MINISTRY OF EDUCATION, YOUTH AND SPORT
THE KINGDOM OF CAMBODIA

# PREPARATORY SURVEY REPORT
# ON
# THE PROJECT FOR IMPROVEMENT
# OF
# FACILITY AND LABORATORY EQUIPMENT
# IN THE INSTITUTE OF TECHNOLOGY OF CAMBODIA
# IN
# THE KINGDOM OF CAMBODIA

**MARCH 2013**


**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)**

**INTEM CONSULTING, INC.**
**MATSUDA CONSULTANTS INTERNATIONAL CO., LTD.**


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# PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to the consortium of INTEM Consulting, Inc. and Matsuda Consultants International Co., Ltd.

The survey team held a series of discussions with the officials concerned of the Government of Cambodia, and conducted field investigations. As a result of further studies in Japan, 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.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Cambodia for their close cooperation extended to the survey team.

March, 2013

Nobuko Kayashima
Director General
Human Development Department
Japan International Cooperation Agency

# Summary

# SUMMARY


## Overview of the Country

The Kingdom of Cambodia (hereinafter referred to as 'Cambodia') is located slightly to the south of the Indochinese Peninsula and is bordered by Thailand to the northwest, Laos to the north and Vietnam to the southeast. The Mekong River flows from north to south, slightly to the east of the central plain, where Lake Tonle Sap is situated slightly to the west. Cambodia has a land area of approx. 181,000 square kilometers (about half that of Japan) and a population of approx. 14.14 million (The State of the World's Children/UNICEF 2012). Cambodia reorganized its administrative divisions in December 2008 and has 23 provinces and the capital Phnom Penh.

Cambodia has a tropical monsoon climate. The dry season is from December to April and the rainy season is from May to November. Intense rain falls in September and October. The annual average rainfall is 1,636 mm (UN Data). The lowest monthly average temperature is between 21 and 25 ℃ and the highest monthly average temperature is between 32 and 37 ℃. It is hot year-round. In addition, considerable rain is recorded during the rainy season, during which time damage caused by strong winds is common. No earthquake has occurred in Cambodia to date, nor has any special typhoon and/or tornado been recorded.

For the economy in Cambodia, the GDP is 14.25 billion US dollars, GDP per capita is 934 US dollars, economic growth rate is 6.45 percent and inflation rate is 3.61 percent (the estimated figures of IMF: World Outlook Database/October 2012). The economic growth rate became negative in relation with the global recession which occurred after the "Lehman Shock" in September 2008. However, the economic growth rate recovered up to 6 percent the following year and stable growth is expected in future. Cambodia ranks 139th of 187 countries in the Human Development Index. Though Cambodia has risen higher than the category of 'Low human development', Cambodia still ranks fourth lowest among the category of 'Medium human development' and still has numerous challenges to overcome.

Industry Breakdown of GDP accounted for 36% of primary industry, 23% of secondary industry and 41% in tertiary industry (the figures of 2009/JETRO: Fundamental Economic Index, April 2011). The main industry is agriculture. By the decade of the civil strife, Cambodia's economy was subject to devastating damage. Since 1991, supported by western countries, social infrastructure and a market economy have developed and GDP has surged. After 1998, Cambodia's macroeconomy has remained stable. The Cambodian government promotes trade and investment and is seeking to promote economic growth, acknowledging that further promotion of economic growth is essential to reduce poverty.

Total ODA through bilateral development assistance of DAC countries in Cambodia is equivalent to 30 percent of Cambodia's national budget. To free itself from ODA dependency, Cambodia has developed investment laws that favor foreign investment and is also implementing measures such as installing a special economic zone for further economic development by attracting

foreign direct investment. According to statistical data of the Cambodia Investment Board, China (34.9%), South Korea (15.8%), Malaysia (11.6%), and the United Kingdom (10.0%) occupy a majority of the accumulated investment amount (approved basis).

## Background, History and Outline of the Requested Japanese Assistance

The GDP share of the Mining and Manufacturing Industry in Cambodia remains at around 22%, while the Sewing Industry and Construction Industry dominate the majority. Conversely, direct investment from foreign countries to Cambodia has doubled in the 4 years from 2005 to 2008. The contemplation of branching out of Japanese companies has also accelerated since the latter half of 2010. Cambodia aims to ensure the economy grows sustainably by diversifying industry and enlarging Manufacturing Industry in particular, making efficient use of foreign funds. However, it is pointed out that the skill level of graduates from higher educational institutes in Cambodia for practical work is insufficient in terms of the following points:

- too few graduates have studied engineering majors
- the few graduates having studied engineering majors were mainly educated in the classroom, not a laboratory

Accordingly, foreign companies, including Japanese, have been forced to hire employees from neighboring countries instead of Cambodia.

Under these circumstances, the Cambodian Government ranked "Capacity building and Human resource development" in the paper of the National Development Strategy "Rectangular Strategy", comprising 4 tasks as the main task for accelerating growth and established a policy of strengthening the development of human resources with skill and technique satisfying labor market needs. The Cambodian Government has also been stressing the set-up of equipment for basic educational activities to develop human resources in engineering and mathematics/science fields as one of the key concepts in the educational sector development plan "Educational Strategic Plan 2009-2013".

There are only two public institutes of higher education for engineering in Cambodia, namely the Institute of Technology of Cambodia (hereinafter referred to as 'ITC') and the University of Battambang. The percentage of students studying engineering relative to the total number of students registered in Bachelor courses (1-4 grades total) is between 3.04 and 3.58% (2006-2011), which is very low compared with other fields such as business management (approx. 45%), foreign language (approx. 13%) and so on.

The need to install expensive equipment to carry out practical exercises in class in Engineering Institutes has been considered one of the major reasons for the circumstances above. However, the experimental equipment currently owned by ITC is quite old and insufficient and ITC has partly been using those donated by the ex-Soviet Union since the 1980s. As the type of laboratory needed differs in each department, ITC cannot hold enough experimental classes for some subjects.

With this in mind, the Cambodian Government has requested Grant Aid for Japan as a Project involving the construction of facilities and procurement of experimental equipment targeting ITC to develop human resources (Engineers) with practical skills for industrial fields by enhancing the capacity of education and research, including the ability of practical exercise.

## Outline of the Survey Results and Description of the Project

Having the request from Cambodia, the Japanese Government decided to conduct a preparatory survey on the Project. Japan International Cooperation Agency (hereinafter referred to as 'JICA') organized a survey team for outline design from October 1 to 27, 2012. The survey team conducted a site survey based on the confirmed request by the Cambodian side and discussed with personnel such as the Ministry of Education, Youth and Sport (hereinafter referred to as 'MoEYS'), ITC and other relevant bodies in Cambodia. Subsequently, in Japan, the survey team analyzed documents and information collected during the survey and prepared a draft preparatory survey report; designing targeted and prioritized educational equipment and key facilities needed to conduct practical experiments in class. The survey team returned to Cambodia from December 16 to 22, 2012, explained the contents of the draft report to the Cambodian side and finalized this preparatory survey report.

The major contents of the Project, based on the series of discussions with the Cambodian side, are as follows:

### (1) Scope of Works/Components

The number of ITC students has been doubled in the 7 years since 2004. Although ITC has been striving at its own expense, such as constructing a new 4-story-building F comprising classrooms of the department of Foundation Year and department of Information and Communication Engineering, etc. in 2008, the shortage of experimental equipment and space for the same is prominent in many laboratories and departments. ITC has still been using equipment donated from the ex-Soviet Union since the 1980s, which has become overwhelmingly obsolete nowadays.

Conversely, ITC plans to establish Master Courses in all departments by the beginning of the academic year 2014/15 as well as Doctor Courses in some departments at the beginning of academic year 2015/16. ITC has been implementing Technical Cooperation Project "The Project for Educational Capacity Development of Institute of Technology of Cambodia" (hereinafter referred to as 'ECaD-ITC') supported by the Japanese Government. To attain a synergetic effect, the Project aims to improve educational equipment for the 3 departments targeted by ECaD-ITC; basically together with the other departments, but also equipment for research, important for establishing Master Courses in the near future, shall be included in the Project based on an analysis of the number and level of researchers.

In the Project, a facility accommodating 3-story laboratories shall be newly constructed in the area northwest of the ITC premises. Since the priority of the Project is to procure experimental

equipment, the facility size depends on the shortage of space for equipment procured in the Project. Therefore, the component of the facility shall be minimized only for the required laboratories and other related equipment.

### (2)Equipment Plan

Regarding the equipment requested, major items such as the relevant curriculum/syllabus, purpose of use, quantity needed and reason, components/essential accessories and options and main specifications have been confirmed and the validity of each piece of equipment has evaluated according to the following criteria:

Selection Criteria

①: Equipment with valid contents of experiments, research activities, curriculum and syllabus

②: Equipment with validity in terms of the level of ITC lecturers regarding the methods of equipment usage

③: Equipment with a sustainable market value in future and not immediately outdated

④: Equipment not needing expensive consumables frequently

⑤: Equipment with an appropriate technical level for ITC technicians in terms of maintenance

Deleting Criteria

A: Equipment which overlaps that procured by the Technical Cooperation Project (ECaD-ITC) and/or other donors

B: Equipment for which it has been confirmed that no other equivalent product exists and no reason for specifying model

C: Equipment for which infrequent usage and "low-cost effectiveness" has been confirmed

D: Equipment confirmed as overlapping other equipment requested for the Project and capable of being substituted by other equipment

E: Equipment which is relatively low-priority compared to other equipment when the budget for the Project is limited

### (3)Facility Plan

A laboratory building will be constructed to store the equipment to be procured and provide the space of practice for students.

#### 1) Layout plan

The proposed site is designated on the north-western part of the existing ITC premises and surrounded with one-story buildings. The position of the building is designed and the pillars of the passage are removed so that the longitude wall line of the proposed building and existing B and E blocks are aligned in rows. The number of stories is also set to be the same as those of existing buildings.

#### 2) Structural design

The deep foundation and thick slab are designed in consideration of the weak ground condition. As there is no record of earthquakes in Phnom Penh, seismic action is not considered in the calculation, while the local standard wind load is calculated for the structural design. The existing buildings have common dimensions: 4.4 m for the distance of pillars on the longitudinal axis, 9.35 to 9.45 m for the depth of rooms and 3.8 to 3.9m for floor height. The dimensions for the Project are decided with reference to those existing and familiar to campus users.

#### 3) Exterior enclosure

The material, specification and grade of the exterior enclosure of the building are designed to be harmonized with the existing building and the environment. A concrete louver is installed on the enclosure of the staircase and passage exposed to strong sunlight under the tropical climate with hot temperatures and sudden squalls year-round. A built-up bituminous system with insulation and concrete protection applied to the roof, reflecting the use of the rooftop for photovoltaic cells and heat insulation against strong sunlight, is urgently required.

#### 4) Building service

Water tanks are installed on the proposed building for gravity supply of toilets, washbasins, laboratory sinks and hose reels as well as existing buildings in consideration of the current unstable water supply situation. Wastewater from the bowls and sinks and sewage from the toilets are conveyed to the respective existing drainage networks. Light fixtures and power outlets are installed according to the layout of the planned equipment with suspended cable trays for flexible wiring. Only empty pipes through walls for the communication system are installed. ITC management must design, purchase and install the communication system by itself.

An outline of the equipment and facility plans is shown as follows:

Outline of the Equipment Plan

| Category | Description | Purpose of Use | Q'ty |
|---|---|---|---|
| Electrical and Energy Engineering Department | Optical Communication Training Set | Experiment for Optical Communication System | 1 set |
| | Universal Relay Trainer | Experiment for Universal Relay | 1 set |
| | Differential Relay Trainer | Experiment for Differential Relay | 1 set |
| | Frequency Relay Trainer | Experiment for Frequency Relay | 1 set |
| | Building Management System | Experiment for Building Management System | 1 set |
| | Modern Control experiment Set | Experiment for Modern Control System | 1 set |
| | Control System Production Kit & Small Mobile Robot experimental Kit | Experiment for Control System and Robot | 1 set |
| | Milling Machine | Experiment for tooling work | 1 set |
| | Automation Trainer | Experiment for Automation | 1 set |
| | Process Control Trainer | Experiment for Process Control | 1 set |
| | Microprocessor experimental Set | Experiment for Processor Circuit | 1 set |
| Industrial and mechanical Engineering Department | Torsion Testing Machine | Measuring of Torsion Testing of Metal Material | 1 set |
| Geo-Resources and Geotechnical Engineering Department | X-ray Fluorescence (XRF) | Analysis of Mineral Element | 1 set |
| | Trinocular Optical Polarizing Microscope | Observation of Mineral Element | 2 sets |
| | Total Station | Experiment of Geological Measuring | 5 sets |
| | Automatic Polishing Machine | Polishing of Mineral Sample | 1 set |
| Civil Engineering Department | Triaxial Test Apparatus | Measuring of Soil Sample | 1 set |
| Food Technology and Chemical Engineering Department | HPLC System | Analysis of Sample Element | 1 set |
| | Ion Chromatography | Analysis of Sample Element | 1 set |
| | Gas Chromatograph Mass Spectrometer (GCMS) | Analysis of Sample Element | 1 set |
| Information and Communication on Engineering Department | Equipment for Computer Networking Lab | Experiment of Networking | 1 set |
| | Equipment for Mobile Application Lab | Experiment of developing mobile application | 1 set |
| Foundation Year | Equipment for Computer Lab | Experiment of applied mathematics | 1 set |

Outline of the Facility

| Block | Structure and stories | Description | Total floor area |
|---|---|---|---|
| Laboratory | - Concrete pile foundation<br>- Three stories and penthouse | - Laboratories (Electrical and Energy Engineering Department, Food Technology and Chemical Engineering Department, Geo-Resources and Geotechnical Engineering Department)<br>-Toilet<br>-Building services | 1,314.66 sqm. |

## Project Schedule and Cost Estimate

The construction period for implementing the Project will be about 20.0 months in total, including 5.5 months for the detailed design, 2.5 months for tender procedures and 12.0 months of construction work, including the procurement and installation of equipment The total cost to be borne by the Cambodian side is estimated at approximately 0.04 million yen.

## Project Evaluation

### (1)Relevance

The Project is considered valid as a Japanese Grant Aid Project based on the following points:

#### 1) Beneficiary of the Project

The targeted area of the Project is Phnom Penh City, where ITC is based. The number of direct beneficiaries shall be 1.5 million (population of Phnom Penh in 2008)[1], which is approx.10% of the total 14.1 million population of Cambodia. Since ITC is the top Engineering Institute in Cambodia, the Project will contribute enormously to the development of Cambodian industry, hence its validity is reasonably recognized.

#### 2) Viewpoint of Human Security

Human security is a concept that encourages personal independence and the creation of a sustainable society through protection and empowerment to realize the abundant potential inherent in each individual. It is also intended to focus on the individual human being and protect people from a broad and serious threat to their survival, livelihood and dignity. Through the implementation of the Project, enhancing the opportunity for practical experiments in class at ITC, the top Engineering Institute in Cambodia, the capacity of ITC graduates will be enhanced in relation to their contribution to develop Cambodian industry and society. For that perspective, the Project is consistent with the essence of human security and related to efforts to improve the lives of Cambodian people.

1 Based on the data of "General Population Census 2008", National Institute of Statistics, Ministry of Planning, Cambodia

### 3) Contribution to the Achievement of the Medium/Long Term Development Plan

The NSDP (National Strategic Development Plan 2009-2013 Update) has devised concrete policies and prioritized fields for implementing the 2nd Rectangular Strategy. "Improving the Quality of Education", which is one of the policies of "Capacity Building and Development of Human Resources" of 2nd Rectangular Strategy, includes 3 themes such as "Guarantee of fair access to educational services", "Improvement of the quality and efficiency of educational services" and "Improvement of the system of decentralization and Capacity Development of administrative officers in the educational sector" in the plan. The ESP (Education Strategic Plan 2009-2013) also mentions details of the improvement of facilities for basic learning activities relating to the human resource development of the mathematics field, meaning the validity of the Project is reasonably recognized.

### 4) Consistency with Japanese Policy for Official Development Assistance

In the "Policy Paper of ODA for Cambodia issued by the Ministry of Foreign Affairs, April 2012 - Key issue (mid-term objective) – (1) Strengthening of Economic Structure – Strengthening of Private Sector", it is stated that "Assistance for training of human resources in the industrial area, especially training of human resources for engineers and middle management who are required to expand the manufacturing industry shall be stressed". This is consistent with the objective of the Project "To procure facilities and equipment for experiments targeting ITC for developing human resources (Engineers) with practical skills by enhancing the capacity of education and research, including the ability of practical exercise". Thus, the validity of the Project in relation to Japanese ODA Policy is reasonably recognized.

## (2)Effectiveness

The following shows the outputs expected by implementing the Project:

### 1) Quantitative Effects

| Indicators | Baseline (2012) | End line (2017)<br>(3 years after completion of the Project) |
|---|---|---|
| ① The number of laboratories for 7 departments targeted by the Project<br>(unit: laboratory) | 37 | 45 |
| ② The number of subjects utilizing experimental equipment in class for 7 departments targeted by the Project<br>(unit: subject) | 129 | 176 |

**2) Qualitative Effects**

① The educational environment shall be improved with the necessary experimental equipment for practical training as the top Engineering Institute in Cambodia

② By using experimental equipment for practical training for education and research, human resources (engineers) with practical skills will be increased

③ To benefit the demand for human resources in the industrial area of Cambodia, including Japanese companies expanding into the country

In conclusion, the validity of the Project to be implemented by Japanese Grant Aid shall be highly confirmed and its anticipated effectiveness also fully recognized.

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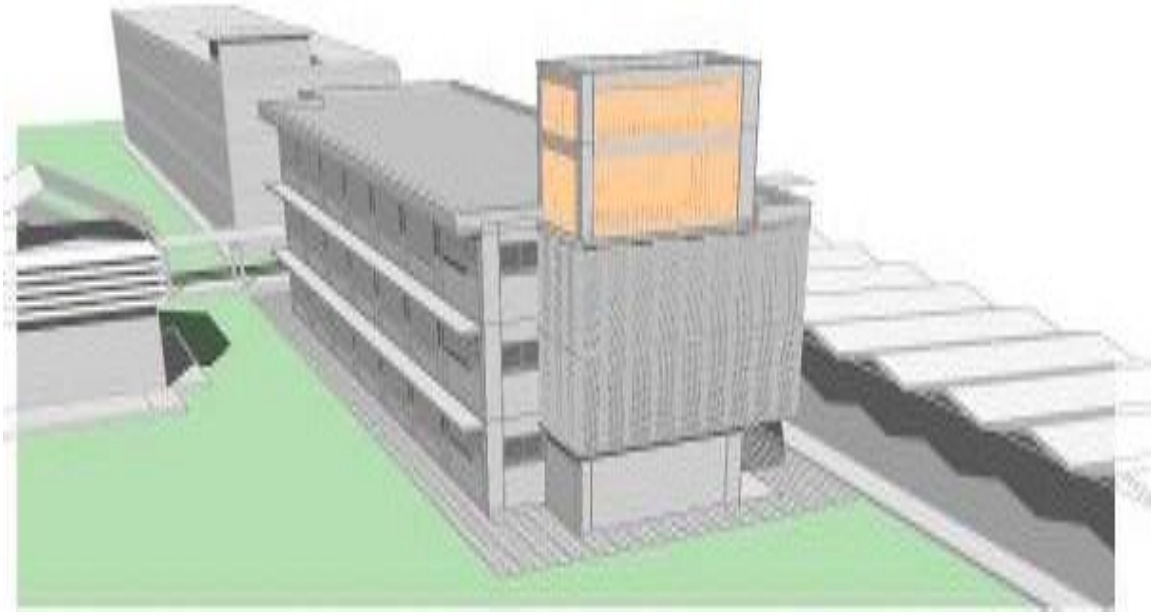
# LOCATION MAP

# PERSPECTIVE



Above: looking down from northwest,  Below: looking up from the west

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# ABBREVIATIONS

| Abbreviation | Original Name |
|---|---|
| ACC | Accreditation Council of Cambodia |
| ASEAN | Association of South−East Asian Nations |
| AUF | Agence Universitaire de la Francophonie |
| CDC | Council for the Development of Cambodia |
| CUD | Commission Universitaire pour le Développement |
| DAC | Development Assistance Committee |
| ECaD-ITC | Project for Educational Capacity Development of Institute of Technology of Cambodia |
| ESP | Education Strategic Plan |
| GDP | Gross Domestic Product |
| HDI | Human Development Index |
| ITC | Institute of Technology of Cambodia |
| JETRO | Japan External TRade Organization |
| JICA | Japan International Cooperation Agency |
| JIS | Japanese Industrial Standards |
| KOICA | Korea International Cooperation Agency |
| MoEYS | Ministry of Education, Youth and Sport |
| MoLVT | Ministry of Labour and Vocational Training |
| NSDP | National Strategic Development Plan |
| ODA | Official Development Assistance |
| SEZ | Special Economic Zone |
| TVET | Technical and Vocational Education and Training |
| UNDP | United Nations Development Programme |
| UNICEF | United Nations Children’s Fund |
| VAT | Value Added Tax |

# Chapter 1 Background of the Project

# Chapter 1 Background of the Project

## 1-1 Background, History and Outline of the Requested Japanese Assistance

The GDP share of Mining and Manufacturing Industry in Cambodia remains at around 22%; primarily dominated by Sewing and Construction Industries. Conversely, the direct investment from foreign countries to Cambodia has doubled in the 4 years from 2005 to 2008, while the number of Japanese companies contemplating branching out has also accelerated since the latter half of 2010. Cambodia aims to ensure the sustainable growth of the economy by diversifying Industry; especially by enlarging Manufacturing Industry and making efficient use of foreign funds. However, it has been highlighted that graduates from higher educational institutes in Cambodia lack the following in terms of their skill level for practical work:

・too few graduates studied engineering majors

・the few graduates having studied engineering majors were educated mainly in the classroom, not the laboratory

Therefore, foreign companies, including Japanese, are forced to hire employees from neighboring countries instead of Cambodia.

There are only two public institutes of higher education for engineering in Cambodia, namely the Institute of Technology of Cambodia and the University of Battambang. The percentage of students studying engineering relative to the total number of students registered in Bachelor courses (1-4 grades total) is between 3.04 and 3.58% (2006-2011), which is very low compared with other fields such as business management (approx. 45%), foreign language (approx. 13%) and so on.

The need to install expensive equipment to carry out practical exercises in class in Engineering Institutes has been considered one of the major reasons for the circumstances above. However, the experimental equipment currently owned by ITC is quite old and insufficient and ITC has partly been using those donated by the ex-Soviet Union since the 1980s. As the type of laboratory needed differs in each department, ITC cannot hold enough experimental classes for some subjects.

The objective of the Project is to procure experimental equipment for 7 departments and construct facilities for 4 departments targeting ITC to develop human resources (Engineers) with practical skills for industrial fields by enhancing the capacity of education and research, including the ability of practical exercise.

