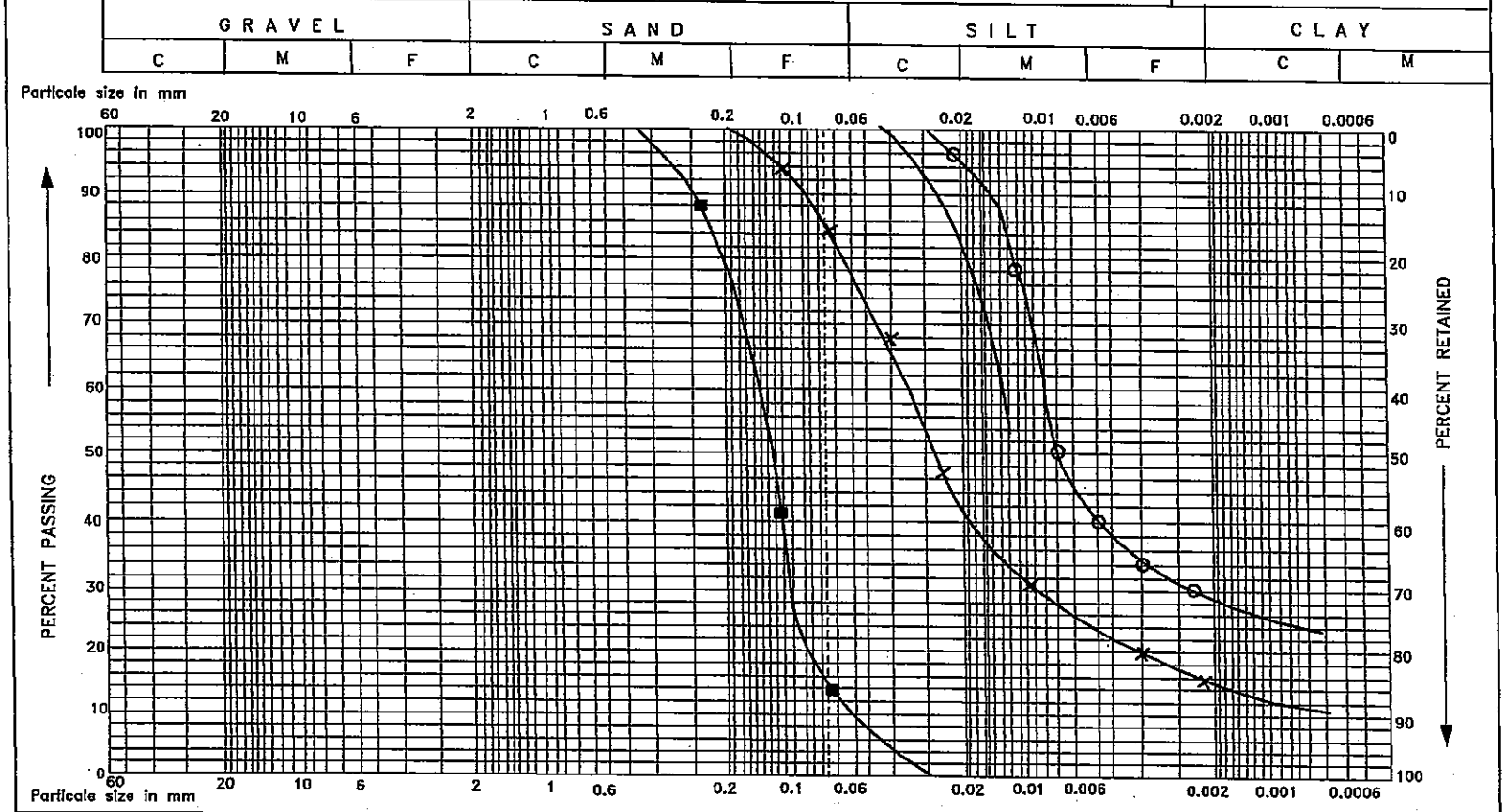
CLIENT : KOKUSAI KOGYO CO, LTD

PROJECT : STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH

LOCATION : 36–37 MOHAKHALI, DHAKA.