## 1-2 Natural Conditions

Cambodia is located in the central part of the Indonesian Peninsula; surrounded by Thailand, Laos and Vietnam. The Mekong River flows south through the country's eastern regions and Tonle Sap Lake, located in the central regions, characterizes the country's landscape. Cambodia

has an area of 181 thousand square kilometers and an estimated population of 14.14 million people (The State of the World's Children 2012, UNICEF). Cambodia is divided into 23 provinces and Phnom Penh City.

### (1) Geography

Phnom Penh is situated on the banks of the Tonlé Sap, Mekong, and Bassac rivers and the proposed site is in the central district of this city. The site is rectangular, measuring 360 to 380 meters east to west and 175 to 195 meters north to south, with a total area of approximately 75 thousand square meters. The site borders the Russian Federation Boulevard to the south and Kim Il Sung Boulevard to the east and its land level is lower than that of the aforementioned roads. The site also borders a high-density residential area to the north and vacant space to the west without any level gap.

### (2) Geology and Soil Conditions

Phnom Penh is set on sedimentary layers brought by the Tonlé Sap and Mekong rivers and the soil conditions for construction are generally considered inappropriate. The Survey Team carried out a geological survey to obtain essential information for the foundation design of the proposed building, which was carried out by the local survey firm. A summary of the result is shown in the following table, details of which are attached at the end of this report.

Table 1-1 Summary of the Result

| | |
|---|---|
| Boring | 2 holes, 20 meters in depth |
| Location | Two points (BH1 and BH2) located at the east and west ends of the proposed building position |
| Standard Penetration Test | Every meter, according to ASTM D-1586 |
| Laboratory Test | Specific gravity test, moisture density test, particle size analysis, liquid limit and plasticity limit test, unconfined compressive test, consolidation test and shear box test |

Table1-2 Description of Strata

| Layer | Depth | Description | N-value |
|---|---|---|---|
| 1st layer | 2.5 to 3.0m below ground level (GL) | Soft to stiff light gray lean clay and fat clay with sand | 4 to 10 |
| 2nd layer | 6 meters from GL below the 1st layer | Medium dense light gray lean and fat clay with sand | 14 to 22 |
| 3rd layer | 8 to 8.5 meter from GL below the 2nd layer | Stiff light brown lean and fat clay with sand | 12 to 17 |
| 4th layer | 11 to 11.5 meter from GL below the 3rd layer | Medium dense yellow light gray with sandy clay with gravel | 12 to 21 |
| 5th layer | 15 to 16 meter from GL below the 4th layer | Dense and medium dense light gray clayish sand with gravel | 25 to 61 |
| 6th layer | 20 meter or deeper below the 5th layer | Very dense yellow light gray clayish sand with gravel | 37 to 61 |

### (3) Climate

Cambodia's climate is dominated by monsoons, of the tropical wet and dry variety. Southwest monsoons blow inland, bringing moisture-laden winds from the Gulf of Thailand and Indian Ocean from May to November. The northeast monsoon ushers in the dry season, which lasts from December to April. The precipitation peaks from September to October, while the driest period is from January to February. Annual precipitation is calculated as 1,636 millimeters as the average of several regions (UN Data).

According to the Statistical Yearbook of Cambodia 2011, Phnom Penh, where the site is stated, has almost no rainy season from December to March and the heaviest rain in October; recording 288 millimeters on average and 742 millimeters at most. The rainy season, which runs from May to October, can see temperatures drop to 22 °C and is generally accompanied by high humidity. The dry season lasts from November to April when temperatures can rise up to 40 °C around April.

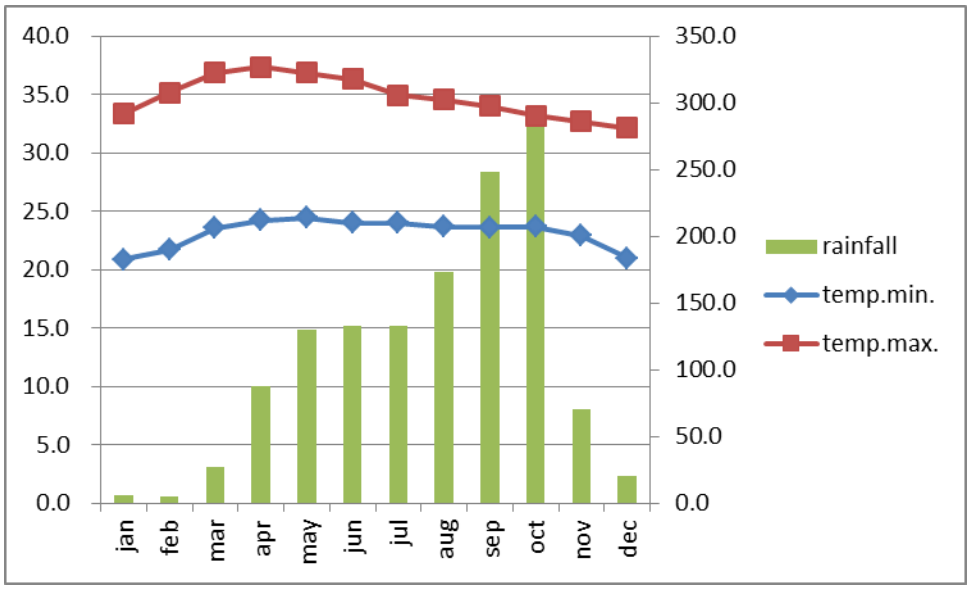


Figure 1-1 Climate of Phnom Penh (2003 to 2010)

Source: Statistical Yearbook of Cambodia 2011, National Institute of Statistics, Ministry of Planning

## 1-3 Environmental and Social Considerations

The Project includes the procurement of laboratory equipment and construction of a small-scale laboratory building within the premises of the existing institute. No disposition of residence due to site acquisition, creation of land and extensive tree trimming are expected through the implementation of the Project, which is intended to minimize impact on the ecosystem, aquatic ecology and geology. Since the pile foundation of the proposed building is designed above the water table, no impact on existing groundwater is expected. Temporary vibration, noise and dust generated by the construction work may occur and shall be controlled via appropriate measures. Additionally the following measures are planned to minimize the impact on the environment:

- A boring method of pile foundation is applied rather than the driving method, taking into consideration the fact that the proposed building is close to the existing building within the premises.

- Protection of harsh sunlight is designed for the planned building to protect the inner thermal environment and reduce the impact on global warming by implementing the Project.

- The layout and height of the building are designed to harmonize with existing buildings in terms of landscape.

Accordingly, the Project is supposed to be classified as Category C of Guidelines for Environmental and Social Considerations of JICA and likely to have minimal or little adverse impact on the environment and society.

In Cambodia, the Law on Environmental Protection and Natural Resource Management (EPNRM) is a framework law governing environmental protection and natural resource management enacted by the National Assembly in 1996. The Sub-Decree on Environmental Impact Assessment, issued in 1999, mandates general requirements, procedures and responsibilities. The sub-decree states that "EIAs are required for various kinds and scales of projects." EIA became a requirement for projects and investments that are submitted to the Council of Development of Cambodia for approval. The Project, which constructs a small-scale building within the premises, is not supposed to be required of this EIA sub-decree.

# Chapter 2 Contents of the Project

# Chapter 2 Contents of the Project

## 2-1 Basic Concept of the Project

The GDP share of Mining and Manufacturing Industry in Cambodia remains at around 22%; primarily dominated by Sewing and Construction Industries. Conversely, the direct investment from foreign countries to Cambodia has doubled in the 4 years from 2005 to 2008, while the number of Japanese companies contemplating branching out has also accelerated since the latter half of 2010. Cambodia aims to ensure the sustainable growth of the economy by diversifying Industry; especially by enlarging Manufacturing Industry and making efficient use of foreign funds. However, it has been highlighted that graduates from higher educational institutes in Cambodia lack the following in terms of their skill level for practical work:

・too few graduates studied engineering majors

・the few graduates having studied engineering majors were educated mainly in the classroom, not the laboratory

Therefore, foreign companies, including Japanese, are forced to hire employees from neighboring countries instead of Cambodia.

Under these circumstances, the Cambodian Government ranked "Capacity building and Human resource development" in the paper of the National Development Strategy "Rectangular Strategy" comprising 4 tasks as the main task for accelerating growth and established a policy of strengthening the development of human resources with skills and techniques satisfying the needs of the labor market. The Cambodian Government has also been stressing the "Development of Higher Education and Research" as one of the key concepts in the educational sector development plan "Educational Strategic Plan 2009-2013".

ITC is the targeted organization for the Project and the top engineering institute among higher educational organizations in Cambodia. However, the experimental equipment ITC currently uses is relatively old and insufficient, some of which was donated by the ex-Soviet Union since the 1980s. As the type of laboratory needed differs in each department, ITC cannot hold sufficient experimental classes for some subjects.

The objective of the Project is to procure experimental equipment for 7 departments[2] and facilities for 3 departments[3] targeting ITC to develop human resources (Engineers) with practical skills by enhancing the capacity of education and research, including the ability in terms of practical exercise.

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2 7 departments such as the Electrical and Energy Engineering, Industrial and Mechanical Engineering, Geo-Resources and Geotechnical Engineering, Foundation Year, Civil Engineering, Food Technology and Chemical Engineering and Information and Communication Engineering

3 3 departments such as Electrical and Energy Engineering, Geo-Resources and Geotechnical Engineering and Food Technology and Chemical Engineering

The Japanese Government is currently implementing a Technical Cooperation Project (ECaD-ITC) for 3 departments[4] in ITC in terms of improving the quality of education and its environment of using equipment in class. ECaD-ITC shall collaborate with the Project by revising the syllabus, experimental documents, improving teaching skills and assisting in the use of experimental equipment based on the equipment to be procured in the Project.

For the University of Battambang and Svay Rieng University, which are initially included as two of the three targeted organizations for the Project together with ITC in the Form of a Request from the Cambodian side, both universities have been excluded from the Project. This is because the equipment requested is unlikely to be utilized effectively due to the serious lack of lecturers in the University of Battambang and the lack of skilled lecturers in Svay Rieng University, although the need for experimental equipment in both Universities is recognized based on the results of the survey to confirm the current situations in the Universities.

## 2-2 Outline Design of Japanese Assistance

### 2-2-1 Design Policy

#### 2-2-1-1 Basic Policy

The number of ITC students has been doubled in the 7 years since 2004. Although ITC has been striving at its own expense, such as constructing a new 4-story-building F comprising classrooms of the department of Foundation Year and department of Information and Communication Engineering, etc. in 2008, the shortage of experimental equipment and space for the same is prominent in many laboratories and departments. ITC has still been using equipment donated from the ex-Soviet Union since the 1980s, which has become overwhelmingly obsolete nowadays.

Conversely, ITC plans to establish Master Courses in all departments by the beginning of the academic year 2014/15 as well as Doctor Courses in some departments at the beginning of academic year 2015/16. ITC has been implementing Technical Cooperation Projects (ECaD-ITC) supported by the Japanese Government. To attain a synergetic effect, the Project aims to improve educational equipment for the 3 departments targeted by ECaD-ITC; basically together with the other departments, but also equipment for research, important for establishing Master Courses in the near future, shall be included in the Project based on an analysis of the number and level of researchers.

In the Project, a facility accommodating 3-story laboratories shall be newly constructed in the area northwest of the ITC premises. Since the priority of the Project is to procure experimental equipment, the facility size depends on the shortage of space for equipment procured in the Project. Therefore, the component of the facility shall be minimized only for

[4] 3 departments such as Electrical and Energy Engineering, Industrial and Mechanical Engineering and Geo-Resources and Geotechnical Engineering

the required laboratories and other related equipment.

### 2-2-1-2 Policy for Natural Environmental Conditions

#### (1) Policy for climatic conditions

For the Project, protecting the interior of the building against the harsh heat and heavy rainfall is crucial for the design. Appropriate waterproof and heat insulation on a flat roof, sun shade on walls, heat-reflective paint and a storm water ditch around the proposed building are measures. For frequent lightning, lightning protection equipment shall be installed in the proposed building.

#### (2) Ground conditions and earthquake

Phnom Penh is located on the banks of the Mekong River and the ground conditions are generally poor. In recent years, the ITC premises have been exposed to land subsidence, which has caused cracks in slabs and between the concrete frame and wall of block E, which has no piles, on the ground floor slab of block A. According to the soil boring test report, there is a good soil bed with an N-value of 30 or more 12 to 13m below the ground surface. For the proposed building, the end of pile foundation is more than 13m below the ground surface. As no earthquake has been recorded in Phnom Penh, seismic action is not considered in the calculation.

#### (3) Others

For damage caused by termites often seen in general, termiticides shall be sprayed around the foundation and building. In addition, hardwood shall be used for the doors and frames to prevent termite damage.

### 2-2-1-3 Policy for Socioeconomic Conditions

#### (1) Equipment planning issues to be considered

Investment from foreign countries in Cambodia has been expanding considerably in the last few years. Cambodia aims to maintain sustainable economic growth by enlarging the manufacturing industry through these foreign investments. Japanese companies, including manufacturing companies, have also been making inroads into the Cambodian market since the latter part of 2010. The contents of the equipment plan for the Project shall take account of the needs of those Japanese companies making inroads into the Cambodian market.

#### (2) Issues to be considered in facilities planning

- For male and female toilets, the number of sanitary fixtures shall be the same in consideration of gender. A hand spray shall be installed for each toilet according to the local custom.
- Located in the heart of Phnom Penh, ITC has comparatively good security. However, ITC must take measures against theft for the expensive equipment to be procured.

### 2-2-1-4 Policy for Conditions of Procurement and Construction

#### (1) Availability of local procurement of materials

Almost all educational equipment planned for the Project shall be procured from Japan and/or European/American countries. PC equipment, Audio Visual equipment and Furniture shall only be procured in Cambodia. For equipment frequently requiring consumables, the existence of agents in Cambodia and/or neighboring countries shall be considered.

Many construction materials for the Project are produced in nearby Thailand and Vietnam. The effective transportation between Phnom Penh, Bangkok and Ho Chi Minh City mean most of the materials needed are available in Phnom Penh. The materials for the Project shall be chosen from among local choices with durability and ease of maintenance.

#### (2) Building code and related laws

It is necessary to obtain a building permit, regardless of the Project, for new buildings or extensions according to the Building Code of Cambodia (1997). As this Project is an extension of Government premises, the Government itself has the authority to issue the permit. Based on the premise of previous ITC projects, for which a permit has been obtained through procedures within MoEYS, the permit for the Project is supposed to be issued through the same process. Work must commence within one year of the issuance of the building permit. As this building Code does not stipulate dimensions, strength and performance, the design is developed with reference to Japanese standards.

#### (3) Quality and quantity of local labor

Given the very active construction industry market in Phnom Penh, where many construction projects, including high-rise, are seen, the workmanship of skilled workers is good enough. However, many belong to local contractors and earn considerably expensive wages. Therefore, the Project design will be developed using a local method in principle to facilitate work with local workers.

### 2-2-1-5 Policy for Collaboration with Local Contractors and Consultants

Cambodia in Southeast Asia has been developing with steady economic growth, while direct investment is also on the up. Local contractors in Phnom Penh have developed technical capabilities through many investment projects, meaning construction designed using local methods is possible with the utilization of local contractors. However the scale of the Project is so small that big firms are unlikely to be interested in bidding. To ensure the implementation of the Project, care must be taken to avoid selecting local contractors with substandard work.

### 2-2-1-6 Policy for Operation and Maintenance

#### (1) Policy for Operation and Maintenance of Equipment

More than 2 technicians for maintaining equipment are placed in each laboratory, at a level

whereby they can handle simple problems affecting the equipment. However, they may be unable to deal with more complicated equipment issues and/or sensitive safety-related matters. In some cases, a technician from the manufacturer may be required, so the existence of agents in Cambodia and/or neighboring countries shall be carefully considered when selecting equipment for the Project.

**(2) Policy for Operation and Maintenance of Facilities**

In principle, the design shall allow users to maintain the facility easily. (e.g. Every glass window can be wiped without ladders. Users can easily access the concrete louver where the outdoor unit of the air-conditioner is placed.) The material and method shall be chosen among locally procured products with sustainability in mind. In addition, for laboratory equipment, replacement in future is highly likely in consideration of the characteristics of the function of the Institute. Therefore, a room for additional power and water supply shall be secured to ensure design flexibility is maintained.

### 2-2-1-7 Policy of the Grade of Equipment and Facilities

**(1) Policy of the Grade of Equipment**

ITC is the highest level Engineering University in Cambodia, with many lecturers having obtained doctor's degrees from Foreign Universities. The skilled practical techniques of ITC graduates are acknowledged by local companies. ITC plans to establish Master Courses in all departments by the beginning of academic year 2014/15 and also plans to activate research programs. Therefore, the Project is primarily targeting efforts to procure educational equipment but equipment for research activities shall also be included.

**(2) Policy of the Grade of Facilities**

Since the proposed building will be built within the premises of Cambodia's top level Engineering Institute, this proposed building will easily catch people's attention and be compared with other existing buildings. The grade of the proposed building and utility is set to be equivalent to the existing one.

### 2-2-1-8 Policy for Construction, Procurement Method and Construction Period

**(1) Construction Method**

Certain matters shall be specified regarding the facility design, such as the method of concrete louvers and pile foundation. In consideration of the clay soil, which tends to get stiff in the dry season and the proximity of the proposed building to that already existing, a cast-in situ pile method with less noise and vibration is applied. The installation of concrete louvers shall be developed to ensure durability and cost efficiency based on local method.

**(2) Construction Period**

In consideration of the fact that the proposed building has three floors, with a penthouse, reinforced concrete structure and pile foundation, the construction period is estimated at

twelve months if the Project is carried out using Japanese Grant Aid. The procurement and installation work for the equipment is supposed to be completed within the same period.

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

#### 2-2-2-1 Equipment Plan

**(1) Policy for Equipment Plan**

Regarding the equipment requested, the following points were confirmed with each department during discussions:

- Curriculum, Syllabus and Applicable Experimental Documents
- Purpose of Use, Quantities needed and reasons
- Component, Essential accessories and options
- Main specifications with parameters
- Priority among the equipment requested
- Reference models and Local agents

In the course of discussions, the list of requested equipment was modified according to the following perspectives:

**1) Integration of the Equipment Used Together**

Some equipment requested as an independent item, but practically used as a single set, has been integrated into a single item and assigned the same priority. Certain tools have also been integrated into one item.

**2) Generalization of Requested Specifications**

In the steps of implementing the Japanese Grant Aid Project, equipment shall be procured through general competitive tender. Therefore, it is advisable not to specify models in the Tender Documents in terms of securing competitiveness. Accordingly, some contents of the requested items have been generalized by breaking them down into small general parts and rearranging them as a set of general parts.

Furthermore, the following have been deleted from the list of equipment requested by mutual consensus between ITC and the survey team:

**3) Deletion of the Requested Equipment for HVL and EMC Laboratories**

Regarding the equipment requested for the High Voltage Laboratory (HVL) and Electro Magnetic Laboratory (EMC) of the Electrical and Energy Engineering Department, the lack of a skilled lecturer in the department and scope for effective use of the equipment requested was confirmed. It was therefore agreed that these items should be deleted from the list for the Project. Besides, there was also a request from ITC to include electrical transmission trainers in the list of equipment for the Project. However, the previous inclusion of similar equipment in the list negating such need was also confirmed.

**4) Deletion of items in terms of the consistency of Grant Aid Scheme**

Regarding the maintenance service of switching hubs and routers requested for the Network lab of the Information and Communication Engineering Department, this was deleted from the list of equipment for the Project as such service comes within the scope of work of the Cambodian side within the Project. Besides, regarding the mobile terminal devices requested to develop mobile applications within Information and Communication Engineering Department, since models of such mobile terminals change quickly and the completion of the Project is scheduled at the end of 2014, the value of the terminals requested is very vague at present in terms of technique and continuity at 2014. Thus, the equipment shall be deleted from the list for the Project.

The following Table 2-1 is the policy of equipment planning by department:

Table 2-1 Policy of Equipment Planning by department

| Department | Policy of Equipment Planning |
|---|---|
| Department of Foundation Year | Equipment for 3 categories (Mechanics, Thermodynamics and Electro-Kinetics) of 6 experimental practice categories needed shall be planned. Equipment for practical mathematics, which is scheduled to start from academic year 2014/15, shall also be included for the Project. |
| Department of Electrical and Energy Engineering | |
| Communication Engineering Lab. (Existing Lab.) | 2 of equipment not to be procured by the Technical Cooperation Project (ECaD-ITC) shall be planned for the Project. |
| New and Renewable Energy Lab. | Basic equipment relating to solar photovoltaic power generation and an electrical transmission system shall be planned. Equipment necessary for the activities of Master Course shall also be included for the Project. |
| Control and Automation Lab. | Basic equipment relating to building management information system, control and automation training system shall be planned. Equipment necessary for the activities of Master Course shall also be included for the Project. |
| Industry Electronics Engineering lab. | Basic equipment relating to data processing and a trainer for designing electronics circuits shall be planned for the Project. |
| Department of Industrial and Mechanical Engineering | Basic equipment relating to material testing, thermodynamics engineering and fuel combustion engineering shall be planned for the Project. |
| Department of Food Technology and Chemical Engineering | Equipment relating to food chemical, water analysis, microbiology, applied analysis and biotechnology for 5 existing laboratories and food processing equipment for a new laboratory shall be planned. Equipment for research purposes such as GCMS and HPLC shall also be included in the Project for the activities of researchers and upper-grade students. |
| Department of Civil Engineering | Among the 3 existing laboratories, three of the sets of equipment shall be planned for the Soil Lab (2 of which to replace the broken existing unit) and one set of equipment shall be planned for the Asphalt lab. The planned equipment shall be used for research activities for the Master Course established in 2011. |
| Department of Information and Communication on Engineering | Equipment for the existing Network Lab., Multipurpose Lab and that to develop mobile applications for mobile terminals shall be planned for the Project. |

| | |
|---|---|
| Department of Geo-Resource and Geotechnical Engineering | There is no equipment for practice except that supported by the Japanese Cultural Grant Aid Project, which is established in March 2013, because the department has been just re-established in 2011. Thus, equipment for mineral geology, geochemistry, topography, mineral exploration, earth physics and petroleum engineering shall be planned for the Project. |

### (2) Equipment Plan

Regarding the equipment requested, its validity has been evaluated according to the following criteria:

Selection Criteria

①: Equipment with valid contents of experiments, research activities, curriculum and syllabus

②: Equipment with validity in terms of the level of ITC lecturers regarding the methods of equipment usage

③: Equipment with a sustainable market value in future and not immediately becoming outdated

④: Equipment not needing expensive consumables frequently

⑤: Equipment with an appropriate technical level for ITC technicians in terms of maintenance

Deleting Criteria

A: Equipment which overlaps that procured by the Technical Cooperation Project (ECaD-ITC) and/or other donors

B: Equipment for which it has been confirmed that no other equivalent product exists and no reason for specifying model

C: Equipment for which infrequent usage and "low-cost effectiveness" has been confirmed

D: Equipment confirmed as overlapping other equipment requested for the Project and capable of being substituted by other equipment

E: Equipment which is relatively low-priority compared to other equipment when the budget for the Project is limited

The result of the selection is shown in the following Table 2-3.

Table 2-2 Equipment Selection Criteria and Results

| No. | Department/Lab. | Name of Equipment | Q'ty | Selection Criteria | | | | | Delete Criteria | | | | | Evaluation | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | A | B | C | D | E | | |
| 1 | Electrical and Energy Engineering | Motor Experiment Set | 1 | O | O | O | O | O | | | | × | | × | |
| 2 | | Optical Comunication Training Set | 2 | O | O | O | O | O | | | | | | O | |
| 3 | | Optical Splicer | 1 | O | O | O | O | O | | | | | | O | |
| 4 | | Telecommunication System Training Set | 1 | O | O | O | O | O | | | | | × | × | |
| 5 | Electrical and Energy Engineering / Power Electric and Energy Lab. | Universal Relay Trainer | 1 | O | O | O | O | O | | | | | | O | |
| 6 | | Deferential Relay Trainer | 1 | O | O | O | O | O | | | | | | O | |
| 7 | | Frequency Relay Trainer | 1 | O | O | O | O | O | | | | | | O | |
| 8 | | Distance Relay Trainer | 1 | O | O | O | O | O | | | | | × | × | |
| 9 | | Electric Power Transmission Training System | 1 | O | O | O | O | O | | | | | × | × | |
| 10 | | PSCAD | 1 | O | O | O | O | O | | | | | | O | |
| 11 | | Solar Panel | 20 | O | O | O | O | O | | | | | | O | |
| 12 | | Pyranometer | 1 | O | O | O | O | O | | | | | | O | |
| 13 | | Solar Reference Cell | 1 | O | O | O | O | O | | | | | | O | |
| 14 | | Photovoltaic Inverter Set | 1 | O | O | O | O | O | | | | | | O | |
| 15 | | Photovoltaic Inverter 2 | 1 | O | O | O | O | O | | | | × | | × | |
| 16 | | IV Curve Tracer | 1 | O | O | O | O | O | | | | | × | × | |
| 17 | | Programmable Electronic Load | 1 | O | O | O | O | O | | | | | | O | |
| 18 | | Electrical Network Analyzer | 1 | O | O | O | O | O | | | | | | O | |
| 19 | | Power Quality Analyzer | 1 | O | O | O | O | O | | | | | | O | |
| 20 | | Electrical Safety Checker | 1 | O | O | O | O | O | | | | | | O | |
| 21 | | Clamp Wattmeter | 2 | O | O | O | O | O | | | | | | O | |
| 22 | | Portable Multimeter | 2 | O | O | O | O | O | | | | | | O | |
| 23 | | Clamp Measurement of Earth and Leakage Current | 1 | O | O | O | O | O | | | | | | O | |
| 24 | | Multifunction HVAC and IAQ Meter | 1 | O | O | O | O | O | | | | | | O | |
| 25 | | Temperature/Humidity Tester | 1 | O | O | O | O | O | | | | | | O | |
| 26 | | Laptop PC | 1 | O | O | O | O | O | | | | | | O | |
| 27 | | Desktop PC | 2 | O | O | O | O | O | | | | | | O | |
| 28 | Electrical and Energy Engineering / Control and Automation Lab. | Building Management System & Energy Audit tool | 1 | O | O | O | O | O | | | | | | O | |
| 29 | | PC set | 1 | O | O | O | O | O | | | | | | O | |
| 30 | | Mordern Control Experimental Set | 1 | O | O | O | O | O | | | | | | O | |
| 31 | | Ball and Beam System | 2 | O | O | O | O | O | | | | | | O | Included in No.30 |
| 32 | | Rotary Inverted Pendulum System | 2 | O | O | O | O | O | | | | | | O | Included in No.30 |
| 33 | | Motor Position and Velocity Control System | 8 | O | O | O | O | O | | | | | | O | Included in No.30 |
| 34 | | Flexible Link System | 2 | O | O | O | O | O | | | | | | O | Included in No.30 |
| 35 | | Heat Flow System | 2 | O | O | O | O | O | | | | | | O | Included in No.30 |
| 36 | | Couple Tank System | 2 | O | O | O | O | O | | | | | | O | Included in No.30 |
| 37 | | Rotary Flexible Joint | 2 | O | O | O | O | O | | | | | | O | Included in No.30 |
| 38 | | Data Acquisition set for Control System Lab. | – | – | – | – | – | – | | | | | | – | Integrated into No.30 |
| 39 | | PCI Data Acquisition Board | 10 | O | O | O | O | O | | | | | | O | Included in No.38 |
| 40 | | USB Data Acquisition Board | 5 | O | O | O | O | O | | | | | | O | Included in No.38 |
| 41 | | Data Acquisition | 5 | O | O | O | O | O | | | | | | O | Included in No.38 |
| 42 | | 16-ch Analogue Data Acquisition | 15 | O | O | O | O | O | | | | | | O | Included in No.38 |
| 43 | | 8-Channel Counter/Timer with Digital I/O | 10 | O | O | O | O | O | | | | | | O | Included in No.38 |
| 44 | | Shielded Cable | 25 | O | O | O | O | O | | | | | | O | Included in No.38 |
| 45 | | Connector | 25 | O | O | O | O | O | | | | | | O | Included in No.38 |
| 46 | | Control Design Software | 1 | O | O | O | O | O | | | | | | O | Included in No.38 |
| 47 | | Amplifier for Automatic Control system 1 | 8 | O | O | O | O | O | | | | | | O | Included in No.38 |
| 48 | | Amplifier for Automatic Control system 2 | 6 | O | O | O | O | O | | | | | | O | Included in No.38 |
| 49 | | Amplifier for Automatic Control system 3 | 4 | O | O | O | O | O | | | | | | O | Included in No.38 |
| 50 | | Research Oscilloscope | 1 | O | O | O | O | O | | | | | | O | |
| 51 | | Student Oscilloscope | 8 | O | O | O | O | O | | | | | | O | |
| 52 | | Robotec Experimental Lab. | – | – | – | – | – | – | | | | | | – | Divided into No.53 to 58 |
| 53 | | Autonomous Mobile Robot for Teaching | 5 | O | O | O | O | O | | | | | | O | |
| 54 | | 2 DOF Planar Robot | 1 | O | O | O | O | O | | | | | | O | |
| 55 | | Autonomous Robot | 1 | O | O | O | O | O | | | | | | O | |
| 56 | | Humanoid Robot | 1 | O | O | O | O | O | | | | | | O | |
| 57 | | Quadrotor for Indoor Unmanned Aerial Vehicle | 1 | O | O | O | O | O | | | | | | O | |
| 58 | | Control System Production Kit & Small Mobile Robot Experimental Kit | 1 | O | O | O | O | O | | | | | | O | |
| 59 | | Workshop Equipment | – | – | – | – | – | – | | | | | | – | Divided into No.60 to 63 |
| 60 | | Lathe Machine | 1 | O | O | O | O | O | | | | | | O | |
| 61 | | Milling Machine | 1 | O | O | O | O | O | | | | | | O | |
| 62 | | Drilling Machine | 1 | O | O | O | O | O | | | | | | O | |
| 63 | | Tooling Machine Set | 1 | O | O | O | O | O | | | | | | O | |
| 64 | | Automation Control Kit lab | 1 | O | O | O | O | O | | | | | | O | |
| 65 | | Mechatronic Control Kits | 1 | O | O | O | O | O | | | | | | O | |
| 66 | | Hydraulics training systems | 1 | O | O | O | O | O | | | | | | O | |
| 67 | | Level Liquid Filling Machine | 1 | × | × | O | O | × | | | | | × | × | |
| 68 | | DSPACE module | 1 | × | × | O | O | × | | | | | × | × | |
| 69 | | LCD Projector | 2 | × | O | O | O | O | | | | | × | × | |
| 70 | | 3D Printers | 1 | × | × | × | × | O | | | | | × | × | |
| 71 | Electrical and Energy Engineering / Industrial Electronics Lab. | Electronic Experimental Kit | 1 | O | O | O | O | O | | | | × | | × | |
| 72 | | PCB Making Machine & 5 Extra Tool Set | 1 | O | O | O | O | O | | | | | | O | |
| 73 | | CNC Laser Cutting Machine | 1 | O | O | O | O | O | | | | | | O | |
| 74 | | Microprocessor Experimental Set | 1 | O | O | O | O | O | | | | | | O | |
| 75 | | Network Development Kit | 5 | O | O | O | O | O | | | | | | O | |
| 76 | | Development Board for Open Source OS | 1 | O | O | O | O | O | | | | | | O | |
| 77 | | Workshop Tool Set | 1 | O | O | O | O | O | | | | | | O | |
| 78 | | Laptop PC | 3 | O | O | O | O | O | | | | × | | × | |
| 79 | | Image Processing Development Kit | 1 | × | × | O | O | × | | | | | × | × | |
| 80 | | Audio Processing Development Kit | 1 | × | × | O | O | × | | | | | × | × | |
| 81 | | Video Conference System | 1 | × | × | O | O | O | | | | | × | × | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 82 | Industrial and Mechanical Engineering | Torsion Testing Machine | 1 | O | O | O | O | O | | | | | | O | |
| 83 | | Thermal Conductivity System | 1 | O | O | O | O | O | | | | × | | × | |
| 84 | | Centrifugal Pump Module | 1 | O | O | O | O | O | | | | | | O | |
| 85 | | Two-stage Pumps | 1 | O | O | O | O | O | | | | | | O | |
| 86 | | Wire-Cut | 1 | O | O | O | × | × | | | | | | × | |
| 87 | | Drop Weight Impact Testing Machine | 1 | O | O | O | O | O | | | | × | | × | |
| 88 | | Environmental Applications Learning System | 1 | O | O | O | O | O | | | | | | O | |
| 89 | | Refrigerant & Combustible Gas Leak Detector | 1 | O | O | O | O | O | | | | | | O | |
| 90 | | IEQ Checker | 1 | O | O | O | O | O | | | | | | O | |
| 91 | | Infrared Thermometer | 5 | O | O | O | O | O | | | | | | O | |
| 92 | | Diagnostic Refrigerant Analyzer | 1 | O | O | O | O | O | | | | | | O | |
| 93 | | Recovery Machine | 1 | O | O | O | O | O | | | | | | O | |
| 94 | | Air Velocity Meter | 2 | O | O | O | O | O | | | | | | O | |
| 95 | | Precision Balance A | 1 | O | O | O | O | O | | | | | | O | |
| 96 | | Precision Balance B | 1 | O | O | O | O | O | | | | | | O | |
| 97 | | Heating/Refrigerated Circulator | 1 | O | O | O | O | O | | | | | | O | |
| 98 | | Fuel Analyzer | 1 | O | O | O | O | O | | | | | | O | |
| 99 | | Portable gasoline analyzer | 1 | O | O | O | O | O | | | | × | | × | |
| 100 | | Machine Tool Set | 1 | O | O | O | O | O | | | | | | O | |
| 101 | | Desktop PC | 4 | O | O | O | O | O | | | | | | O | |
| 102 | | Multifunction Copier | 1 | O | O | O | O | O | | | | × | | × | |
| 103 | | Laptop PC | 4 | O | O | O | O | O | | | | | | O | |
| 104 | | Color Laser Printer | 1 | O | O | O | O | O | | | | | | O | |
| 105 | | Monochrome Laser Printer | 2 | O | O | O | O | O | | | | | | O | |
| 106 | | Titrator | 1 | O | O | O | O | O | | | | | | O | |
| 107 | | Flash Point Tester | 1 | O | O | O | O | O | | | | | | O | |
| 108 | | Cloud Point and Pour Point Tester | 1 | O | O | O | O | O | | | | | | O | |
| 109 | | Oxidation Stability Testing Machine | 1 | O | O | O | O | O | | | | | | O | |
| 110 | **Geo-Resources and Geotechnical Engineering** | X-ray Fluorescence (XRF) | 1 | O | O | O | O | O | | | | | | O | |
| 111 | | Trinocular Optical Polarizing Microscope | 2 | O | O | O | O | O | | | | | | O | |
| 112 | | Heating/Freezing Stage Apparatus | 1 | O | O | O | O | O | | | | | | O | |
| 113 | | Total Station | 5 | O | O | O | O | O | | | | | | O | |
| 114 | | Hand Auger Equipment | 2 | O | O | O | O | O | | | | | | O | |
| 115 | | Automatic Polishing Machine for Thin Section | 1 | O | O | O | O | O | | | | | | O | |
| 116 | | Electric Furnace | 1 | O | O | O | O | O | | | | | | O | |
| 117 | | Precision Electric Balance | 1 | O | O | O | O | O | | | | | | O | |
| 118 | | Electrical Oven | 1 | O | O | O | O | O | | | | | | O | |
| 119 | | Agate Mortar, small size | 3 | O | O | O | O | O | | | | | | O | |
| 120 | | Agate Mortar, large size | 3 | O | O | O | O | O | | | | | | O | |
| 121 | | Magnetometer | 1 | O | O | O | O | O | | | | | | O | |
| 122 | | Floor Stand Manual Drill Press | 1 | O | O | O | O | O | | | | | | O | |
| 123 | | Instructional Gas Permeameter | 1 | O | O | O | O | O | | | | | | O | |
| 124 | | Instructional Helium Porosimeter | 1 | O | O | O | O | O | | | | | | O | |
| 125 | | Instructional Gravimetric Capillary Pressure System | 1 | O | O | O | O | O | | | | | | O | |
| 126 | | Bench Top Liquid Permeability Measurement Syste | 1 | O | O | O | O | O | | | | | | O | |
| 127 | | Eclipse software | 1 | O | O | × | O | O | | × | | | | × | |
| 128 | | Micro-Deval Apparatus | 1 | O | O | O | O | O | | | | | | O | |
| 129 | | Unconfined Compression Tester | 5 | O | O | O | O | O | | | | | | O | |
| 130 | | Hydrometer Analyser | 1 | O | O | O | O | O | | | | | | O | |
| 131 | | Liquid Limit Apparatus | 5 | O | O | O | O | O | | | | | | O | |
| 132 | | Plotter | 1 | O | O | O | O | O | | | | | | O | |
| 133 | | Desktop PC Set | 1 | O | O | O | O | O | | | | | | O | |
| 134 | | Laptop PC | 2 | O | O | O | O | O | | | | | | O | |
| 135 | **Civil Engineering** | Direct Shear Test Apparatus | 1 | O | O | O | O | O | | | | | | O | |
| 136 | | CBR Test Apparatus | 1 | O | O | O | O | O | | | | | | O | |
| 137 | | Plate Test Apparatus | 1 | O | O | O | O | O | | | | | | O | |
| 138 | | Ductility Test Apparatus | 1 | O | O | O | O | O | | | | | | O | |
| 139 | | Triaxial Test Apparatus | 1 | O | O | O | O | O | | | | | | O | |
| 140 | **Food Technology and Chemical Engineering** | Microwave Digestion Apparatus | 1 | O | O | O | O | O | | | | | | O | |
| 141 | | HPLC System | 1 | O | O | O | O | O | | | | | | O | |
| 142 | | Smasher for Sample Preparation in Microbiology | 1 | O | O | O | O | O | | | | | | O | |
| 143 | | Filter Press | 1 | O | O | O | O | O | | | | | | O | |
| 144 | | Press Hydrolic | 1 | O | O | O | O | O | | | | | | O | |
| 145 | | Laboratory Juicer | 1 | O | O | O | O | O | | | | | | O | |
| 146 | | Filling Machine | 1 | O | O | O | O | O | | | | | | O | |
| 147 | | Freezer | 1 | O | O | O | O | O | | | | | | O | |
| 148 | | Ion Chromatography | 1 | O | O | O | O | O | | | | | | O | |
| 149 | | Gas Chromatograph Mass Spectrometer (GCMS) | 1 | O | O | O | O | O | | | | | | O | |
| 150 | | Viscosimeter | 1 | O | O | O | O | O | | | | | | O | |
| 151 | | Bioreactor | 1 | O | O | O | O | O | | | | | | O | |
| 152 | | Biogas Analyzer | 1 | O | O | O | O | O | | | | | | O | |
| 153 | | System Water Purification | 1 | O | O | O | O | O | | | | | × | × | |
| 154 | | Ultraviolet and Visible Range spectrophotometers | 1 | O | O | O | O | O | | | | | × | × | |
| 155 | | Rotary Evaporator | 1 | O | O | O | O | O | | | | | × | × | |
| 156 | | Multiparameter Water Quality Control | 1 | O | O | O | O | O | | | | | × | × | |
| 157 | | Moisture Analyzer | 2 | O | O | O | O | O | | | | | × | × | |
| 158 | | Digital Hand Held Refractometer | 2 | O | O | O | O | O | | | | | × | × | |
| 159 | | Digital Pocket Ethyl Alcohol Refractometer | 2 | O | O | O | O | O | | | | | × | × | |
| 160 | | Oven | 1 | O | O | O | O | O | | | | | × | × | |
| 161 | | Floor Freeze Dryers | 1 | O | O | O | O | O | | | | | × | × | |
| 162 | | Precision Balance | 2 | O | O | O | O | O | | | | | × | × | |
| 163 | | Laboratory Scale Spray Dryer | 1 | O | O | O | O | O | | | | | × | × | |
| 164 | | Air conditioner | 1 | O | O | O | O | O | | | | | × | × | |
| 165 | | Water Actvity Meter | 1 | O | O | O | O | O | | | | | × | × | |
| 166 | | Micro Pipette Set | 2 | O | O | O | O | O | | | | | × | × | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 167 | Information and Communication on Engineering | Equipment for Computer Networking Lab | 1 | O | O | O | O | O | | | | | | O | |
| 168 | | Equipment for Android Mobile Application Development Lab | 1 | O | O | O | O | O | | | | | | O | |
| 169 | | Equipment for iOS Mobile Application Development | 1 | O | O | O | O | O | | | | | | O | |
| 170 | | Equipment for Multipurpose Development Lab | 1 | O | O | O | O | O | | | | | | O | |
| 171 | Foundation Year | Equipment for Computer Lab | 1 | O | O | O | O | O | | | | | | O | |
| 172 | | Experimental Kit for Physics | 5 | O | O | O | O | O | | | | | | O | |
| 173 | | Ballistic Pendulum Apparatus | 5 | O | O | O | O | O | | | | | | O | |
| 174 | | Experimental Kit for Hook's Law | 5 | O | O | O | O | O | | | | | | O | |
| 175 | | Inclined Plane Apparatus | 5 | O | O | O | O | O | | | | | | O | |
| 176 | | Air Track Complete Set | 5 | O | O | O | O | O | | | | | | O | |
| 177 | | Free Fall Apparatus | 5 | O | O | O | O | O | | | | | | O | |
| 178 | | Gyroscope | 5 | O | O | O | O | O | | | | | | O | |
| 179 | | Oscillation of Simple Pendulum Apparatus | 5 | O | O | O | O | O | | | | | | O | |
| 180 | | Circuit Experimental Set | 5 | O | O | O | O | O | | | | | | O | |
| 181 | | Charge and discharge capacitor | 5 | O | O | O | O | O | | | | × | | × | |
| 182 | | Measurement of unknown Resistancs | 5 | O | O | O | O | O | | | | × | | × | |
| 183 | | Boyle's Gas Law Apparatus | 5 | O | O | O | O | O | | | | | | O | |
| 184 | | Experiment of optic' s light | 5 | O | O | O | O | O | | | × | | | × | |
| 185 | | Photocopier | 2 | O | O | O | O | O | | | | | | O | |

= Deleted Items

# Table 2-3 Planned Equipment List

| No. | Equipment No. | Name of Equipment | Q'ty |
|---|---|---|---|
| Electrical and Energy Engineering | | | |
| 1 | EE-02 | Optical Communication Training Set | 2 |
| 2 | EE-03 | Optical Splicer | 1 |
| 3 | NREL-01 | Universal Relay Trainer | 1 |
| 4 | NREL-02 | Deferential Relay Trainer | 1 |
| 5 | NREL-03 | Frequency Relay Trainer | 1 |
| 6 | NREL-06 | PSCAD | 1 |
| 7 | NREL-07 | Solar Panel | 20 |
| 8 | NREL-08 | Pyranometer | 1 |
| 9 | NREL-09 | Solar Reference Cell | 1 |
| 10 | NREL-10 | Photovoltaic Inverter Set | 1 |
| 11 | NREL-12 | Programmable Electronic Load | 1 |
| 12 | NREL-13 | Electrical Network Analyzer | 1 |
| 13 | NREL-14 | Power Quality Analyzer | 1 |
| 14 | NREL-15 | Electrical Safety Checker | 1 |
| 15 | NREL-16 | Clamp Wattmeter | 2 |
| 16 | NREL-17 | Portable Multimeter | 2 |
| 17 | NREL-18 | Clamp Measurement of Earth and Leakage Current | 1 |
| 18 | NREL-19 | Multifunction HVAC and IAQ Meter | 1 |
| 19 | NREL-20 | Temperature/Humidity Tester | 1 |
| 20 | NREL-21 | Laptop PC-A | 1 |
| 21 | NREL-22 | Desktop PC-A | 2 |
| 22 | CAL-01 | Building Management System & Energy Audit tool | 1 |
| 23 | CAL-02 | PC set | 1 |
| 24 | CAL-03 | Mordern Control Experimental Set | 1 |
| 25 | CAL-04 | Research Oscilloscope | 1 |
| 26 | CAL-05 | Student Oscilloscope | 8 |
| 27 | CAL-07 | Autonomous Mobile Robot for Teaching | 5 |
| 28 | CAL-08 | 2 DOF Planar Robot | 1 |
| 29 | CAL-09 | Autonomous Robot | 1 |
| 30 | CAL-10 | Humanoid Robot | 1 |
| 31 | CAL-11 | Quadrotor for Indoor Unmanned Aerial Vehicle | 1 |
| 32 | CAL-12 | Control System Production Kit & Small Mobile Robot Experimental Kit | 1 |
| 33 | CAL-13 | Lathe Machine | 1 |
| 34 | CAL-14 | Milling Machine | 1 |
| 35 | CAL-15 | Drilling Machine | 1 |
| 36 | CAL-16 | Tooling Machine Set | 1 |
| 37 | CAL-18 | Automation Control Kit lab | 1 |
| 38 | CAL-19 | Mechatronic Control Kits | 1 |
| 39 | CAL-20 | Hydraulics Training Systems | 1 |
| 40 | IEL-02 | PCB Making Machine & 5 Extra Tool Set | 1 |
| 41 | IEL-03 | CNC Laser Cutting Machine | 1 |
| 42 | IEL-04 | Microprocessor Experimental Set | 1 |
| 43 | IEL-05 | Network Development Kit | 5 |
| 44 | IEL-06 | Development Board for Open Source OS | 1 |
| 45 | IEL-07 | Workshop Tool Set | 1 |
| Industrial and Mechanical Engineering | | | |
| 46 | GIM-01 | Torsion Testing Machine | 1 |
| 47 | GIM-03 | Centrifugal Pump Module | 1 |
| 48 | GIM-04 | Two-stage Pumps | 1 |
| 49 | GIM-06 | Environmental Applications Learning System | 1 |
| 50 | GIM-07 | Refrigerant & Combustible Gas Leak Detector | 1 |
| 51 | GIM-08 | IEQ Checker | 1 |
| 52 | GIM-09 | Infrared Thermometer | 5 |
| 53 | GIM-10 | Diagnostic Refrigerant Analyzer | 1 |
| 54 | GIM-11 | Recovery Machine | 1 |
| 55 | GIM-12 | Air Velocity Meter | 2 |
| 56 | GIM-13 | Precision Balance A | 1 |
| 57 | GIM-14 | Precision Balance B | 1 |
| 58 | GIM-15 | Heating/Refrigerated Circulator | 1 |
| 59 | GIM-16 | Fuel Analyzer | 1 |
| 60 | GIM-18 | Machine Tool Set | 1 |
| 61 | GIM-19 | Desktop PC-B | 4 |
| 62 | GIM-21 | Laptop PC-B | 4 |
| 63 | GIM-22 | Color Laser Printer | 1 |
| 64 | GIM-23 | Monochrome Laser Printer | 2 |
| 65 | GIM-24 | Titrator | 1 |
| 66 | GIM-25 | Flash Point Tester | 1 |
| 67 | GIM-26 | Cloud Point and Pour Point Tester | 1 |
| 68 | GIM-27 | Oxidation Stability Testing Machine | 1 |