TITEL

GRAIN SIZE ANALYSIS

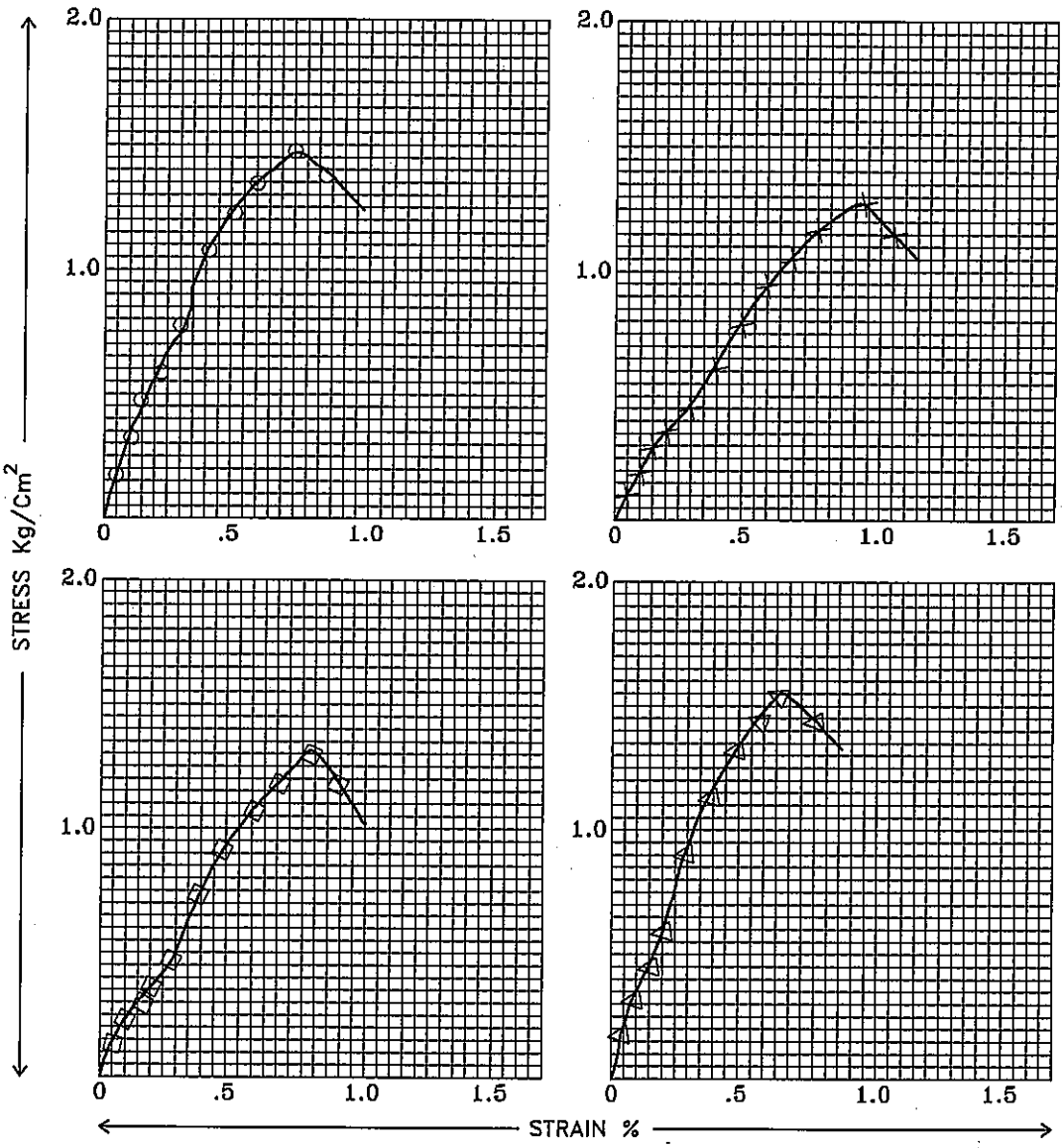


SYMBOL	BORE	SAMPLE	DEPTH IN R.L	DEPTH IN M.	CLASSIFICATION	SP. GR.	SAND %	SILT %	CLAY %	L.L	P.L	P.I
O — O	BH-5	D-3		4.5	SILT SOME CLAY TR. SAND		0	71	29	49	28	21
X — X	BH-5	D-5		7.5	SILT LITTLE CLAY & SAND		15	69	16	—	—	—
■ — ■	BH-5	D-9		12.0	SAND LITTLE CLAY		86	14	0	—	—	—
Δ — Δ	BH-											
● — ●	BH-											
□ — □	BH-											