| No. | Equipment No. | Name of Equipment | Q'ty |
|---|---|---|---|
| Geo Resources and Geotechnical Engineering | | | |
| 69 | GGG-01 | X-ray Fluorescence (XRF) | 1 |
| 70 | GGG-02 | Trinocular Optical Polarizing Microscope | 2 |
| 71 | GGG-03 | Heating/Freezing Stage Apparatus | 1 |
| 72 | GGG-04 | Total Station | 5 |
| 73 | GGG-05 | Hand Auger Equipment | 2 |
| 74 | GGG-06 | Automatic Polishing Machine for Thin Section | 1 |
| 75 | GGG-07 | Electric Furnace | 1 |
| 76 | GGG-08 | Precision Electric Balance | 1 |
| 77 | GGG-09 | Electrical Oven | 1 |
| 78 | GGG-10 | Agate Mortar, small size | 3 |
| 79 | GGG-11 | Agate Mortar, large size | 3 |
| 80 | GGG-12 | Magnetometer | 1 |
| 81 | GGG-13 | Floor Stand Manual Drill Press | 1 |
| 82 | GGG-14 | Instructional Gas Permeameter | 1 |
| 83 | GGG-15 | Instructional Helium Porosimeter | 1 |
| 84 | GGG-16 | Instructional Gravimetric Capillary Pressure System | 1 |
| 85 | GGG-17 | Bench Top Liquid Permeability Measurement System | 1 |
| 86 | GGG-18 | Micro-Deval Apparatus | 1 |
| 87 | GGG-19 | Unconfined Compression Tester | 5 |
| 88 | GGG-20 | Hydrometer Analyser | 1 |
| 89 | GGG-21 | Liquid Limit Apparatus | 5 |
| 90 | GGG-22 | Plotter | 1 |
| 91 | GGG-23 | Desktop PC-C | 1 |
| 92 | GGG-24 | Laptop PC-C | 2 |
| Civil Engineering | | | |
| 93 | GCI-01 | Direct Shear Test Apparatus | 1 |
| 94 | GCI-02 | CBR Test Apparatus | 1 |
| 95 | GCI-03 | Plate Test Apparatus | 1 |
| 96 | GCI-04 | Ductility Test Apparatus | 1 |
| 97 | GCI-05 | Triaxial Test Apparatus | 1 |
| Food Technology and Chemical Engineering | | | |
| 98 | GCA-01 | Microwave Digestion Apparatus | 1 |
| 99 | GCA-02 | HPLC System | 1 |
| 100 | GCA-03 | Smasher for Sample Preparation in Microbiology | 1 |
| 101 | GCA-04 | Filter Press | 1 |
| 102 | GCA-05 | Press Hydrolic | 1 |
| 103 | GCA-06 | Laboratory Juicer | 1 |
| 104 | GCA-07 | Filling Machine | 1 |
| 105 | GCA-08 | Freezer | 1 |
| 106 | GCA-09 | Ion Chromatography | 1 |
| 107 | GCA-10 | Gas Chromatograph Mass Spectrometer (GCMS) | 1 |
| 108 | GCA-11 | Viscosimeter | 1 |
| 109 | GCA-12 | Bioreactor | 1 |
| 110 | GCA-13 | Biogas Analyzer | 1 |
| Information and Communication Engineering | | | |
| 111 | GIC-01 | Equipment for Computer Networking Lab | 1 |
| 112 | GIC-02 | Equipment for Android Mobile Application Development Lab | 1 |
| 113 | GIC-03 | Equipment for iOS Mobile Application Development Lab | 1 |
| 114 | GIC-04 | Equipment for Multipurpose Development Lab | 1 |
| Foundation Year | | | |
| 115 | FDY-01 | Equipment for Computer Lab | 1 |
| 116 | FDY-02 | Experimental Kit for Physics | 5 |
| 117 | FDY-03 | Ballistic Pendulum Apparatus | 5 |
| 118 | FDY-04 | Experimental Kit for Hook's Law | 5 |
| 119 | FDY-05 | Inclined Plane Apparatus | 5 |
| 120 | FDY-06 | Air Track Complete Set | 5 |
| 121 | FDY-07 | Free Fall Apparatus | 5 |
| 122 | FDY-08 | Gyroscope | 5 |
| 123 | FDY-09 | Oscillation of Simple Pendulum Apparatus | 5 |
| 124 | FDY-10 | Circuit Experimental Set | 5 |
| 125 | FDY-13 | Boyle's Gas Law Apparatus | 5 |
| 126 | FDY-14 | Photocopier | 2 |

### 2-2-2-2 Building Plan

#### (1) Building Layout Plan

Two linear buildings are arranged in parallel to form the existing building layout. The proposed building is requested at the west end of the north linear buildings; next to block E across the covered walkway, while the wall line and setback of the ground floor are aligned with these linear buildings. The proposed building is surrounded with block C and a renewable energy plant to the north; block D to the south, the canteen to the west and the covered walkway to the east. Since the proposed building had to be built within such a narrow site, it had to be designed as a multi-story building. It is also important that the ground floor of the proposed building and its neighboring structures be harmonized so as to form an integrated environment.

The proposed building is arranged in an east-west axis naturally based on the site conditions, which is appropriate to reduce the impact of sunlight. Since the central part of the construction site is subject to depression, there is the risk of storm water gathering to the proposed building during heavy rain. For this reason, land leveling and the construction of a drainage ditch were executed.

#### (2) Floor Planning

As well as the existing building, the plan of the proposed building includes laboratories along the corridor. Considering the three-floor structure, staircases are arranged on both sides of the building for bi-directional evacuation. Toilets are arranged next to the west staircase, where a water supply system is also installed. The west staircase features an approach to the roof to form a penthouse there, upon which a water tank will be installed. The ground floor space of the east staircase is used as an electrical room, while a vertical duct for the power supply is installed on adjacent laboratories. To develop an efficient water system, the water supply points of each laboratory are placed along the north wall. Designing pipe spaces per pillar on wall, the drainage pipes are installed within this pipe space down to the exterior drainage ditch. This space is also used to pipe water drainage and condensation of the air-conditioning refrigerant tube also includes equipment to be updated in future.

The longitudinal spacing of the laboratory pillars in most existing buildings is 4.4m in common, which indicates the basic module of the ITC facility plan. The spacing dimension of the proposed building is also decided at 4.4m. The depth of laboratories varies, namely 9.35m for block B, housing most of the laboratories and 9.45m for block E, which was recently built. The depth of rooms of the Project is decided at 9.5m in consideration of these current situations of ITC and the potential for installing large equipment. The application of the current dimension system allows ITC trainers to consider equipment layout based on their experience. The number of units is decided depending on the contents of the activity and the equipment for each laboratory, while the function and floor area of each laboratory are organized as shown in the following table:

Table 2-4 Function and Area of Rooms

| | Room | Department | Activity | Area | Remarks |
|---|---|---|---|---|---|
| Ground floor | Workshop | Electrical and Energy Engineering | Manufacturing exercise of Robot, PCB, etc. | 125.14sqm | Workshop of industrial mechanical department, 199.1sqm |
| | Food Processing Lab. | Food Technology and Chemical Engineering | Exercise to process of fruit | 83.42sqm | Similar lab. of food chemical department, 82.28sqm |
| 1st floor | Control and Automation Lab. | Electrical and Energy Engineering | Experiment/exercise of automatic-control, automation system, etc. | 83.42sqm | Similar lab. of electrical energy department, 41.14sqm |
| | Industrial Mechanics Lab. | Electrical and Energy Engineering | Experiment/exercise of the characteristics of material, heat exchange system, internal‐combustion engine | 83.42sqm | NA |
| | Electricity and Energy Lab. | Electrical and Energy Engineering | Experiment/Exercise of Power electric system, renewable energy | 83.42sqm | NA |
| 2nd floor | Geotechnical Lab. | Geo-Resources and Geotechnical Engineering | Exercise of the characteristics of rock and soil | 83.42sqm | NA |
| | Petroleum Engineering Lab. | Geo-Resources and Geotechnical Engineering | Exercise of the characteristics of source rock | 41.71sqm | NA |
| | Computer Lab. | Geo-Resources and Geotechnical Engineering | Exercise of GIS and Remote Sensing | 83.42sqm | Computer lab. on block E, 83.16sqm |
| Ground and 2nd | Storage | Common | For accessories, documents and consumable of equipment, working for technician | 41.71sqm | NA |

### (3) Sectional Design

- The ground floor level of the corridor is set to be the same as the adjacent corridor, with a small gap between the corridor and the laboratories.

- The construction site has a depression in the central part and a perimeter adjacent to surrounding buildings. The designed ground level is determined to be equivalent to that of the perimeter area, while the central part of the site will be raised to make the land surface even.

- The standard floor height is 3.9m, like existing buildings, so that tall equipment can be moved and installed, even under the girders. No suspended ceiling is included, to ensure sufficient overhead space for hot air to rise and wind to flow through the rooms.

- To keep out direct sunlight and rain and allow in indirect light and wind, staircases and corridors will be covered with louvers. Since rain flows into the building when the wind is strong, corridors and staircases shall have drainage and gradient and a floor gap between the corridor and laboratories shall be considered.

- Concrete eaves of sufficient dimensions to prevent direct light during daytime shall be designed on windows on the north side. This shall also be the space in which the outdoor unit of an air-conditioner and maintenance are housed.

- To prevent roof slabs getting hot by direct light, the roof is insulated on the waterproof layer. In addition, protective concrete shall be installed on the insulation.

- The foundations of solar panels, cable box and handrails are also installed on the roof, while a water tank is installed on the roof of the staircase.

### (4) Structural Design

#### 1) Design Principles

Based on the load set in this section, the building is designed according to the Structural Building Code and Standard of the Architectural Institute of Japan.

#### 2) Substructure

Taking account of the risk based on the results of an earth boring survey carried out on-site and the situation of ground settlement, the pile foundation design adopted is as shown below. With ground subsidence in mind, the ground floor slab is designed as a supporting slab.

Type : Pile foundation (concrete pile, 400x400, L=12m)
Supporting layer : deeper than GL-12m (allowable load capacity is 480kN)

#### 3) Superstructure

The main frame of the superstructure is a rigid frame structure, which is common in Cambodia as follows:

Roof: concrete slab
Wall: brick masonry double layer for the exterior wall, single layer for the inner wall

#### 4) Design load

The dead load, live load and wind load are considered for calculations as follows:

- Live load

Based on the actual situation of each room, load capacity is determined as follows:

- Corridor, staircase, roof : 2,300 N/sqm
- Toilet : 1,800 N/sqm
- Laboratories : 3,000 N/sqm

- Wind load

According to Cambodian regulations, the reference wind speed is 120km/hr (33m/sec). The wind load is calculated with this wind speed according to the Japanese standards.

#### 5) Material

Prioritized materials for the Project shall be the following, which can be locally procured.

Concrete: Design strength 25 N/mm²

Rebar : D10 to D25 variant of standard rebar JIS (SD295A /SD345, JIS G3112)

### (5) Electrical service plan

#### 1) Power distribution system

The Cambodian side shall extend the lead-in cable to the building from the existing electrical room. The main distribution panel is installed in the building and the distribution cable is extended to the sub-distribution panel. Wiring is installed on the duct to each room.

#### 2) Lighting system

In laboratories, fluorescent fixtures are installed on the suspended cable rack with 200 lux brightness to illuminate the entire room. In toilets, fluorescent fixtures are suspended from the ceiling with 120 lux and installed on the wall for lavatories. In corridors fluorescent fixtures are installed on the ceiling every bay and underneath the slab in staircases.

#### 3) Power outlets

Multi-type outlets are arranged on the floor and wall according to the furniture layout plan. Users can install additional power cables using a cable rack.

#### 4) Lightning protection system

A lightning arrester is installed on the rooftop of the penthouse, with a lightning conductor to the ground to protect the entire building. In addition, each distribution panel is installed with a surge protect circuit to avoid damage to electrical apparatus when lightning occurs.

#### 5) Communication system (Internet and telephone)

An empty pipe and trunking are installed from the incoming point to each use point. Cables and terminal board, phones or hubs and a router are prepared by the Cambodian side.

### (6) Plumbing, drainage, ventilation and air-conditioning service

#### 1) Water supply

Although the water pressure enables water supply up to the fourth floor of the existing building, the water supply is unstable. Water will be supplied to the toilet and sink in each laboratory with gravity from a water tank placed on the rooftop of the staircase penthouse. The total number of students who will study in the proposed building is 200: this is calculated assuming twenty five students per laboratory. Moreover, three tons is calculated as the necessary capacity per day, assuming fifteen liters per person per day. A three-ton tank is installed and pipes are installed within the pipe space of the toilet.

#### 2) Sanitary system

Referring to the number of existing buildings, the number of sanitary units on each floor is decided as more than two. Water closets for women and squat-type pans for men are installed with a toilet spray. In addition, lavatories and work sinks are installed.

#### 3) Drainage system

Gray waste water runs into the storm water ditch and flows into the pond in the south-western part of the premises. Regarding black waste water, a drainage pipe is connected to the existing drainage network extended by the Cambodian side. This waste water runs into the underground pit and flows into the city drainage via a septic tank on the adjacent premises.

#### 4) Air-conditioning and ventilation system

To avoid thermal damage to electrical equipment, each laboratory is air-conditioned with a package-type AC. A ceiling fan is also installed in each laboratory to diffuse cold air throughout the rooms, as well as an extractor fan is installed on the wall. The toilet has natural wind ventilation.

#### 5) Fire- fighting equipment

A fire brigade connection is installed on the ground floor and a dry riser outlet is installed on each floor.

### (7) Building material planning

When selecting building materials, enabling a facility which suits the climate of Cambodia, adopts traditional local materials and finishing methods and is easily maintained, shall be the design policy.

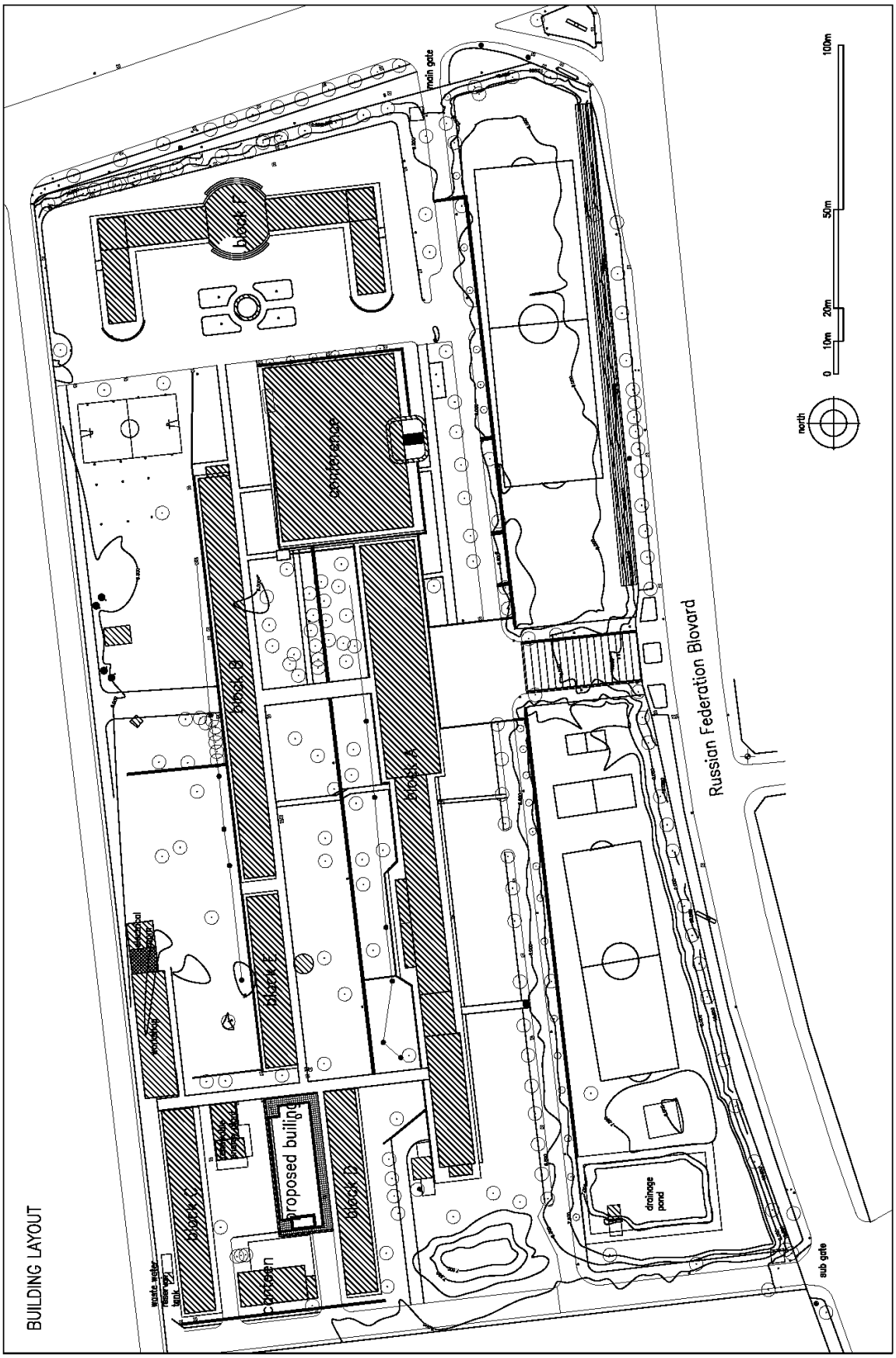
Table 2-5 Building Material Planning

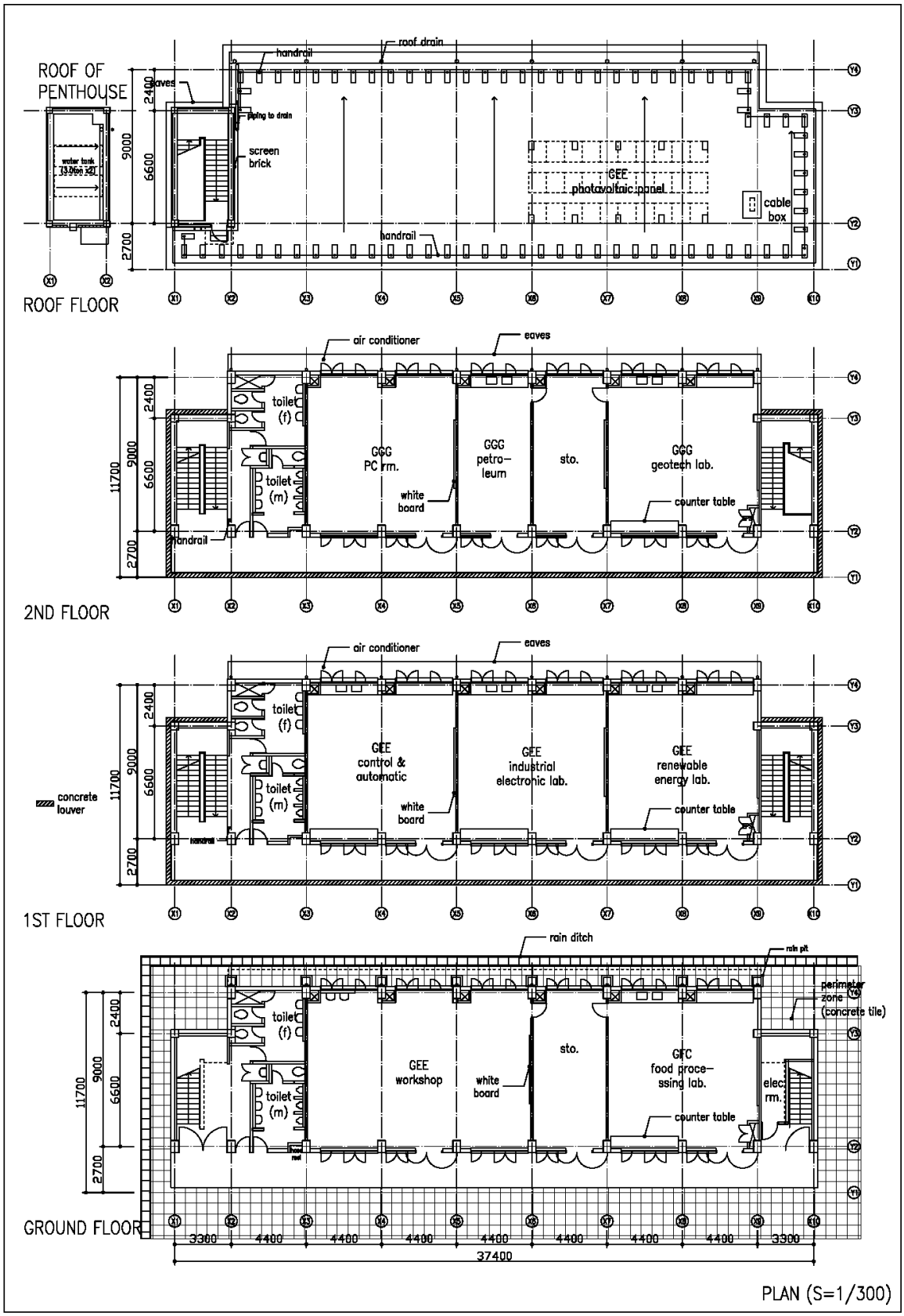
| | | Local method | Adopted method | Reason for adoption |
|---|---|---|---|---|
| Exterior | Flat roof | Asphalt waterproof with mortar and tile finish | Asphalt waterproof with a concrete layer | Improved local common method, available for maintenance by locals. |
| | Wall | Brick wall with mortar and paint finish | Same as on the left | Common locally, easy installation and reasonable |
| | Door | Wooden or Steel door | Same as on the left | Wooden door on major parts. Steel door for only exterior and machine doors |
| | Window | Wooden casement window, Aluminum casement or sliding window | Aluminum casement window | Common locally and easy processing and maintenance |
| | Sun shade | Concrete louver | Same as on the left | Improved local common method to facilitate work |

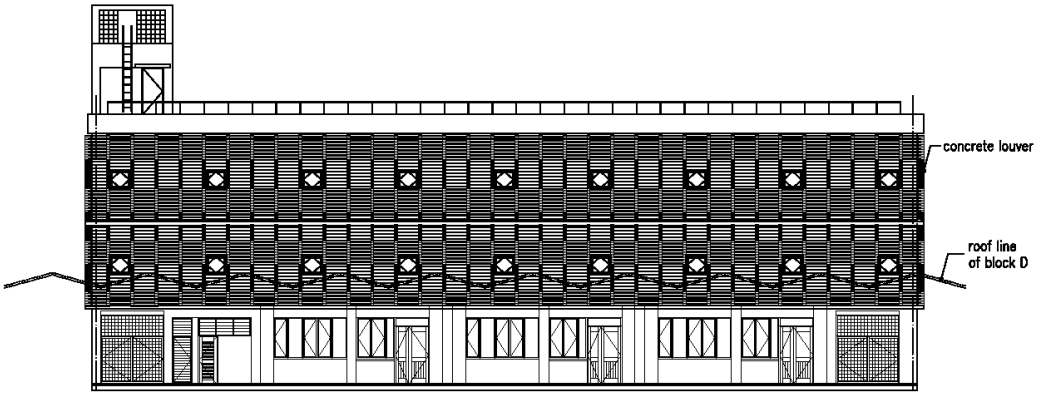
| | | | | |
|---|---|---|---|---|
| Interior | Ceiling | Concrete ceiling, Acoustic board with T-section suspension | Concrete ceiling | Reasonable |
| | Wall | Brick wall with mortar and paint finish | Same as on the left | Common locally, easy installation and reasonable |
| | Wall for wet zone | Glazed tile finish | Same as on the left | Common locally, easy cleaning and durable |
| | Floor | Porcelain tile finish, terrazzo in situ | Porcelain tile finish | Common locally, easy installation and reasonable |

### 2-2-3 Outline Design Drawing

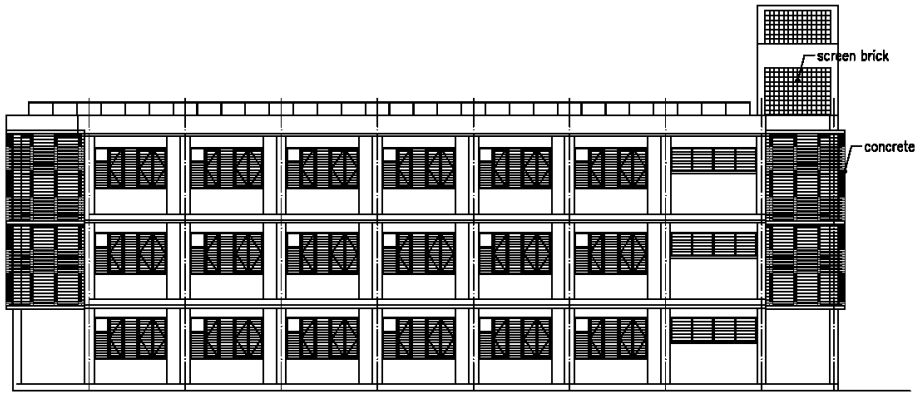
The Outline Design Drawing is shown as follows:


BUILDING LAYOUT
main gate
sub gate
Russian Federation Blovard
block A
block B
block C
block D
block E
block F
proposed building
canteen
basketball court
volleyball court
drainage pond
waste water reservoir tank
north
0
10m
20m
50m
100m

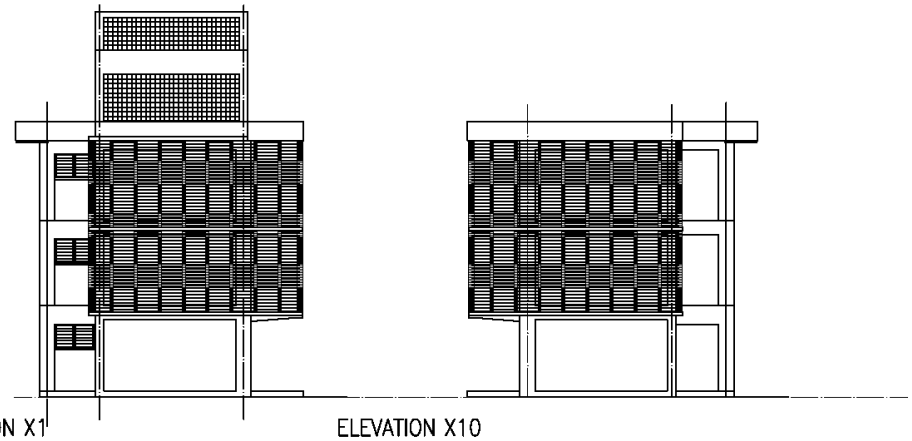

ROOF OF PENTHOUSE
ROOF FLOOR
handrail
roof drain
eaves
piping to drain
screen brick
water tank
GEE photovoltaic panel
cable box
handrail
2400
9000
6600
2700
2ND FLOOR
air conditioner
eaves
toilet (f)
toilet (m)
GGG PC rm.
GGG petro-leum
sto.
GGG geotech lab.
white board
counter table
handrail
11700
1ST FLOOR
concrete louver
GEE control & automatic
GEE industrial electronic lab.
GEE renewable energy lab.
GROUND FLOOR
rain ditch
rain pit
perimeter zone (concrete tile)
GEE workshop
GFC food proce-ssing lab.
elec. rm.
3300
4400
37400
PLAN (S=1/300)




ELEVATION Y1



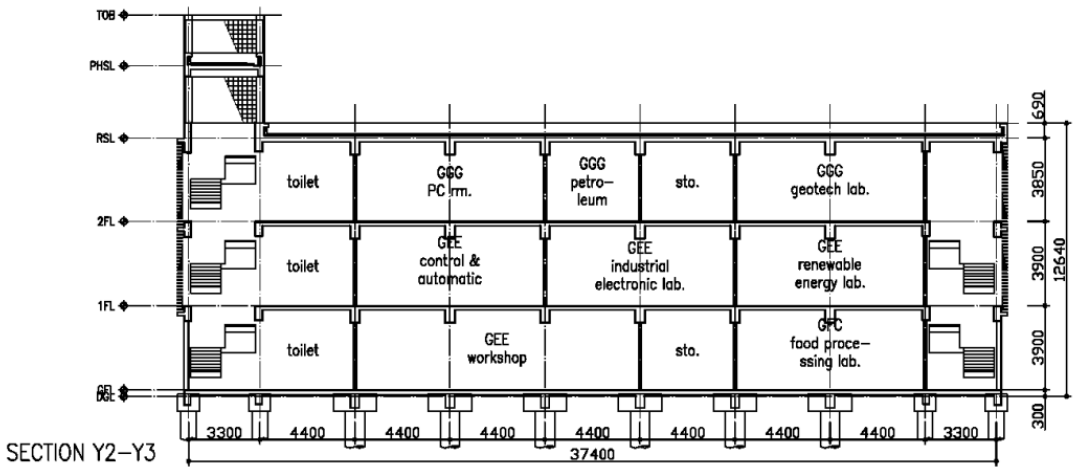

ELEVATION Y4



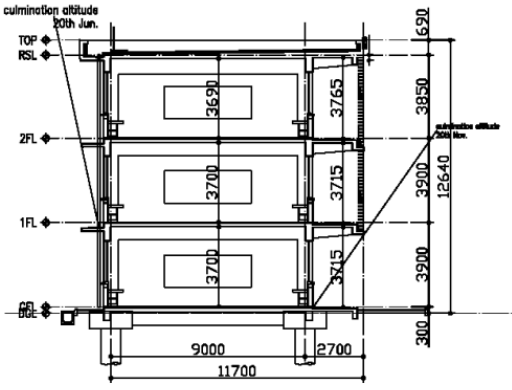
ELEVATION X1

ELEVATION X10

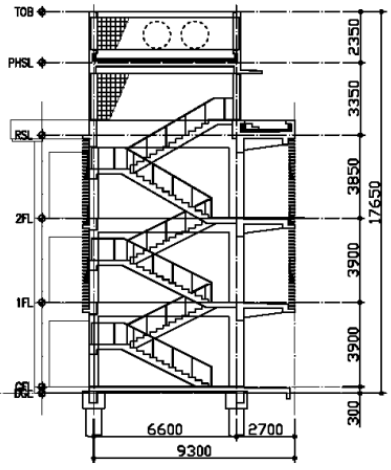
ELEVATION (S=1/300)




SECTION Y2–Y3




SECTION X4–8




SECTION X4–8

SECTION (S=1/300)

### 2-2-4 Implementation Plan

#### 2-2-4-1 Implementation Policy

**(1) Basis for Project Implementation**

The Project will be implemented on the basis of the framework of the Government of Japan for its Grant Aid Scheme, after signing of Exchange of Notes (hereinafter referred to as 'E/N') regarding the implementation of the Project between the Government of Japan and the Government of Cambodia and conclusion of the Grant Agreement (hereinafter referred to as 'G/A') between JICA and the Government of Cambodia, following the approval of the Japanese Cabinet. Subsequently, the Government of Cambodia and a Japanese consulting company will enter into a contract, and detailed designs of the facilities and equipment will be prepared. Upon completion of the detailed design and tender documents, a competitive tender among Japanese companies meeting the specified requirements shall be carried out. Construction of the facilities and procurement of the necessary equipment shall be executed based on the contract concluded between the selected companies and the Government of Cambodia. In this Project, tenders for construction work and equipment procurement shall be conducted separately.

**(2) Project Implementation System**

**1) Implementing Organization on the Cambodian Side**

The Ministry of Education, Youth and Sport is the organization responsible for the Project in Cambodia, while the Institute of Technology of Cambodia, which will be an operating body after the Project is handed over, is in charge of coordinating and promoting the whole Project as the implementing organization. ITC is in charge of concluding the design and supervision contracts and construction works and equipment procurement contracts with Japanese companies, procedures related to opening bank accounts and making payments and the preparation of site and other issues to be handled on-site. Besides, regarding the budgetary measures necessary to cover the undertakings to be taken by the Cambodian side and the obtaining of approvals and authorizations necessary for the Project, MoEYS is responsible together with ITC. Regarding the conclusion of the E/N, the Ministry of Foreign Affairs and International Cooperation of Cambodia will be in charge on behalf of the Government of Cambodia. Moreover, regarding the conclusion of the G/A, the Ministry of Economy and Finance will be in charge

**2) Japan International Cooperation Agency**

JICA concludes a G/A with the Ministry of Finance of Cambodia and is in charge of supervising the implementation of the Project so that it will be carried out in accordance with the Japanese Grant Aid Scheme.

**3) Consultant**

The Consultant is, in accordance with the design and supervision contracts concluded with the Cambodian implementing organization, in charge of working out the detailed design of

the facilities and equipment as well as supervising the construction and procurement works based on the content of this report.

Moreover, the Consultant also develops tender documents and supports the selection of the Contractor and/or the Supplier and the conclusion of construction work and equipment procurement contracts with the same. To facilitate the operations mentioned above, the Consultant will work cooperatively with ITC, the implementing organization, and dispatch a resident engineer required at the site during the construction and procurement period.

#### 4) Contractor/Supplier

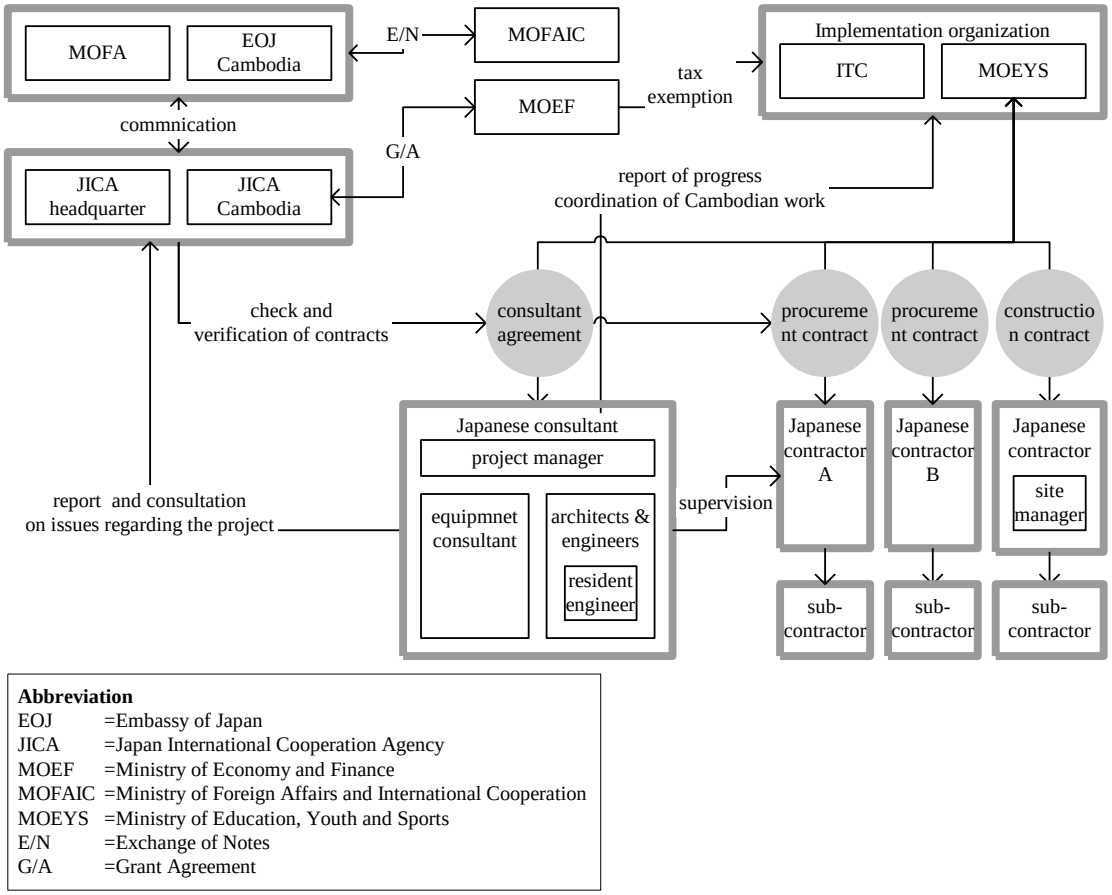
The Japanese Contractor/Supplier selected through competitive tender will complete the construction and equipment procurement works within the implementation period, in accordance with the contract documents, based on the construction and equipment procurement contracts concluded with the Cambodian implementing organization. During the actual construction and equipment procurement works, they shall establish an effective system for construction and procurement in accordance with the scope and content of the Project.

#### 5) Collaboration with Local Contractors

As Cambodia has a local construction market of sufficient size, local contractors and suppliers capable of quality control could be procured within the country. The Japanese Contractor can therefore collaborate with these local contractors in various types of work.

#### 6) Project Implementing System

The figure below shows the relationship between the organizations related and the system for promoting the Project at the implementing stage:




**Abbreviation**

| | |
|---|---|
| EOJ | =Embassy of Japan |
| JICA | =Japan International Cooperation Agency |
| MOEF | =Ministry of Economy and Finance |
| MOFAIC | =Ministry of Foreign Affairs and International Cooperation |
| MOEYS | =Ministry of Education, Youth and Sports |
| E/N | =Exchange of Notes |
| G/A | =Grant Agreement |

Figure 2-1 Project Implementation System

### 2-2-4-2 Implementation Conditions

#### (1) Common Issues

Import duties have been exempted by the Ministry of Economy and Finance and CDC using a master list in previous projects. However, regarding the exemption of VAT, the procedures are unclear. There is a risk of non-exemption in certain cases involving small materials and equipment, especially in the case of purchasing materials by sub-contractors. For construction materials, local procurement shall be standard, hence reliable methods of exemption and the role of responsible organizations for the Project shall be thoroughly discussed.

#### (2) Conditions for Equipment Procurement

In the Project, the equipment shall be procured through Tender procedure and the equipment planned shall be divided into 2 lots for the Tender. One is for equipment for existing buildings and the other is for equipment for a new building constructed by the Japanese side within the Project. Regarding the lot of equipment for existing buildings, all equipment shall be installed into the rooms of the existing buildings before the beginning of the new academic year (around mid-October); hence careful scheduling is required by both ITC and the Japanese side.

It is crucial to impart knowledge and skills regarding the appropriate operation and maintenance of the equipment to ensure proper operation of the procured equipment upon completion of the Project and handover. Therefore, the conditions required for engineers of installation work shall be carefully described in tender documents to ensure skilled engineers can be selected for proper operation of the equipment. Besides, enough time for operational training shall be allotted and a sufficient understanding of the recipient side for operation and maintenance shall be confirmed.

**(3) Notes on the Construction**

In Cambodia, especially Phnom Penh, although there are many well-managed qualitative contractors found mainly among large companies, given the small scale of the construction of the Project, a qualitative local contractor, capable of understanding the quality management required by Japanese Grant Aid, should be selected, e.g. a contractor with previous experience of implementing Japanese Grant Aid projects. Moreover, although imported materials are available at the local market, considering the relatively short duration of the construction period, the procurement work shall be planned as early as possible to avoid hindering the overall work scheduling.

In addition, the construction inside the premises of an existing institute, which is narrow and surrounded by other structures, is the major characteristic of the Project. In this case, key factors include: the placement of guards to ensure safety in terms of traffic control of vehicles for construction, planning of a temporary flow line to avoid intersecting the flow line of students and staff, the selection of methods and machines with low noise and vibration, operational considerations such as idling prohibition and good communication of work progress via regular attendance of meetings.

### 2-2-4-3 Scope of Works

**(1) Work to be borne by the Japanese side**

**1) Procurement of Equipment**

- Procurement, Transportation to the Site, Installation and Instruction for operation and maintenance of experimental/practical equipment

**2) Construction of the Facilities**

- Construction of one laboratory building and the necessary building service (water supply, drainage, power supply, lighting, air-conditioning and ventilation, sanitary equipment)

**(2) Scope of Work for Both Countries**

The following table shows the work to be borne by each Government:

Table 2-6 Work to be Borne by Each Government

| Items | To be borne by the Japanese side | To be borne by the Cambodian side |
|---|---|---|
| Water supply | Construction of water supply in the building from the connection point after | Extension of water pipe to the designated connection point |
| Power supply | Electrical work in the building after the building from the main distribution panel<br>Provision of extension cables and switches to the building of the minutes from the electrical room | Extension of the power cable from the electrical room and connection to the main distribution board in the building |
| Drainage | Extension of the drainage pipe to the sewage drainage pit newly installed by GoC<br>Construction of a rainwater and wastewater ditch and connecting to the existing ditch | Extension of the sewage drainage pipe near the building up to the newly established connection pit<br>Extension of the existing rainwater and gray water ditch to the designated position |
| Telephone and internet | Installation of piping and empty duct for wiring in the building | Organization of Internet wiring systems and installation of the necessary equipment |

#### 2-2-4-4 Consultant Supervision

**(1) Supervision Policies**

The Consultant will target the consistent implementation of the Project throughout work that includes the detailed design, tender, supervision of construction and procurement, and handover based on the framework of the government of Japan for its Grant Aid and on the outline design. When supervising the construction and procurement, the Consultant shall maintain close communication between the Governments of Cambodia and Japan and promptly provide those involved in the construction and procurement with necessary advice, so that the facilities and equipment procurement will be completed promptly in accordance with the contract documents.

**(2) Procurement Supervision Plan**

The equipment is planned to be procured in Japan or third countries. The inspection of equipment shall be performed at the loading port, prior to shipment, by an entrusted and neutral inspection agency. The consultant should check the certificate of shipment inspection provided by the inspection agency and issue the inspection report to the implementing agency of Cambodia after confirming the completion of inspection. All the equipment procured in the Project will be inspected and provisionally handed over at site. The final handover should be conducted in the presence of the buyer, supplier and consultant. The names of the models, product origin, names of manufacturers, stickers printing the name of Japanese Grant Aid attached or not and appearance will be inspected following the items in the contract documents.

Regarding procurement supervision, the following consultants will be assigned:

・Resident procurement supervision engineer: 1 person
Procurement supervision during the whole period of installation and initial operational instruction for operation and maintenance

・Procurement supervision engineer: 1 person
Final inspection/Handover to the Cambodian side

・Inspection engineer: 2 persons
Confirmation of procurement schedule, preparation for third party inspection prior to shipment, checking the inspection certificate

### (3) Construction Supervision Plan

To supervise the construction work appropriately, the Consultant will dispatch an architect/engineer to the site, to be based in Cambodia throughout the construction period. The role of the resident engineer covers the following items:

- To examine the plans and schedules such as the implementation plan, work schedule, procurement plan for construction materials, furniture and equipment, quality control plan and safety measures, and instruct and advise the Contractor or adjust them as necessary

- To confirm the shop drawings, production drawings and sample products submitted by the Contractor and to approve them

- To grasp the progress status of the construction and procurement work, and instruct the Contractor when necessary as well as submitting work progress reports to the relevant organizations of both countries

- To confirm the safety management plans formulated by the Contractor on how to secure safety on site, check the actual safety measures on site, and advise when necessary

- To conduct inspections on the quality and workmanship of each work and advise the Contractor when necessary

- To make technical adjustments and confirm the progress status of the work to be borne by the Cambodian side

- To support the issuance of certificates regarding payment and the implementation of various procedures upon completion of the work

- To conduct inspections on the completion of work, witness the handover of the facilities and equipment to the recipient country and confirm the guidance by the Contractor concerning the operation and maintenance

To supervise the construction and procurement work in the Project, the resident engineer must have a wide range of abilities to perform various different tasks, including on-site coordination relating to equipment procurement, and close communication with the Cambodian organizations concerned as well as supervising the general construction of the facilities. Therefore, it is necessary to select a resident engineer from among those not only with technical expertise in construction but also a thorough knowledge of the facilities, equipment and Japanese Grant Aid.

Furthermore, the Project manager in Japan should assign engineers in various fields, including architectural design, structural design and electrical and mechanical design so that a system is established to handle the overall supervision of the Project, communication and coordination with the organizations concerned in Japan, and support for resident engineers by sharing the supervisory task of inspecting the materials and equipment procured in Japan. In addition, as the Project progresses, different professional engineers are to be dispatched for short periods to witness the inspection at the planned site or give guidance on the construction work.

#### 2-2-4-5 Quality Control Plan

The proposed building has a rigid structure of reinforced concrete and a brick masonry wall with a render finish. The building is three stories. Quality control will be focused on structural work such as concrete piles, structural concrete work, waterproof work, concrete louver work and building service work; all of which are essential for the building. Regarding the standards of the materials and tests, this Project will basically follow JIS or other industrial code.

- Prior to the commencement of each work, the Contractor shall develop a work method document, which includes the materials and accessories, equipment, methods and procedures of work, test methods, and quality requirements, and submit the same to the Consultant for approval.

- Regarding pile works, confirmation of soil of hole bottoms, curing of wall holes, confirmation of hole depth and slime treatment shall be executed intensively. In addition, where the method uses tremie concrete placement, the pipe must be inserted more than 2m into concrete.

- Regarding reinforcing bars, an approved material quality check will be conducted based on the product test results issued by the manufacturer each time the reinforcing bars are delivered.