BANDLADESH ENGINEERING & TECHNOLOGICAL SERVICES (BETS) LTD

FIGURE NO : 9

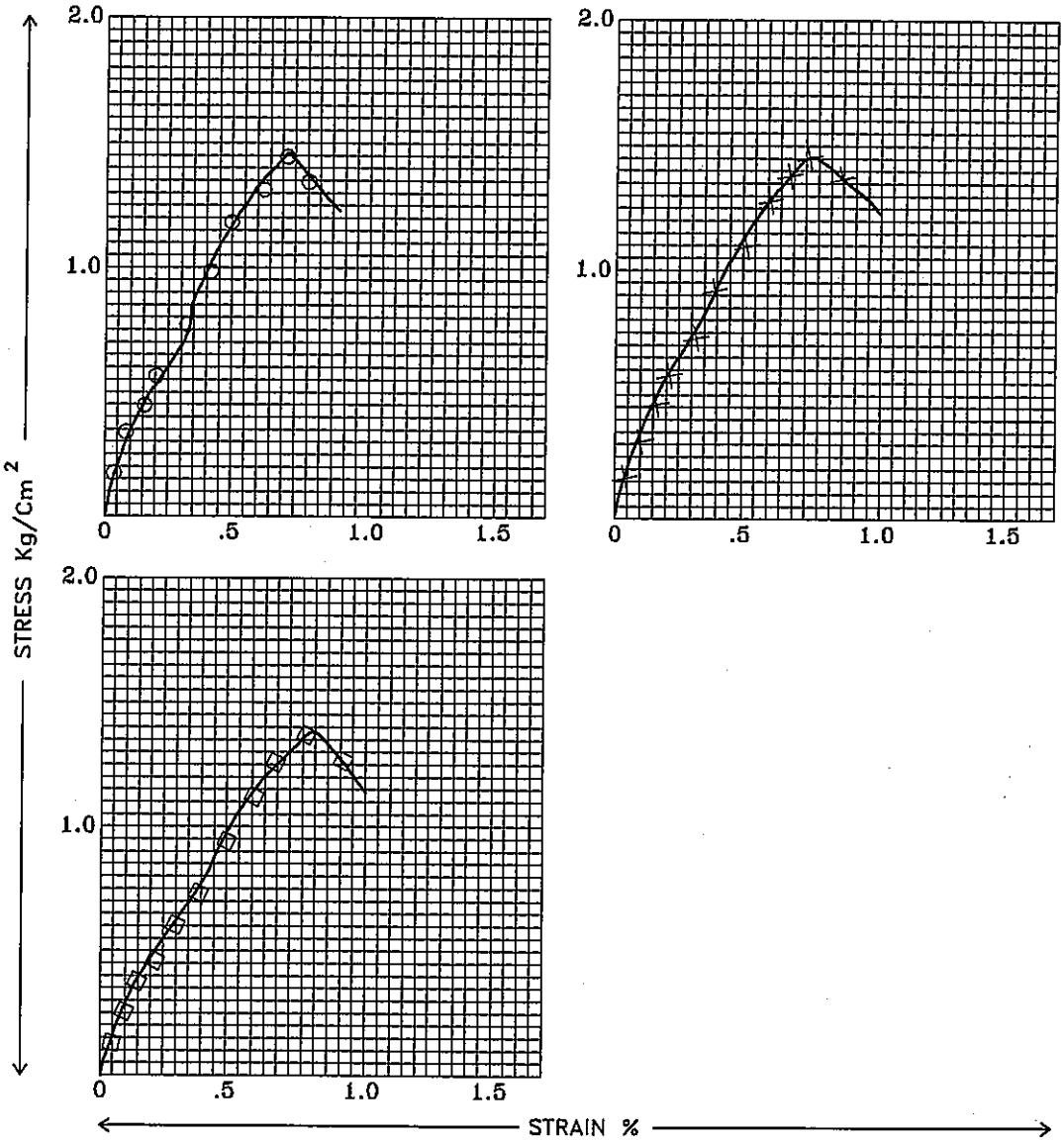
CLEINT:	KOKUSAI KOGYO CO., LIMITED	TITLE: UNCONFINED COMPRESSION TEST
PROJECT:	STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH	
LOCATION:	36-37 MOHAKHALI, DHAKA.	