- Concrete: A ready-mixed concrete plant within the city will be applied for the Project. The compressive strength is monitored with the cylinder sample strength for quality control. The specified mix proportion will be decided based on the trial mix, and the

slump, temperature, amount of air and chloride content of the fresh concrete on site will be checked and recorded. In addition, a compressive strength test will conducted on three specimens with concrete aged 7 and 28 days respectively by every 50m³ and every structural element respectively.

- Regarding concrete work in hot weather, the necessary measures will be taken, such as sprinkling water over the aggregate, managing water temperature and ensuring surface protection by sheets after the concrete is cast.

- The amount of chloride contained in the fresh concrete should not be allowed to exceed 0.3kg/m³ with anti-corrosion in mind.

- Regarding masonry work, especially concrete louvers, because this work will be finished and impressive, the quality of work will affect the overall impression of the building. With this in mind, each unit shall be laid carefully and accurately to retain the horizontal and vertical line of the masonry wall using a leveling line and the maximum height of the wall shall be below 1.6m per day.

- Regarding the waterproof work, based on the specifications and standard method of the manufacturer, the actual roofing procedures shall be thoroughly confirmed using the specified procedure documents and execution drawings. At the construction site, the waterproof work shall be carefully checked by clarifying the required accuracy and important parts such as the joints and supporting metals.

### 2-2-4-6 Procurement Plan

#### (1) Procurement of Equipment

The equipment to be procured shall be products of Japan or third countries for which after-sales service is available via agents in Cambodia or neighboring countries. Regarding equipment procured from the third countries, as well as the pricing aspect, other aspects such as after-sales service, familiarity of equipment and ease of maintenance shall also be considered. Besides, tender conditions such as limiting the country of origin to DAC and/or OECD countries shall also be considered to ensure the quality of the equipment.

#### (2) Construction Materials

Most construction materials can be sourced locally, and the material for the Project shall be procured locally in principle. The Project actively utilizes materials that can be purchased locally as they will be preferable for operation and maintenance once the facilities are completed. As for materials and equipment that are difficult to procure locally or for which a certain quality must be ensured, these will be purchased in Japan. The table below is a list of suppliers for the main materials and equipment:

Table 2-7 Suppliers of Main Construction Materials and Equipment

| Material name | | Procured in Cambodia | | Procured in Japan | Remarks |
|---|---|---|---|---|---|
| | | Domestic product | Imported product | | |
| Construction Material | Sand, aggregate | ○ | | | |
| | Cement | ○ | ○ | | Reliable Thai manufacturer's products, import items and domestic one under license is available. Portland cement, Type I (ASTM C-150) |
| | Fresh concrete | ○ | | | Concrete plants are available within the city. |
| | Brick | ○ | ○ | | 80 x 80 x 180 mm hollow units are widely available for substrate walls. Finish screens and ventilation bricks are imported from Vietnam. |
| | Timber | ○ | | | Hardwood such as Pchek and Beng is appropriate for doors, frame and furniture to avoid damage by termites. |
| | Cement product | ○ | ○ | | Ventilation blocks, decorative pillars, pavement materials and drainage pits are available but the texture is so rough; making it difficult to apply to this Project as finish material. Louvers and windowsills shall be manufactured under appropriate quality control by the Contractor. |
| | Re-bars | | ○ | | JIS products from Vietnam are available. |
| | Concrete pile | ○ | | | Commodities are low-quality. The pile shall be manufactured under appropriate quality control by the Contractor. |
| | Waterproofing material | | ○ | | Agents to treat products of large chemical firms in Europe exist. Modified asphalt (torch-in method), liquid-applied agent and plastic sheet methods are available and these agents will delegate the work with their responsibility. |
| | Door and windows | ○ | | | Aluminum, steel and timber products are available. Aluminum is applied to windows and timber to doors these days. Steel products are limited for use. Hardware from China and ASEAN countries is widely available, as are European products. |
| | Porcelain tiles | | ○ | | Print-type tiles from China or other ASEAN countries but prone to scratch damage. Homogenous tiles from Europe are appropriate for this Project. |

| | | | | | |
|---|---|---|---|---|---|
| | Paints | | ○ | | Standard products from major Japanese and European companies are available. A product with heat-reflective technology is applied to save energy. |
| | Metal product | ○ | ○ | | Handrails, grilles and ladders using domestic steel tube are manufactured in small factories and low-quality products. The metal product for this Project shall be manufactured under appropriate quality control by the Contractor. |
| | Scaffolding materials | ○ | ○ | | Forms and supports are available in both timber and steel. Ties, strips and metal inserts from Thailand and Vietnam are available. |
| Service equipment | Distribution board | | ○ | | Third country products manufactured by Japanese companies are applied in terms of quality. |
| | Light fixture, wire and cable, trunking | | ○ | | Commodities from third countries are applied in terms of quality and maintenance. |
| | Sanitary equipment, valves,, pipes, tank, floor drainage | | ○ | | Ditto |
| | Air-conditioners, ventilation fans, pipes | | ○ | | Ditto |

### (3) Route of Transportation of Materials

It will take for about three weeks to ship the materials and equipment from Japan to Sihanoukville Port in Cambodia. After unloading the port, customs clearance shall be done. Import tax shall be exempted by submitting a master list. In case the master list is submitted prior to arrival, the customs clearance will take around 1 week. Inland transportation to the site is expected to take about 4 hours/230km in distance by truck via national road number 4. Roads from the Port to Phnom Penh are paved and mostly in good condition.

## 2-2-4-7 Operational Guidance Plan

Regarding the equipment procured for the Project, under the management of the Supplier, with initial operational and maintenance training by an experienced installation engineer and/or Japanese engineer and/or local manufacturer engineer, an understanding on how to

utilize equipment of users such as lecturers and researchers shall be fully ensured. The Consultant shall supervise the proper implementation of such operational training on site. When handing over the equipment to the Cambodian side, the Consultant shall check whether the relevant training has been fully completed and the understanding of personnel of the Cambodian side is sufficient through direct confirmation with the responsible personnel.

#### 2-2-4-8 Soft Component Plan

No Soft Component shall be implemented in the Project.

#### 2-2-4-9 Implementation Schedule

Under the Japanese Grant Aid, the Project shall be implemented through the following phases after signing of E/N and G/A between both Governments.

**(1) Detailed Design (approx. 5.5 months)**

The Consultant will conclude a consultancy agreement with the implementing organization of Cambodia and develop detailed design drawings and tender documents. The Consultant will come to Cambodia to meet with the implementing organization when they commence their work and explain the drawings and tender document for the final approval which will complete the work. The period from the conclusion of agreement to the completion of this phase is estimated to be about 5.5 months.

**(2) Tender (approx. 2.5 months)**

Upon approval of the tender documents, the Consultant acts on behalf of the implementing organization, advertises an invitation to prequalification (hereinafter referred to as 'P/Q') on a paper and conducts the P/Q to confirm the capability and resource of potential tenderers to perform the particular work. The tender documents will be delivered to the passed tenderers and the prepared tenders will be opened in the presence of the representatives from the implementing organization.

The tenderer who proposes the lowest price will win, if the content of the bid is evaluated as appropriate, and concludes a contract on the construction work and equipment procurement with the implementing organization. The period required between the public announcement of the P/Q and conclusion of the contract is estimated to be about 2.5 months.

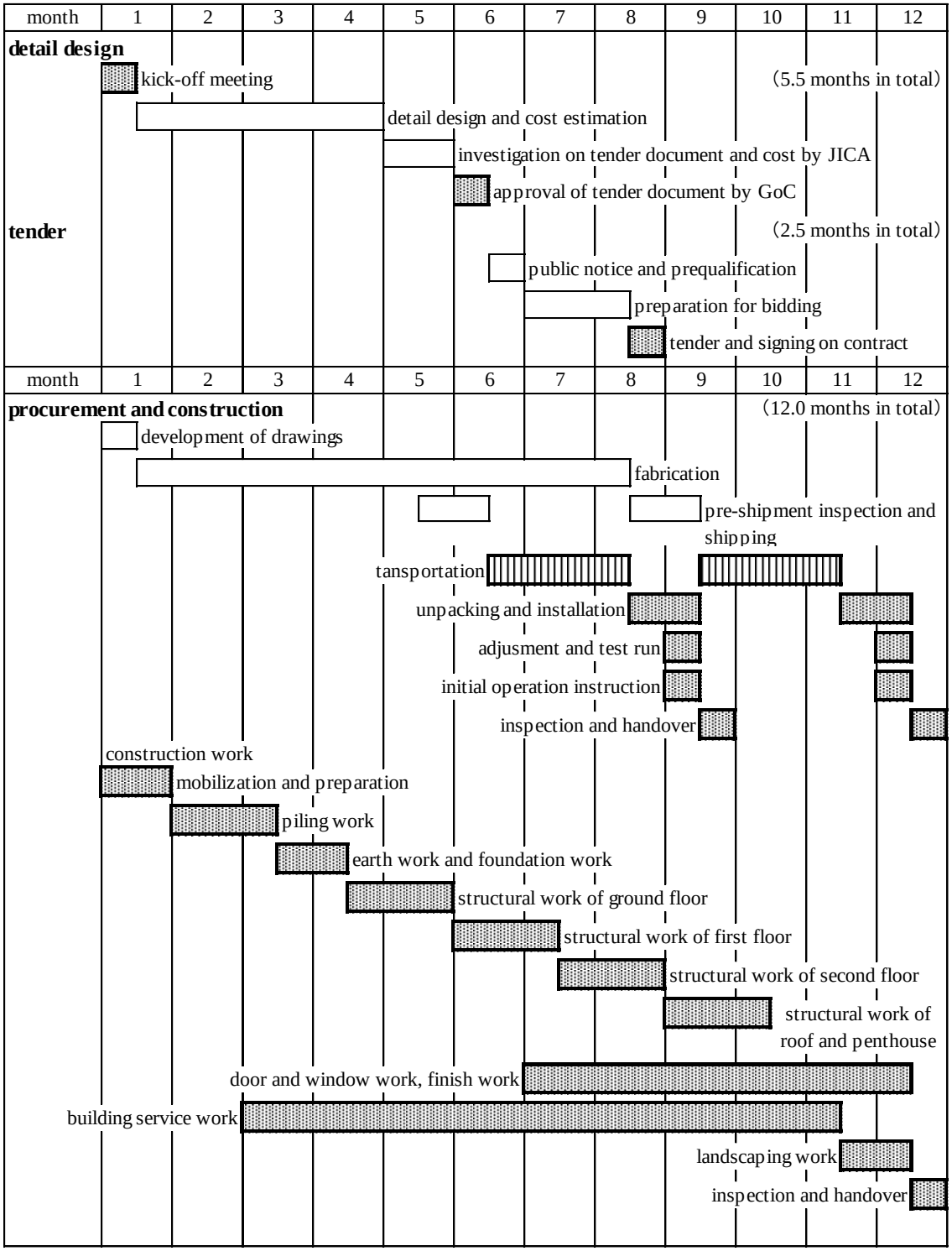
**(3) Construction/Procurement (approx. 12.0 months)**

After signing the contract, the Contractor will commence the construction work and the procurement of equipment. In consideration of the scale, the specific conditions of the construction work and the local labor efficiency, it will take about 12.0 months to perform the construction, procurement and installation work. This estimation assumes the material and equipment procurement will proceed smoothly, the necessary procedures will be

conducted promptly by the organizations concerned on the Cambodian side, and that the work undertaken by the Cambodian side will proceed smoothly.

The table of the Implementation Schedule is as follows:

Table 2-8 Implementation Schedule



### 2-3 Obligations of Recipient Country

#### (1) Procedural Issues

In implementing the Project with the Japanese Grant Aid Scheme, the obligations of the Government of Cambodia (GoC) are shown in the following table. Through the discussions, the State Secretary of MoEYS will be responsible for these issues and the deputy director in charge of planning and development of ITC will be nominated as the person in charge of implementing these issues on the field. Given the extensive scopes of the necessary items, the Cambodian and Japanese sides shall communicate closely with each other for the implementation of the Project.

Among the items in the table below, costs will be incurred for 4, 6 and 14 to 19. As Items 4 and 6 need around 100 million yen, GoC must take the necessary measures to generate these expenses within the fiscal year 2013. Other items 14 to 20 represent expenses applicable for 2014 fiscal year or later, therefore GoC must take measures to budget for the same, if the Project is approved by the Japanese Cabinet. It is expected that ITC could work with their staff without problem to implement certain portions of works because the scale of work is limited.

Table 2-9 Obligations of Recipient Country

| Item | Responsible Organization | Targeted Time |
|---|---|---|
| [1] Exchange of Note | MOFAIC | (within 1 month of Cabinet Approval) |
| [2] Grant Agreement | MOEF | Ditto |
| [3] Consultancy Agreement | ITC | Within 2 weeks of [2] |
| [4] Banking Arrangement | MOEF | Within 2 weeks of [3] |
| [5] Issuance of Authorization to Pay | ITC | Within 2 weeks of [3] |
| [6] Removal of the existing structures and underground cable and pipes within the construction site | ITC | Before the notification of the tender |
| [7] Approval of tender documents | ITC, MOEYS | After completion of tender docs. |
| [8] Acquisition of building permit | ITC, MOEYS | Before the notification of the tender |
| [9] Notice of Commencement of Work | ITC, MOEYS | Within 2 weeks of conclusion of contract |
| [10] Approval of Master list for exempted items | ITC, MOEYS, MOEF and CDC | Within 1 month after submission of list |
| [11] Exemption of duties and VAT | ITC, MOEYS | Timely upon request from the Contractor |
| [12] Support to the contractors for unloading and custom clearance | ITC, MOEYS | Ditto |

| | | |
|---|---|---|
| [13] Support to obtain permits for Japanese nationals and nationals of third countries who work for this Project to stay and work | ITC, MOEYS | Ditto |
| [14] Extension of power cable and connection to the distribution board of the building | ITC | Three months before completion |
| [15] Extension of water pipe and installation of valve | ITC | Three months before completion |
| [16] Extension of black wastewater drainage pipe and installation of underground pit for connection | ITC | Three months before completion |
| [17] Other necessary preparation to start using the equipment and building | ITC | After the handover of the building |
| [18] Building the communication system and installing in the building | ITC | Ditto |
| [19] Budgeting of necessary expense and assignment of personnel for operation of the equipment and building to be procured on this Project. | ITC | Ditto |

**(2) Tax exemption**

Import tax for the equipment procured from outside Cambodia for the Project shall be exempted by submitting a master list from the Supplier/Contractor and a letter from MoEYS based on the submission of the master list. For the Value Added Tax (VAT) applicable to equipment procured inside Cambodia, the Supplier/Contractor shall pay VAT temporarily, whereupon the VAT shall be refunded via designated procedures by the Cambodian side. The detailed procedures are as follows:

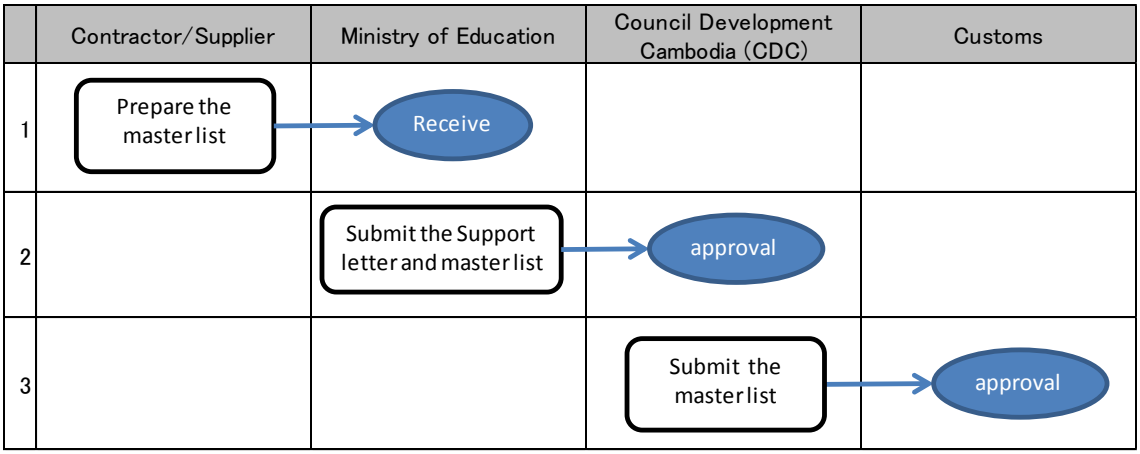
① Supplier/Contractor shall make a master list with information such as the cargo type, quantity, price and etc.

② Supplier/Contractor shall apply tax exemption to MoEYS by submitting the master list.

③ MoEYS shall prepare a supporting letter for tax exemption based on the master list and submit it to Council Development Cambodia (CDC).

④ CDC shall examine the master list. Upon receiving permission from CDC, application for tax exemption to customs shall be possible.

Table 2-10 Flow chart of Tax exemption for Equipment Imported




When the Supplier/Contractor ship cargo not mentioned on the master list, modification of the master list will be required. The Supplier/Contractor should therefore be very careful when making the master list.

## 2-4 Project Operation Plan

### (1) System for Maintenance

Except lecturers, the technicians in each laboratory are those who coordinate the maintenance of the equipment procured for the Project. The following table 2-11 shows the number of technician in each laboratory.

Table 2-11 Number of technicians for each laboratory

| Name of Job | Status | FDY | GEE | GIM | GCA | GCI | GIC | GGG | GRU | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Lab. Technician | Full-time | 1 | 3 | 3 | 4 | 2 | 2 | 2 | 2 | 19 |
| | Part=time | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |

Beside the above, 3 staff of the IT service section of the planning dept. maintain affairs relating to IT. For the facility maintenance, 9 staff of the technical management sector cover the entire ITC facilities.

### (2) Maintenance Method

By excluding advanced systems and complicated specifications, the design of the planned facilities has achieved ease of maintenance, but to keep the buildings in good condition for an extended period, ITC must ensure daily cleaning and inspections to avoid problems caused by wear, tear and ageing at an early stage.

- Regular cleaning: Daily, weekly and quarterly cleaning schedules must be developed to achieve regular cleaning by the cleaning staff.

- Regular repair of the facilities: To repair worn, torn or aged parts of the facilities, regular inspections and repairs will be needed, including annual inspections of the doors and windows, touching up of the painted areas every three years and repainting every ten to fifteen years, and so on.

- Maintenance of the building services: Daily “preventive maintenance” will be important before any damage or waste of consumables occurs. The life of building services can certainly be extended by proper operation, daily maintenance, lubrication, adjustment, cleaning, fixing and so on.

- In the Project, building services widely used in Cambodia were adopted and complicated systems were excluded. ITC must establish a system to conduct minor repairs, replacement of parts and so on by themselves, based on the maintenance manuals to be provided upon completion, and outsource regular inspections of pumps and power generators to external contractors.

- Maintenance of equipment: Inspection, maintenance and replacement of consumables and spare parts will be carried out in accordance with the users’ manuals provided by the suppliers. Each department keeping the equipment must develop an inventory and maintenance record to ensure proper maintenance of the equipment.

## 2-5 Project Cost Estimation

### 2-5-1 Initial Cost Estimation

Details of the estimated expenses to be borne on the Cambodian side are as follows based on the conditions for calculating the amount shown in (2), when the Project is implemented through Japanese Grant Aid.

#### (1) Expenses to be borne by the Cambodian Side

Estimated Project cost: Approximately 4.1 million JPY

| Item | Estimated cost | |
|---|---|---|
| | (thousands Riel) | (million JPY) |
| [4] Banking Arrangement | 30,750 | 0.6 |
| [6] Removal of the existing structures and cables within the site | 25,420 | 0.5 |
| [14]-[16] Extension of services to the building and connection | 50,840 | 1.0 |
| [17] Other necessary preparation to start use | 50,840 | 1.0 |
| [18] Building the communication system and installing in the building | 50,840 | 1.0 |
| Total | 208,690 | 4.1 |

#### (2) Conditions for Estimate of Accumulation

① Estimated as of: October 2012

② Exchange Rate: 1USD (local currency) ＝80.40JPY

③ Construction/Procurement Schedule: The required duration for Design and Construction and Procurement Stages is as shown in the Table 2-8 Implementation schedule.

④ Others: Cost estimation shall be calculated based on the system of Japanese Grant Aid.

### 2-5-2 Operation and maintenance Cost

#### (1) Operation and Maintenance of the Equipment

Among the equipment planned for the Project, the consumables required are as follows:

Table 2-12 Annual expense for additional consumables by implementing the Project

| Description | Name of Consumable | Unit Price | Quantity annually needed | Amount (thousand Riel) |
|---|---|---|---|---|
| Optical Splicer | Splicing sleeve | 12.63 | 500 | 6,316.32 |
| | Splicing sleeve | 12.13 | 500 | 6,063.67 |
| | Splicing sleeve | 15.16 | 500 | 7,579.59 |
| | Splicing sleeve | 20.21 | 500 | 10,106.11 |
| PCB Making Machine | Milling cutter 90 degree | 197.07 | 25 | 4,926.73 |
| | Hatching cutter 1.0mm | 176.86 | 5 | 884.28 |
| | Drill bit 0.6mm | 90.96 | 5 | 454.78 |
| | Drill bit 0.8mm | 90.96 | 10 | 909.55 |
| | Drill bit 1.0mm | 90.96 | 10 | 909.55 |
| | Drill bit 1.2mm | 90.96 | 5 | 454.78 |
| | Drill bit 3.0mm | 90.96 | 2 | 181.91 |
| | Drill bit for reference pin boring | 96.01 | 1 | 96.01 |
| | Forming cutter 1.0mm | 141.49 | 5 | 707.43 |
| | Forming cutter 1.5mm | 141.49 | 5 | 707.43 |
| | Both sided PCB 250x200mm (20 sheets) | 1,515.92 | 5 | 7,579.59 |
| CNC Laser Cutting Machine | Primary Filter | 151.59 | 12 | 1,819.10 |
| | Secondary Filter | 242.55 | 6 | 1,455.28 |
| | Deodorizer (Activated Carbon)15kg | 1,010.61 | 2 | 2,021.22 |
| X-ray Fluorescence (XRF) | PR Gas Cylinder | 5,053.06 | 1 | 5,053.06 |
| Trinocular Polarizing Microscope | Halogen Lamp | 101.06 | 10 | 1,010.61 |
| | Immersion Oil | 151.59 | 2 | 303.18 |
| Heating/Freezing Stage Apparatus | $N_2$ Gas Cylinder | 25.27 | 10 | 252.65 |
| Automatic Polishing Machine | Polishing Cloth TexMet P (5sheets/set) | 1,243.05 | 2 | 2,486.10 |
| | MetaDai Monocrystalline Diamond Suspension 1μm 0.47L | 1,091.46 | 2 | 2,182.92 |
| | MetaDai Monocrystalline Diamond Suspension 3μm 0.47L | 1,546.24 | 2 | 3,092.47 |
| | MetaDai Monocrystalline Diamond Suspension 9μm 0.47L | 2,182.92 | 2 | 4,365.84 |
| Plotter | Roll Paper | 1,147.04 | 2 | 2,294.09 |
| Microwave Digestion Apparatus | Filter (500 sheets) | 424.46 | 1 | 424.46 |
| Viscometer | Air Cartridge | 1,465.39 | 1 | 1,465.39 |
| | Total | | | 76,104.09 |

### (2) Facilities Operation and Maintenance Costs

The actual expense regarding maintenance and power and water supply are organized and analyzed as per the following table:

Table 2-13 Maintenance and Power and Water charge of the ITC (budgetary base)

| | | Unit | 2007/08 | 2008/09 | 2009/10 | 2010/11 | 2011/12 |
|---|---|---|---|---|---|---|---|
| Expense amount | Maintenance | thousand Riel | 114,300.2 | 113,289.5 | 129,762.5 | 179,939.4 | 188,933.8 |
| | Power & water | | 754,168.8 | 450,884.3 | 611,925.2 | 692,673.1 | 599,141.0 |
| Floor area* | | sqm. | 22,216 | 22,216 | 22,216 | 24,116 | 24,116 |
| Unit price | Maintenance | thousand Riel/sqm | 5.2 | 5.1 | 5.9 | 7.5 | 7.8 |
| | Power & water | thousand Riel/sqm | 34.0 | 20.3 | 27.5 | 28.7 | 24.9 |

* Floor area is calculated from a rough measurement by the survey team and defined as the pillar-center area. From 2011 the conference hall opened.