SYMBOL	B.H.NO.	SAMPLE	DEPTH IN M.	q/u Kg/Cm²	%STRAIN	ɣ WETT T/M³	ɣ DRY T/M³	%MOISTURE
○—○	1	U-1	2.00-2.45	1.57	7.43	1.90	1.58	20.25
×—×	2	U-1	0.90-1.35	1.36	9.15	1.82	1.18	23.66
□—□	2	U-2	3.40-3.85	1.41	8.27	1.84	1.50	21.32
△—△	3	U-1	2.40-2.85	1.70	6.49	1.92	1.60	19.65

BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD.	FIGURE NO. 10

CLEINT:	KOKUSAI KOGYO CO., LIMITED	TITLE: UNCONFINED COMPRESSION TEST
PROJECT:	STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH	
LOCATION:	36–37 MOHAKHALI, DHAKA.	

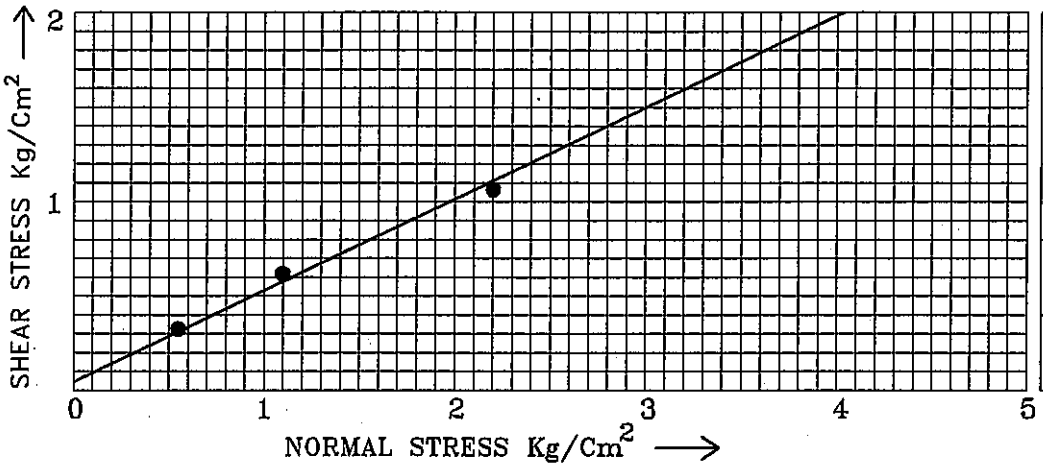


SYMBOL	B.H.NO.	SAMPLE	DEPTH IN M.	q/u Kg/Cm^2	%STRAIN	ɣ WETT T/M^3	ɣ DRY T/M^3	%MOISTURE
○—○	4	U–1	2.00–2.45	1.53	7.22	1.88	1.54	21.42
×—×	5	U–1	0.80–1.25	0.78	10.71	1.76	1.40	25.71
□—□	5	U–2	2.40–2.85	1.48	8.35	1.85	1.50	22.65
△—△								

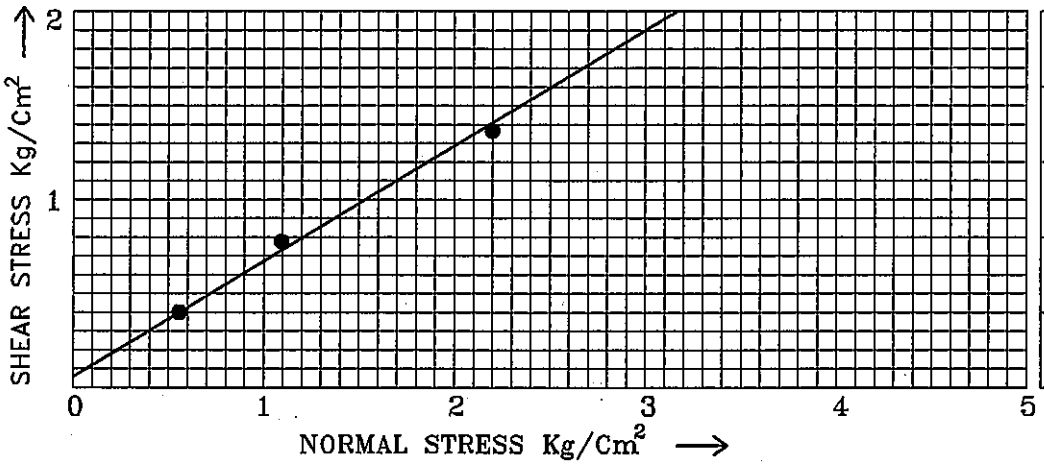
BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD.

FIGURE NO. 11

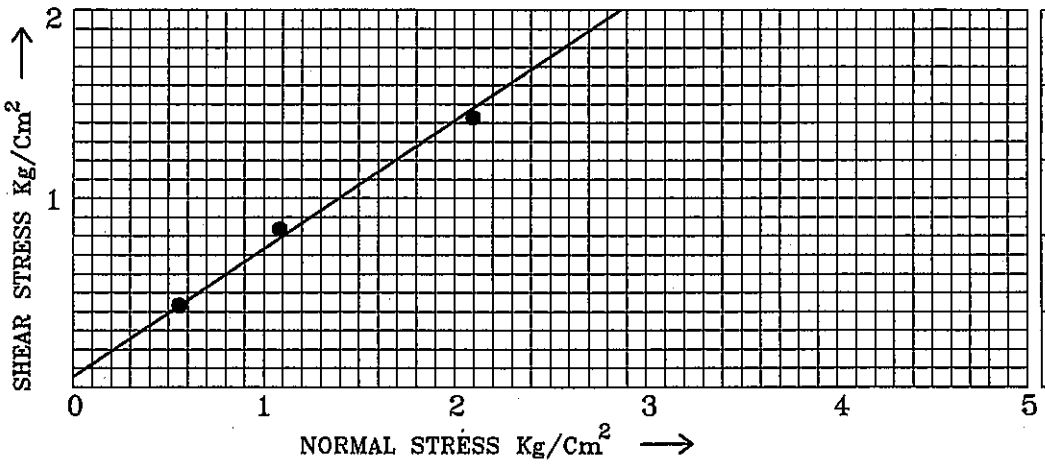
CLEINT:	KOKUSAI KOGYO CO., LIMITED	TITLE: DIRECT SHEAR TEST
PROJECT:	STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH	
LOCATION:	36-37 MOHAKHALI, DHAKA.	



BORING NO.	1
SAMPLE NO.	D-4
DEPTH IN M.	6.0
COHESION C Kg/Cm²	0.06
ANGLE OF INTERNAL FRICTION	25°



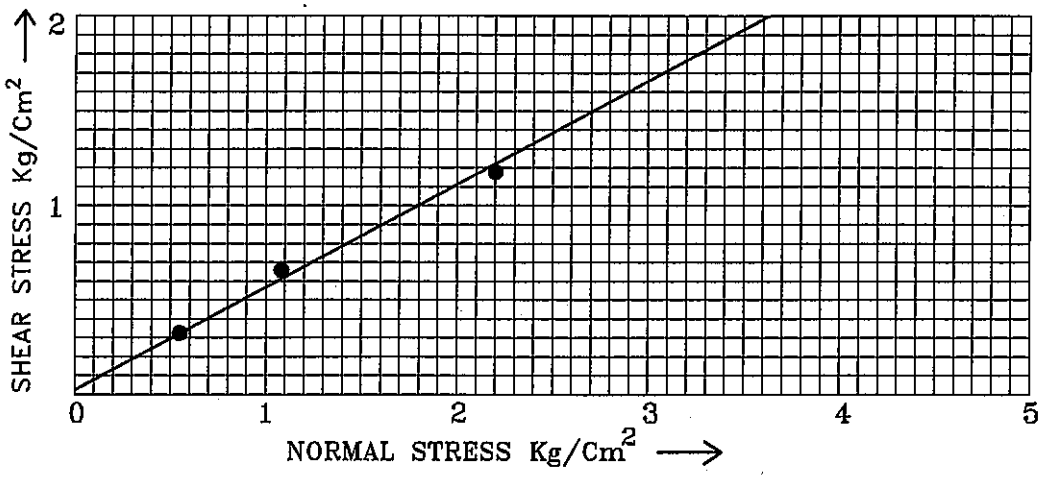
BORING NO.	1
SAMPLE NO.	D-7
DEPTH IN M.	10.5
COHESION C Kg/Cm²	0.05
ANGLE OF INTERNAL FRICTION	32°