The necessary expense for the building and services to be procured on this Project is estimated using this unit price per sqm. For maintenance expense, the recent indicator 7.8 thousands Riel/sqm is applied. Power and water supply expenses vary between 20 and 34 thousands Riel/sqm according to the year and taking into consideration the fact that the proposed building is equipped with air-conditioners 35.5 thousands Riel/sqm is applied for calculation. As a result the additional annual maintenance expense for this Project is estimated as 10,140 thousands Riel and the power and water supply charge are 46,150 thousands Riel as well.

### (3)Analysis of Operation and Maintenance

Annual expenses for additional maintenance cost by implementing the Project are 132,394 thousands Riel (approx. 33 thousand USD) which is the total cost of the equipment and facility. The amount is approx.12% of 1,079,788 thousand Riel, which is the total annual expenses for maintenance of equipment and facilities (cost of consumables for equipment and facility, cost for repair and cost for electricity and water) in fiscal year 2011. Since the average increase in annual expenses between 2008 and 2012 is 21%, it is assumed that the additional amount to be increased shall be fully covered.

Table 2-14 Transition of expenses in the past 5 years of ITC

(Unit: thousand Riel)

| Expenses Fiscal Year | | 2009 | 2010 | 2011 |
|---|---|---|---|---|
| Salary | For lecturers | 1,949,456 | 2,556,376 | 2,896,456 |
| | For administrators | 498,072 | 576,584 | 633,276 |
| | Others | - | - | 172,172 |
| | Total | 2,447,528 | 3,132,960 | 3,701,904 |

| | | | | |
|---|---|---|---|---|
| Development | Library/documents | 26,288 | 22,344 | 12,072 |
| | Training/scholarship | 161,500 | 192,000 | 95,232 |
| | Travel expenses | 76,888 | 89,340 | 96,604 |
| | Science/partnership | - | - | 85,384 |
| | For Master Courses | - | - | 192,624 |
| | Consumables for equipment and facilities | 135,156 | 209,344 | 315,276 |
| | Total | 399,832 | 513,028 | 797,192 |
| Operation | Equipment/facilities | 184,556 | 180,000 | 130,136 |
| | Consumables for administration | 327,020 | 426,728 | 448,744 |
| | Repair | 125,876 | 174,540 | 183,272 |
| | Electricity/water | 593,632 | 671,960 | 581,240 |
| | Others | 103,508 | 68,780 | 57,640 |
| | Total | 1,334,592 | 1,522,008 | 1,401,032 |
| Total | | 4,181,952 | 5,167,996 | 5,900,128 |
| | Growth Rate (%) | 125 | 124 | 114 |

* Fiscal year of ITC is from 1 October to 30 September (Source: ITC)

# Chapter 3 Project Evaluation

# Chapter 3　Project Evaluation

## 3-1 Preconditions

The Project consists of the construction of a laboratory building within the premises of the existing institute and procurement of educational equipment for new and existing laboratories. There are no preconditions regarding the site acquisition. However, the Project prerequisites do include the Cambodian Government timely implementing their obligations described on Clause 3 of Chapter 2: acquisition of a building permit, tax exemption and others.

## 3-2 Necessary Inputs by Recipient Country

To complete the entire Project, the following points must be properly prepared and/or implemented by the Cambodian side:

- The implementation of the obligations of the Cambodian side mentioned in Chapter 2.
- To secure the necessary manpower and budget for use and maintenance of the procured equipment and constructed facilities.
- To secure the necessary space and utilities for the equipment installed in the laboratories of existing buildings

## 3-3 Important Assumptions

The Project involves procuring the necessary equipment for implementing the curriculum and syllabus of each department and constructing new laboratories. The effective utilization of the equipment procured by ITC lecturers and the continuous implementation of high-quality exercise and experiments in class shall be duly required to generate skilled ITC graduates. To accomplish the goals, improvement of the curriculum and documents for experiments regarding those procured for the Project shall be required with the Technical Cooperation Project (ECaD-ITC) currently implemented; centering on the departments of ITC targeted by the Project.

## 3-4 Project Evaluation

### 3-4-1 Relevance

The Project is considered valid as a Japanese Grant Aid Project in terms of the following points:

#### (1) Beneficiary of the Project

The targeted area of the Project is Phnom Penh City where ITC is located in. The number of direct beneficiary shall be 1.5 million（the population of Phnom Penh in 2008） , that is approx.10% of the total population 14.1 million of Cambodia. Since ITC is the best Engineering Institute of Cambodia, the Project shall enormously contribute to the development of Cambodian industry. Thus, the validity of the Project is reasonably recognized.

### (2) Viewpoint of Human Security

Human security is a concept that encourages personal independence and the creation of a sustainable society through protection and empowerment in order to realize the abundant potential inherent in each individual. It is also intended to focus on the individual human being, to protect people from a broad and serious threat to the survival, livelihood and dignity. Through the implementation of the Project, having increasing the opportunity for getting practical experiments in class at ITC which is the best Engineering Institute of Cambodia, the capacity of the graduates of ITC shall be enhanced in relation to the contribution for the development of Cambodian industry and society. For that point of view, the Project is consistent with the essense of human security and is relating to the improvement of the lives of Cambodian people.

### (3) Contribution to Achieving the Medium/Long Term Development Plan

NSDP (National Strategic Development Plan 2009-2013 Update) has come out with the concrete policies and priotitized fields for implementing the 2nd Rectangular Strategy. “Improvement of Quality of Education” that is one of the policies of “Capacity Building and Development of Human Resources” of 2nd Rectangular Strategy has 3 themes such as “Guarantee of the fair access to educational services”, “Improvement of quality and efficiency of educational services” and “Improvement of the system of decentralization and Capacity Development of administrative officers in educational sector” in the plan. ESP (Education Strategic Plam 2009-2013) also mentions about the improvement of facilities for basic learning activities relating to human resource development of mathematics field. Thus, the validity of the Project is reasonably recognized.

### (4) Consistency with Japanese Policy for Official Development Assistance

In the “Policy Paper of ODA for Cambodia issued by the Ministry of Foreign Affairs, April 2012 - Key issue (mid-term objective) – (1) Strengthening of Economic Structure – Strengthening of Private Sector”, it is mentioned that “Assistance for training of human resources in industrial area, especially training of human resources for engineer and middle management who are needed in manufacturing industry being expanded shall be stressed”. This is consistent with the objective of the Project “To procure facilities and equipment for experiments targeting ITC for developing human resources (Engineers) with practical skills by enhancing the capacity of education and research including the ability of practical exercise”. Thus, the validity of the Project to Japanese Policy of ODA is reasonably recognized.

### 3-4-2 Effectiveness

The following shows the outputs expected by implementing the Project:

#### 1) Quantitative Effects

| Indicators | Baseline (2012) | End line (2017)<br>(3 years after completion of the Project) |
|---|---|---|
| ① The number of laboratories for 7 departments targeted by the Project<br>(unit: laboratory) | 37 | 45 |
| ② The number of subjects utilizing experimental equipment in class for 7 departments targeted by the Project<br>(unit: subject) | 129 | 176 |

#### 2) Qualitative Effects

① The educational environment shall be improved with the necessary experimental equipment for practical training as the top Engineering Institute in Cambodia

② By using experimental equipment for practical training for education and research, human resources (engineers) with practical skills will be increased

③ To benefit the demand for human resources in the industrial area of Cambodia, including Japanese companies expanding into the country

In conclusion, the validity of the Project to be implemented by Japanese Grant Aid shall be highly confirmed and its anticipated effectiveness also fully recognized.

# Appendices

1. **Member List of the Survey Team**
2. **Survey Schedule**
3. **List of Parties Concerned in the Recipient Country**
4. **Minutes of Discussions (M/D)**
5. **Other Relevant Data**
6. **References**

## Appendix 1 Member List of the Survey Team

### 1-1 Field Survey 1 (1- 27 October, 2012)

| No. | Name | Position | Organization |
|---|---|---|---|
| 1 | Mr. Tsutomu TANAKA | Leader | Director, Technical and Higher Education Division, Higher Education and Social Security Group, Human Development Department, JICA |
| 2 | Mr. Kazuma INOUE | Project Coordinator | Technical and Higher Education Division, Higher Education and Social Security Group, Human Development Department, JICA |
| 3 | Mr. Akihiro OKAMOTO | Chief Consultant/ Equipment Planning I | INTEM Consulting, Inc. |
| 4 | Ms. Akiko HANAYA | Higher Education Planning | INTEM Consulting, Inc. |
| 5 | Mr. Yasumichi DOI | Equipment Planning II | INTEM Consulting, Inc. |
| 6 | Mr. Kenji KAWAZOE | Architectural/Structure/Construction and Cost Planning | Matsuda Consultants International Co., Ltd. |
| 7 | Mr. Toshio TAMURA | Building Services Planning | Matsuda Consultants International Co., Ltd. |
| 8 | Mr. Seiichi OUCHI | Equipment Procurement and Cost Planning | INTEM Consulting, Inc. |

### 1-2 Field Survey 2 (16-22 December, 2012)

| No. | Name | Position | Organization |
|---|---|---|---|
| 1 | Mr. Tsutomu TANAKA | Leader | Director, Technical and Higher Education Division, Higher Education and Social Security Group, Human Development Department, JICA |
| 2 | Mr. Kazuma INOUE | Project Coordinator | Technical and Higher Education Division, Higher Education and Social Security Group, Human Development Department, JICA |
| 3 | Mr. Akihiro OKAMOTO | Chief Consultant/ Equipment Planning I | INTEM Consulting, Inc. |
| 4 | Mr. Kenji KAWAZOE | Architectural/Structure/Construction and Cost Planning | Matsuda Consultants International Co., Ltd. |

# Appendix 2 Survey Schedule

## 2-1 Field Survey 1

| Date | | | | Officials | Chief Consultant Equipment Planning I | Higher Education Planning | Equipment Planning II | Architectural, Structure, Construction and Cost Planning | Building Services Planning | Equipment Procurement Cost Planning |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Akihiro OKAMOTO | Akiko HANAYA | Yasumichi DOI | Kenji KAWAZOE | Toshio TAMURA | Seiichi OUCHI |
| | | | | 6 days | 27 days | 21 days | 21 days | 27 days | 20 days | 18 days |
| 1 | 1-Oct | Mon | AM | | Flight(Narita-Bangkok-Phnom Penh) | | | Flight(Narita-Bangkok-Phnom Penh) | | |
| | | | PM | | | | | | | |
| 2 | 2-Oct | Tue | AM | | Courtesy Call to EOJ/JICA | | | Courtesy Call to EOJ/JICA | | |
| | | | PM | | Meeting with ITC | | | Meeting with ITC | | |
| 3 | 3-Oct | Wed | AM | | ITC Existing Equipment Survey/ Meeting with ECaD-ITC | | | Cost Survey (Delivering Survey Form) /Preparation of selecting sub-contractor for site survey | ITC Facilities Equipment Survey | |
| | | | PM | | | | | | | |
| 4 | 4-Oct | Thu | AM | | Meeting with ITC (Explanation of Inception Report) | | | Meeting with ITC (Explanation of Inception Report) | | |
| | | | PM | | | | | | | |
| 5 | 5-Oct | Fri | AM | | ITC Existing Equipment Survey/ Procurement Survey | | | Cost Survey (Delivering Survey Form) /Preparation of selecting sub-contractor for site survey | | |
| | | | PM | | | | | | | |
| 6 | 6-Oct | Sat | AM | | ITC Existing Equipment Survey | | | ITC Existing Facility Survey | ITC Existing Building Services Survey | |
| | | | PM | | | | | | | |
| 7 | 7-Oct | Sun | AM | | Document Study | Flight(Narita-Bangkok-Phnom Penh) | | Document Study | | |
| | | | PM | | | | | | | |
| 8 | 8-Oct | Mon | AM | | ITC Survey for Existing Equipment | JICA Expert(Investment advisor) JBAC Interview | ITC Survey for Existing Equipment | Contract of Natural Condition Survey,etc. | Survey of ITC Facility Equipment and Relevant Infrastructures Visiting Relevant Facilities | |
| | | | PM | | | | | | | |
| 9 | 9-Oct | Tue | AM | | Discussion with ITC Equipmet Planning (FY/GCI) | Meeting with ITC JICA Expert (Education) CJCC Interview | Discussion with ITC Equipmet Planning (GEE/GIM) | Discussion with ITC (Questionnare/Facility) | | |
| | | | PM | | | | | | | |
| 10 | 10-Oct | Wed | AM | | Discussion with ITC Equipmet Planning (GIC/GCA) | Meeting with ITC Visiting PP SEZ | Discussion with ITC Equipmet Planning (GEE/GIM) | Discussion with ITC ITC Survey Existing Facility | | Flight (Hanada－BKK－PP) →Procurement Survey |
| | | | PM | | | | | | | |
| 11 | 11-Oct | Thu | AM | | Discussion with ITC Equipmet Planning (GGG) | Meeting with MoEYS WB/Japanese Enterprise Interview | Discussion with ITC Equipmet Planning (GEE/GIM) | Meeting with MoEYS (Costs of Cambodia) Discussion with ITC | | Meeting with MoEYS Visiting Agents of Equipment Procurement |
| | | | PM | | | | | | | |
| 12 | 12-Oct | Fri | AM | | Discussion with ITC Equipmet Planning AUF Interview | Meeting with ITC AUF Interview | Discussion with ITC Equipmet Planning (GEE/GIM) | Survey for Construction material | | Visiting Agents of Equipment Procurement |
| | | | PM | | | | | | | |
| 13 | 13-Oct | Sat | AM | | Relevant Facility Survey | Document Study | | Relevant Facility Survey | Relevant Facility Survey | Document Study |
| | | | PM | | Document Study | | | | | |
| 14 | 14-Oct | Sun | AM | | Equipment and Facilities Planning/ Document Study | | | | | |
| | | | PM | | | | | | | |
| 15 | 15-Oct | Mon | AM | | Equipment and Facilities Planning/ Document Study | | | | | |
| | | | PM | | | | | | | |
| 16 | 16-Oct | Tue | AM | | Equipment and Facilities Planning/ Document Study | | | | | |
| | | | PM | | | | | | | |
| 17 | 17-Oct | Wed | AM | | Discussion with MoEYS (Scope of Work of the Project,etc) Departing from Phnom Penh | | Discussion with ITC Equipmet Planning (GEE/GIM) | Discussion with MoEYS (Scope of Work of the Project,etc) ITC Survey Existing Facility | Document Study | Discussion with MoEYS (Tax Exemption,etc) Departing from PP |
| | | | PM | | 16:00 Arriving in Battambang | | | | 16:00 Arriving in Battambang | |
| 18 | 18-Oct | Thu | AM | | Survey at UBB (items in questionnaire) | | Discussion with ITC Equipmet Planning (GEE/GIM) | Survey for construction material | Survey at UBB (items in questionnaire) | |
| | | | PM | | Departing from Battambang- 19:00 Arriving in Phnom Penh | | | | Departing from Battambang- 19:00 Arriving in Phnom Penh | |
| 19 | 19-Oct | Fri | AM | | Departing from Phnom Penh- Survey at SRU (items in questionnaire) | | Discussion with ITC Equipmet Planning (GEE/GIM) | Discussion with ITC (Facility planning) Local Market Survey | Discussion with ITC (Building Services) | 5:00 Departing from PP- 9:00 Arriving in Svay Rieng - Survey at SRU |
| | | | PM | | Departing from Svay Rieng- 18:00 Arriving in Phnom Penh | | | | Flight(PP-BKK) | Departing from Svay Rieng- 18:00 Arriving in PP |
| 20 | 20-Oct | Sat | AM | | Document Study | | | | Flight(BKK-Narita) | Document Study |
| | | | PM | | | | | | | |
| 21 | 21-Oct | Sun | AM | | Internal Meeting/ Document Study | | | | | Internal Meeting /Document Study |
| | | | PM | | | | | | | |
| 22 | 22-Oct | Mon | AM | Flight(Narita-BKK-PP) | Meeting with ITC Meeting with MoEYS | Discussion with ITC French assistance interview | Discussion with ITC Equipmet Planning (GEE/GIM) | ITC Existing Facility Survey Meeting with MoEYS | | Visiting Agents of Equipment Procurement |
| | | | PM | | | | | | | |
| 23 | 23-Oct | Tue | AM | Internal Meeting | | Collecting Info from MoEYS/ACC Supplemental Survey | Discussion with ITC Equipmet Planning (GEE/GIM) | Internal Meeting Meeting with ITC,etc. | | Visiting Agents of Transportation |
| | | | PM | Discussion with ITC (Planning, Obligations of Cambodia and Japan) | | | | | | |
| 24 | 24-Oct | Wed | AM | Drafting of M/D | | Collecting Relevant Documents from MoEYS | Discussion with ITC Equipmet Planning (GEE/GIM) | Survey of materials Discussion with ITC | | Visiting Agents of Transportation |
| | | | PM | Discussion with ITC (M/D) | | | | | | |
| 25 | 25-Oct | Thu | AM | Reporting to EoJ | | Wrap-Up for Higher Education Planning | Wrap-Up for Equipment Planning | Reporting to EoJ | | Collecting Documents for Equipemt and Transportation |
| | | | PM | Study visit of ITC (Equipment) | | | | Survey of materials | | |
| 26 | 26-Oct | Fri | AM | Signing of M/D, Reporting to JICA | | | | | | Signing M/D, JICA |
| | | | PM | Flight (PP-BKK) | | | | | | Flight(PP-BKK) |
| 27 | 27-Oct | Sat | AM | Flight(BKK-Narita) | | | | | | Flight(BKK-Narita) |
| | | | PM | | | | | | | |

## 2-2 Field Survey 2

| Date | | | | Officials | Chief Consultant<br>Equipment Planning I | Architectural, Structure, Construction and Cost Planning |
|---|---|---|---|---|---|---|
| | | | | | Akihiro OKAMOTO | Kenji KAWAZOE |
| | | | | 6 days | 7 days | 7 days |
| 1 | 16-Dec | Sun | AM | | Flight (Narita-Bangkok-Phnom Penh) | |
| | | | PM | | | |
| 2 | 17-Dec | Mon | AM | Flight<br>(Narita-Bangkok-Phnom Penh) | Discussion with ITC<br>Explanation of Plan (Equipment Specs, Facilities Drawing) | |
| | | | PM | | | |
| 3 | 18-Dec | Tue | AM | Discussion with ITC, Explanation of Preparatory Survey Report (Draft), M/D(Draft) | | |
| | | | PM | Modifying the draft of M/D | Discussion with ITC<br>Explanation of Plan (Equipment Specs, Facilities Drawing) | |
| 4 | 19-Dec | Wed | AM | Meeting with JICA | | |
| | | | PM | Reporting to EoJ | | |
| 5 | 20-Dec | Thu | AM | Meeting with ITC (DDG Norith) | | |
| | | | PM | Meeting with Project coordinator | | |
| 6 | 21-Dec | Fri | AM | Signing of M/D with MoEYS and ITC | | |
| | | | PM | Reporting to JICA, Flight (PP-BKK) | | |
| 7 | 22-Dec | Sat | AM | Flight (BKK-Narita) | | |
| | | | PM | | | |