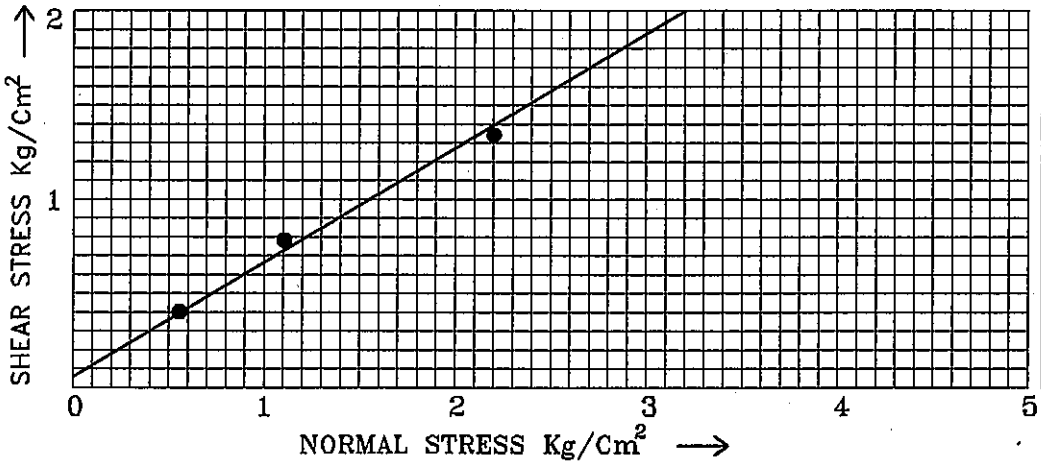
BORING NO.	2
SAMPLE NO.	D-9
DEPTH IN M.	12.0
COHESION C Kg/Cm²	0.07
ANGLE OF INTERNAL FRICTION	34°

BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD.	FIGURE NO. 12

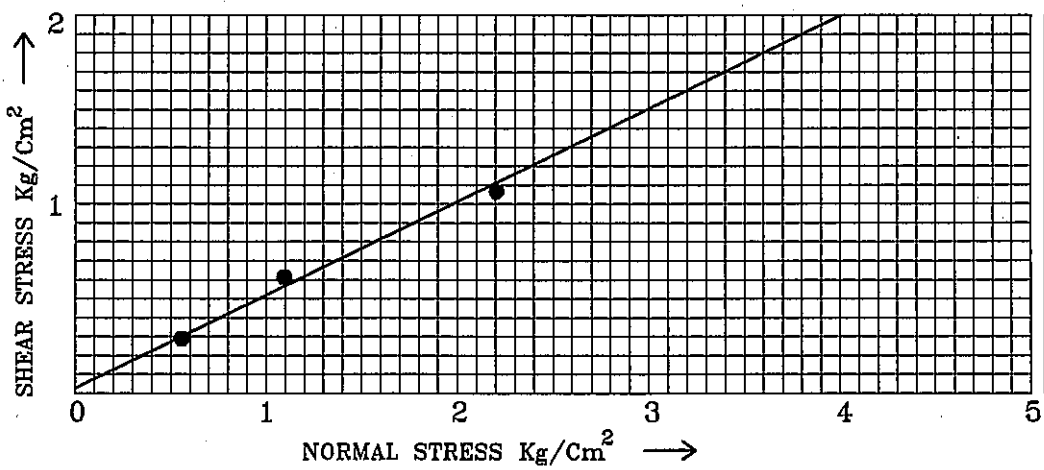
CLEINT:	KOKUSAI KOGYO CO., LIMITED	TITLE: DIRECT SHEAR TEST
PROJECT:	STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH	
LOCATION:	36-37 MOHAKHALI, DHAKA.	



BORING NO.	3
SAMPLE NO.	D-6
DEPTH IN M.	9.0
COHESION C Kg/Cm²	0.02
ANGLE OF INTERNAL FRICTION	27°



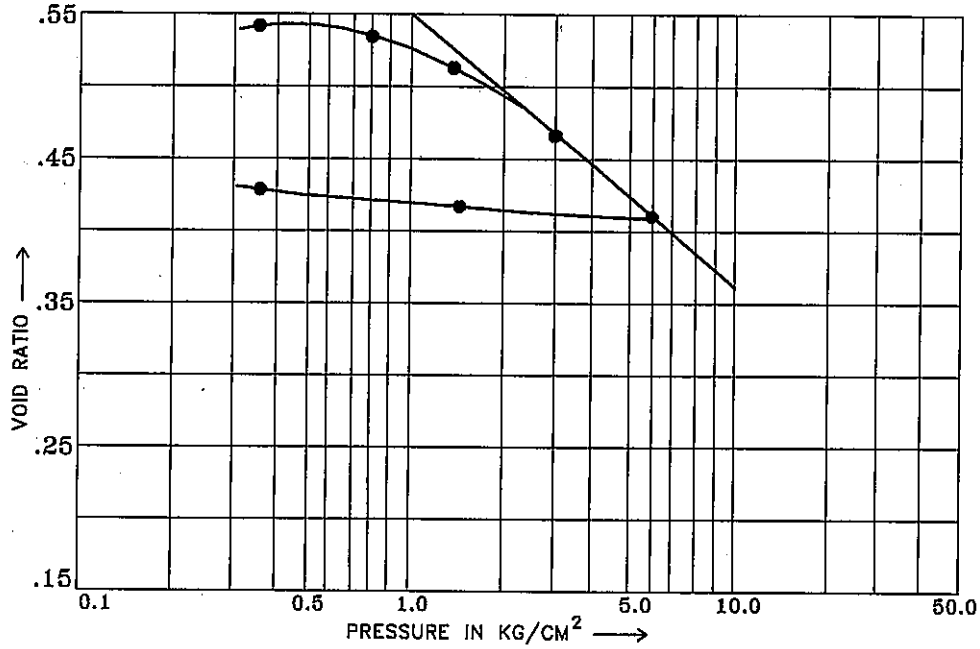
BORING NO.	3
SAMPLE NO.	D-8
DEPTH IN M.	11.0
COHESION C Kg/Cm²	0.06
ANGLE OF INTERNAL FRICTION	31°



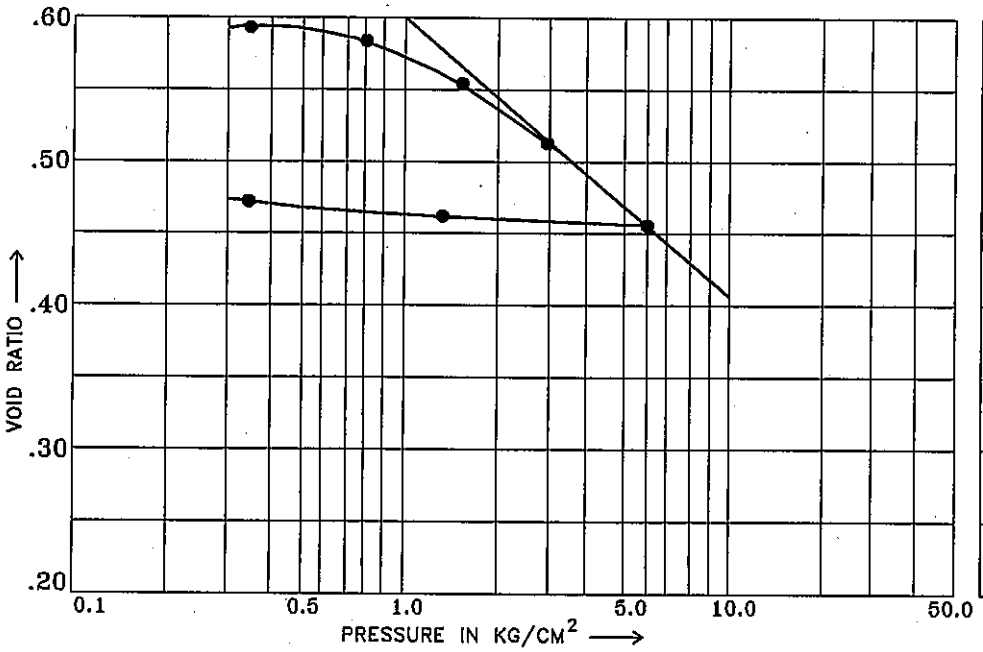
BORING NO.	4
SAMPLE NO.	D-5
DEPTH IN M.	7.50
COHESION C Kg/Cm²	0.05
ANGLE OF INTERNAL FRICTION	26°

BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD.	FIGURE NO. 13

CLEINT:	KOKUSAI KOGYO CO., LIMITED	TITLE: CONSOLIDATION TEST
PROJECT:	STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH	
LOCATION:	36-37 MOHAKHALI, DHAKA.	



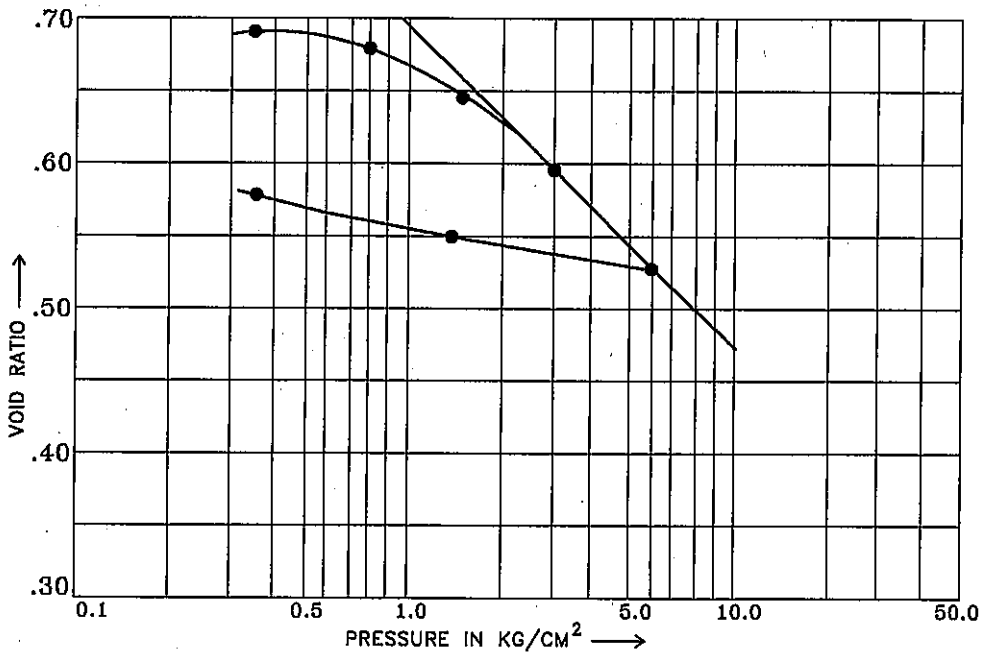
BORING NO.	1
SAMPLE NO.	U-1
DEPTH IN M.	2.00 2.45
MOISTURE CONTENT %	20.25
SPECIFIC GRAVITY	2.674
DRY DENSITY	1.58
INITIAL VOID RATIO E.	0.54
COMP. INDEX Cc	0.175



BORING NO.	2
SAMPLE NO.	U-2
DEPTH IN M.	3.40 3.85
MOISTURE CONTENT %	22.32
SPECIFIC GRAVITY	26.51
DRY DENSITY	1.50
INITIAL VOID RATIO E.	0.585
COMP. INDEX Cc	0.185

BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD.	FIGURE NO. 15

CLEINT:	KOKUSAI KOGYO CO., LIMITED	TITLE: CONSOLIDATION TEST
PROJECT:	STANDARD PENETRATION TEST (SOIL TEST) FOR THE PROJECT ON STRENGTHENING OF WATER EXAMINATION SYSTEM IN THE PEOPLE'S REPUBLIC OF BANGLADESH	
LOCATION:	36–37 MOHAKHALI, DHAKA.	



BORING NO.	5
SAMPLE NO.	U–1
DEPTH IN M.	0.80 1.25
MOISTURE CONTENT %	25.71
SPECIFIC GRAVITY	2.648
DRY DENSITY	1.40
INITIAL VOID RATIO E.	0.675
COMP. INDEX Cc	0.225

BANGLADESH ENGINEERING & TECHNOLOGICAL SERVICES LTD.	FIGURE NO. 17