Appendix 3 List of Parties Concerned in the Recipient Country

| Organization | Position | Name |
|---|---|---|
| Ministry of Education, Youth and Sport (MoEYS) | Secretary of State | PHOEURNG Sackona (Ph.D.) |
| | Deputy Director General /Directorate of Administration and Finance | SOEUR Socheata |
| | Director General /Directorate General of Higher Education | MAK Ngoy |
| | Director /Department of Higher Education | MAK Nang |
| | Deputy Director /Department of Higher Education | VIRAK You |
| | Officer/Department of Higher Education | SENG Sangha |
| | Officer/Department of Higher Education | SOEUR Chumnith |
| | Officer/Department of Scientific Research | LIM Ngor |
| Institute of Technology of Cambodia (ITC) | Director General | OM Romny (Ph.D.) |
| | Deputy Director/Planning and Development | PHOL Norith |
| | Deputy Director/Cooperation and Research | CHUNHIENG Thavarith (Ph.D.) |
| | Deputy Director/Academic Affairs | NUTH Sothan |
| | Deputy Director/Administration | PENH San |
| | Director/Office of Research | HUL Seingheng (Ph.D.) |
| | Director/Undergraduate | SOY Ty |
| | Director/Postgraduate | KHOV Makara (Ph.D.) |
| | Head of department/General Science | NOI Moeung |
| | Head of department/Food and Chemical Engineering | SREY Malis |
| | Head of department/Civil engineering | CHHOUK Chhay Hong |
| | Head of department/Geo-resources and Geotechnical Engineering | PEN Chhorda |
| | Head of department/Computer Science | SENG Sopheap (Ph.D.) |
| | Head of department/Industrial and Mechanical Engineering | PAN Sovanna |
| | Vice Head of department/Food and Chemical Engineering | IN Sokneang (Ph.D.) |
| | Vice Head of department/Civil Engineering | CHREA Rada |
| | Vice Head of department/Electrical and energy Engineering | BUN Long (Ph.D.) |
| | Head of Laboratory/Geo-resources and Geotechnical Engineering | BUN Kim Ngun |
| | Vice Head of department/Rural Engineering | LY Sarann |
| | Academic Adviser/Computer Science | HENG Sokbil |
| | Lecturer/Civil Engineering | VONG Seng |
| | Lecturer/Civil Engineering | SENG Sochan (Ph.D.) |
| | Lecturer/Electrical and energy Engineering | PO Kim Tho (Ph.D.) |

| | | |
|---|---|---|
| | Lecturer/Electrical and energy Engineering | KEO Lychek (Ph.D.) |
| | Lecturer/Electrical and energy Engineering | KY Leng (Ph.D.) |
| | Lecturer/Geo-resources and Geotechnical Engineering | PICH Bunchoeun (Ph.D.) |
| | Lecturer/Geo-resources and Geotechnical Engineering | BUN Kim Ngun (Ph.D.) |
| | Lecturer/Computer Science | HEAN Samboeun |
| | Lecturer/Industrial and Mechanical Engineering | CHAN Sarin (Ph.D.) |
| | Facility management | SETAY Keochhaom |
| | Building Design | CHOEA Rada |
| | IT Service | KHIEV Samnang |
| University of Battambang (UBB) | Vice President | Sieng Em Totim |
| | Vice President | BIN Chhom |
| | Head of department/Foundation year | CHEA Sokhourt |
| | Lecturer/Department of Nuclear and civil Engineering | SAM Nang |
| | Deputy Director of Administration and Finance | EM Dara |
| | Staff | REM Samnang |
| Svay Rieng University (SRU) | President | TUM Saravuh |
| | Vice President/Finance and Administration | SIN Putheasath |
| | Vice President/Academic and Research | LEOK Virak |
| | Adviser of Faculty of Agriculture | YON Peou (Ph.D.) |
| | Chief of Research of Development | CHHAY Veasna |
| | Chief of Administration and Personnel | SO Chamdara |
| | Deputy Chief of Administration and personnel | SAM Saran |
| | Vice-Dean /Faculty of Agriculture | HONG Chhun |
| | Laboratory Operator | Khhun Ratana |
| | Lecturer of Animal Science and Veterinarian | Kong Saroeun |
| Accreditation Committee of Cambodia | Secretary General | San Montaya |
| | Deputy Secretary General | Sou Sophan |
| | Deputy Secretary General | H.E. Mao Bunnin |
| | Deputy Secretary General | Khieu Vicheanon |
| | Deputy Secretary General | Pen Sithol |
| | Director of Program Accreditation | Rath chhang |
| | Director of International Cooperation | Hean Bunnith |
| | Director of Planning, Research and Training Department | Sok Khorn |
| Embassy of Japan in the Kingdom of Cambodia | Second Secretary Economic & ODA Section | Naomitsu Kondo |

| | | |
|---|---|---|
| JICA Cambodia Office | Chief Representative | Yasujiro Suzuki |
| | Senior Representative | Hitoshi Hirata |
| | Representative | Shoko Kanazawa |
| | Project Formulation Adviser | Naoko Ide |
| | JICA Plaza/ENJJ Coordinator | Noriko Ogawa |
| | Program Officer | Pich Thyda |
| JICA expert | Project Coordinator/Project for Educational Capacity Development of Institute of Technology of Cambodia | Hiroshi Iwadate |
| | JICA expert/MoEYS | Akiko Ono |
| | Investment Environment Improvement Adviser/CDC | Yuji Imamura |
| | Consultant, Information & exchange Department/CJCC | Haruo Ono |
| JOCV | IT training for Svay Rieng University | Suguru Hamasato |
| AUF | Responsible d'Antenne | Gilbert Palaoro |
| Cooperation Francaise | Conseiller a la Direction, Chef de Projet | Antoine Perrier-Cornet |
| World Bank | Education Specialist | Tsuyoshi Fukao |
| Japanese Business Association of Cambodia | Chairman | Hiroshi Nakano |
| | Chief of Manufacturing Company Section | Hidehiko Kondo |
| Forval (Cambodia) Co., Ltd. | President | Hideo Kohyama |
| Creative Diamond Links Co., Ltd. | CEO/President | Takanori Narumi |

# MINUTES OF DISCUSSIONS ON THE PREPARATORY SURVEY ON THE PROJECT FOR DEVELOPMENT OF HUMAN RESOURCE AND LABORATORY EQUIPMENT IN THE INSTITUTE OF TECHNOLOGY OF CAMBODIA, SVAY RIENG UNIVERSITY AND UNIVERSITY OF BATTAMBANG

In response to a request from the Government of the Kingdom of Cambodia (hereinafter referred to as "Cambodia"), the Government of Japan decided to conduct a Preparatory Survey on the Project for Development of Human Resource and Laboratory Equipment in the Institute of Technology of Cambodia, Svay Rieng University and University of Battambang (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Cambodia a Preparatory Survey Team (hereinafter referred to as "the Team"), which is headed by Mr. Tsutomu Tanaka, Director, Technical and Higher Education Division, Higher Education and Social Security Group, Human Development Department, JICA Headquarters and is scheduled to stay in the country from October 1st to October 26th, 2012.

The Team held discussions with the officials concerned of the Government of Cambodia and conducted a field survey at the study area.

In the courses of discussions and field survey, both sides confirmed the main items described in the attached sheets. The Team will proceed to further works and prepare the Preparatory Survey Report.

Phnom Penh, October 26th, 2012

**Mr. Tsutomu Tanaka**
Team Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

**H.E. Dr. Sackona PHOEURNG**
Secretary of State
Ministry of Education, Youth and Sport
Kingdom of Cambodia
Cambodia

**Dr. Romny OM**
Director General
Institute of Technology of Cambodia
Kingdom of Cambodia
Cambodia

ATTACHMENT

1. Objective of the Project

The objective of the Project is to develop higher education institution through the provision of laboratory equipment and facilities in order to provide skilled human resource in the field of science and engineering and to fulfill the needs in labor market of industry.

2. Project sites

Based on the result of field survey, both sides confirmed the Project site at Institute of Technology of Cambodia (hereinafter referred to as "ITC"). Svay Rieng University and University of Battambang are not in the scope of the Project.

3. Responsible and Implementing Agency

The Responsible and Implementing Agency is Ministry of Education, Youth and Sport (hereinafter referred to as "MoEYS") and ITC. Organization structures are shown in ANNEX-1.

4. Items requested by the Government of Cambodia

4-1. Both sides confirmed request of equipment and facility updated and selecting process to be taken as follows:

(1) Requested equipment and its priority

The list of requested equipment and its priority were updated as ANNEX-2. The Team will consider delivering equipment according to the priority, although the Team does not necessarily assure that all the equipment in the list or even high prioritized equipment can be provided due to the availability of budget, validity of equipment. In addition, there are some possibilities that JICA cannot deliver the equipment requested with some specified models with names of brands in accordance with the regulation of JICA Grant-Aid scheme.

(2) Requested facility and utility for ITC

The Cambodian side agreed that the plan and the site of facility to be provided are as ANNEX-3.

4-2. JICA will assess the appropriateness of the request and will report the findings to the Government of Japan for approval.

5. Japan's Grant Aid Scheme

5-1. The Cambodian side understood the Japan's Grant Aid Scheme explained by the Team, as described in ANNEX-4 and ANNEX-5.

5-2. The Cambodian side will take the necessary measures, as described in ANNEX-6, for smooth

implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

6. Schedule of the Survey

6-1. The Team will prepare the draft Preparatory Survey Report and dispatch a mission team in order to explain its contents to the Cambodian side and make the Minutes of Discussions between both sides.

6-2. In case that the contents of the draft report are accepted in principle by the Government of Cambodia, the Team will complete the final Preparatory Survey Report and send it to the Government of Cambodia. These timings will be decided hereafter.

7. Other relevant issues

7-1. Operation and maintenance

The Cambodian side agreed to secure and allocate necessary budget and appropriate staff members for the proper operation and maintenance of the equipment and facilities to be provided by the Project.

7-2. Collaboration with the ongoing Technical Cooperation Project by JICA

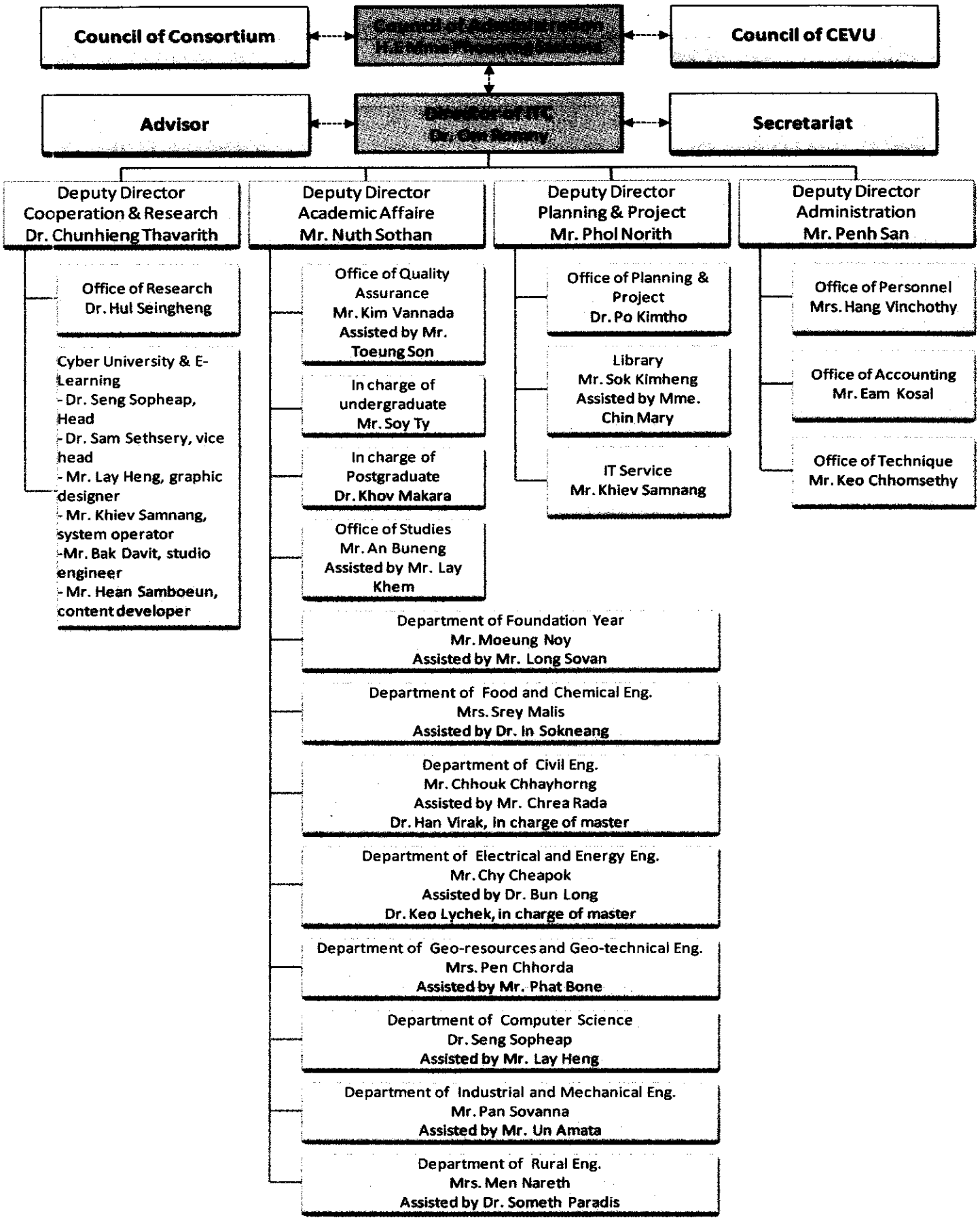
Both sides agreed that the Project will be implemented in collaboration with ongoing Technical Cooperation Project by JICA in higher education sector in terms of improving quality of education and research.

7-3. Recommendation for improvement of existing drainage system

Through the field survey of the existing service system of ITC, the Team found technical problems on drainage system in and out of the premises. The Team have discussed on this issue and recommended to ITC for investigation and renovation of the drainage system

| | |
|---|---|
| ANNEX-1 | Organization structure of ITC |
| ANNEX-2 | List of equipment requested for ITC |
| ANNEX-3 | Request on facility and utility for ITC |
| ANNEX-4 | Japan's Grant Aid Scheme |
| ANNEX-5 | Flow Chart of Japan's Grant Aid Procedures |
| ANNEX-6 | Major Undertakings to be taken by Each Government |

# Organization chart of ITC



List of Equipment Requested

| S. No. | Lab | No. | Description | Q'ty |
|---|---|---|---|---|
| Department of Electrical and Energy Engineering | | | | |
| 1 | EE | 1 | Motor Experiment Set | 1 |
| 2 | | 2 | Optical Communication Training Set | 1 |
| 3 | | 3 | Optical splicer | 1 |
| 4 | | 4 | Telecom Lab | 1 |
| 5 | NREL | 1 | Universal Relay Trainer | 1 |
| 6 | | 2 | Deferential Relay Trainer | 1 |
| 7 | | 3 | Frequency Relay Trainer | 1 |
| 8 | | 4 | Distance Relay Trainer | 1 |
| 9 | | 5 | Electric Power Transmission Training System | 1 |
| 10 | | 6 | PSCAD | 1 |
| 11 | | 7 | Solar panel | 30 |
| 12 | | 8 | Pyranometer | 1 |
| 13 | | 9 | Solar Reference Cell | 1 |
| 14 | | 10 | Photovoltaic Inverter 1 | 1 |
| 15 | | 11 | Photovoltaic Inverter 2 | 1 |
| 16 | | 12 | IV Curve Tracer | 1 |
| 17 | | 13 | Programmable Electronic Load | 1 |
| 18 | | 14 | Electrical Network Analyzer | 1 |
| 19 | | 15 | Power Quality Analyzer | 1 |
| 20 | | 16 | Electrical Safety Checker | 1 |
| 21 | | 17 | Clamp Wattmeter | 2 |
| 22 | | 18 | Portable Multimeter | 2 |
| 23 | | 19 | Clamp Measurement of Earth and Leakage Current | 1 |
| 24 | | 20 | Multifunction HVAC and IAQ Meter | 1 |
| 25 | | 21 | Temperature/Humidity Tester | 1 |
| 26 | | 22 | Laptop PC | 1 |
| 27 | | 23 | Desktop PC | 2 |

List of Equipment Requested

| S. No. | Lab | No. | Description | Q'ty |
|---|---|---|---|---|
| 28 | | 1 | Building Management System & Energy Audit tool | 1 |
| 29 | | 2 | PC set | 1 |
| 30 | | 3 | Data Acquisition set for Control System Lab. | – |
| 31 | | (1) | PCI Data Acquisition Board | 10 |
| 32 | | (2) | USB Data Acquisition Board | 5 |
| 33 | | (3) | Data Acquisition | 5 |
| 34 | | (4) | 16-ch Analogue Data Acquisition | 15 |
| 35 | | (5) | 8-Channel Counter/Timer with Digital I/O | 10 |
| 36 | | (6) | Shielded Cable | 25 |
| 37 | | (7) | Connector | 25 |
| 38 | | (8) | Control Design Software | 1 |
| 39 | | (9) | Amplifier for Automatic Control system 1 | 8 |
| 40 | | (10) | Amplifier for Automatic Control system 2 | 6 |
| 41 | | (11) | Amplifier for Automatic Control system 3 | 4 |
| 42 | | (12) | Analog Oscilloscope | 1 |
| 43 | | (13) | Color Oscilloscope | 8 |
| 44 | | 4 | Plant for Control System Lab. | – |
| 45 | | (1) | Ball and Beam System | 2 |
| 46 | | (2) | Rotary Inverted Pendulum System | 2 |
| 47 | | (3) | Motor Position and Velocity Control System | 8 |
| 48 | CAL | (4) | Flexible Link System | 2 |
| 49 | | (5) | Heat Flow System | 2 |
| 50 | | (6) | Couple Tank System | 2 |
| 51 | | (7) | Rotary Flexible Joint | 2 |
| 52 | | 5 | Robotic Experimental Lab. | – |
| 53 | | (1) | Autonomous mobile robot for teaching | 5 |
| 54 | | (2) | 2 DOF Planar Robot | 1 |
| 55 | | (3) | Autonomous robot | 1 |
| 56 | | (4) | Humanoid Robot | 1 |
| 57 | | (5) | Quadrotor for indoor unmanned aerial vehicle | 1 |
| 58 | | 6 | Workshop Equipment | – |
| 59 | | (1) | CNC/Manual Lathe | 1 |
| 60 | | (2) | Vertical Milling Machine | 1 |
| 61 | | (3) | Drilling Machine | 1 |
| 62 | | (4) | Tool for Machine | 50 |
| 63 | | 7 | Automation Control Kit lab | 1 |
| 64 | | 8 | Mechatronic Control Kits | 1 |
| 65 | | 9 | Hydraulics training systems | 1 |
| 66 | | 10 | Level Liquid Filling Machine | 1 |
| 67 | | 11 | DSPCE module | 1 |
| 68 | | 12 | LCD Projector | 2 |
| 69 | | 13 | 3D Printers | 1 |

List of Equipment Requested

| S. No. | Lab | No. | Description | Q'ty |
|---|---|---|---|---|
| 70 | IEL | 1 | Electronic Experimental Kit | 1 |
| 71 | | 2 | PCB Making Machine & 5 extra tool sets | 1 |
| 72 | | 3 | CNC Laser Cutting Machine | 1 |
| 73 | | 4 | Microprocessor and Microcontroller Experimental System | 1 |
| 74 | | 5 | Network Development Kit | 1 |
| 75 | | 6 | Development Board for Open Sourse OS | 1 |
| 76 | | 7 | Workshop Tool Set | 1 |
| 77 | | 8 | Laptop PC | 3 |
| 78 | | 9 | Image Processing Development Kit | 1 |
| 79 | | 10 | Audio Processing Development Kit | 1 |
| 80 | | 11 | Video Conference System | 1 |
| Department of Industrial and Mechanical Engineering | | | | |
| 1 | | | Torsion Testing Machine | 1 |
| 2 | | | Thermal Conductivity System | 1 |
| 3 | | | Centrifugal Pump Module | 1 |
| 4 | | | Two-stage Pumps | 1 |
| 5 | | | Wire-Cut | 1 |
| 6 | | | Drop Weight Impact Testing Machine | 1 |
| 7 | | | Environmental Applications Learning System | 1 |
| 8 | | | Refrigerant & Combustible Gas Leak Detector | 1 |
| 9 | | | IEQ Checker | 1 |
| 10 | | | Infrared Thermometer | 5 |
| 11 | | | Diagnostic Refrigerant Analyzer | 1 |
| 12 | | | Recovery Machine | 1 |
| 13 | | | Air velocity meter | 2 |
| 14 | | | Precision Balance | 1 |
| 15 | | | Precision Balance | 1 |
| 16 | | | Heating/Refrigerated Circulator | 1 |
| 17 | | | Diesel analyzer | 1 |
| 18 | | | Portable gasoline analyzer | 1 |
| 19 | | | Machine tool set | 1 |
| 20 | | | Desktop PC | 4 |
| 21 | | | Multifunction Copier | 1 |
| 22 | | | Laptop PC | 4 |
| 23 | | | Laser Printer | 1 |
| 24 | | | Laser Printer | 2 |
| 25 | | | Titrator | 1 |
| 26 | | | Flash Point Tester | 1 |
| 27 | | | Cloud point and Pour Point tester | 1 |
| 28 | | | Oxidation Stability | 1 |

List of Equipment Requested

| S. No. | Lab | No. | Description | Q'ty |
|---|---|---|---|---|
| Department of Geo-Resources and Geotechnical Engineering | | | | |
| 1 | | 1 | Equipment for Mineral Identification and Exploration | – |
| 2 | | (1) | X-ray Fluorescence (XRF) | 1 |
| 3 | | (2) | Trinocular optical polarizing microscope | 2 |
| 4 | | (3) | Heating/freezing stage apparatus | 1 |
| 5 | | (4) | Total Station | 5 |
| 6 | | (5) | Hand auger equipment | 2 |
| 7 | | (6) | Automatic Polishing machine for thin section | 1 |
| 8 | | (7) | Electric Furnace | 1 |
| 9 | | (8) | Precision electric balance | 1 |
| 10 | | (9) | Electrical Oven | 1 |
| 11 | | (10) | Agate mortar ,small size | 3 |
| 12 | | (11) | Agate mortar, large size | 3 |
| 13 | | (12) | Magnetometer | 1 |
| 14 | | 2 | Equipment for GIS and Remote Sensing | – |
| 15 | | (1) | Plotter | 1 |
| 16 | | (2) | Desktop PC | 30 |
| 17 | | (3) | Laptop PC | 2 |
| 18 | | 3 | Equipment for Geotechnics | – |
| 19 | | (1) | Micro-Deval Apparatus | 1 |
| 20 | | (2) | Unconfined Compression Tester | 5 |
| 21 | | (3) | Hydrometer analyser | 1 |
| 22 | | (4) | Llimit Liquid Apparatus | 5 |
| 23 | | 4 | Petroleum Testing Equipment | – |
| 24 | | (1) | Floor Stand Manual Drill Press | 1 |
| 25 | | (2) | Instructional Gas Permeameter | 1 |
| 26 | | (3) | Instructional Helium Porosimeter | 1 |
| 27 | | (4) | Instructional Gravimetric Capillary Pressure System | 1 |
| 28 | | (5) | Bench Top Liquid Permeability Measurement System | 1 |
| 29 | | (6) | Eclipse software | 1 |
| Department of Civil Engineering | | | | |
| 1 | | | Direct Shear Test apparatus | 1 |
| 2 | | | CBR Test apparatus | 1 |
| 3 | | | Plate Test apparatus | 1 |
| 4 | | | Ductility Test apparatus | 1 |
| 5 | | | Triaxial Test | 1 |

List of Equipment Requested

| S. No. | Lab | No. | Description | Q'ty |
|---|---|---|---|---|
| Department of Food and Chemical Engineering | | | | |
| 1 | | | Microwave Digestion | 1 |
| 2 | | | HPLC System | 1 |
| 3 | | | Smasher for Sample preparation in microbiology | 1 |
| 4 | | | Filter press | 1 |
| 5 | | | Press hydrolic | 1 |
| 6 | | | Laboratory Juicer | 1 |
| 7 | | | Filling machine | 1 |
| 8 | | | Freezer | 1 |
| 9 | | | Ion Chromatography | 1 |
| 10 | | | Gas Chromatograph Mass Spectrometer (GCMS) | 1 |
| 11 | | | Viscosimeter | 1 |
| 12 | | | Bioreactor | 1 |
| 13 | | | Biogas Analyzer | 1 |
| 14 | | | System Water Purification | 1 |
| 15 | | | Ultraviolet and Visible Range spectrophotometers | 1 |
| 16 | | | Rotary Evaporator | 1 |
| 17 | | | Multiparameter Water Quality Control | 1 |
| 18 | | | Moisture Analyzer | 2 |
| 19 | | | Digital Hand Held Refractometer | 2 |
| 20 | | | Digital Pocket Ethyl Alcohol Refractometer | 2 |
| 21 | | | Oven | 1 |
| 22 | | | Floor Freeze Dryers | 1 |
| 23 | | | Precision Balance | 2 |
| 24 | | | Laboratory Scale Spray Dryer | 1 |
| 25 | | | Air conditioner | 1 |
| 26 | | | Water Actvity Meter | 1 |
| 27 | | | Micro Pipette Set | 2 |
| Department of Information and Communication on Engineering | | | | |
| 1 | | | Equipment for Computer Networking Lab | 1 |
| 2 | | | Equipment for Android Mobile Application Development Lab | 1 |
| 3 | | | Equipment for iOS Mobile Application Development Lab | 1 |
| 4 | | | Equipment for Multipurpose Development Lab | 1 |

List of Equipment Requested

| S. No. | Lab | No. | Description | Q'ty |
|---|---|---|---|---|
| Department of Foundation Year | | | | |
| 1 | | | Computer Lab | 1 |
| 2 | | | Experimental Kit for Physics | 5 |
| 3 | | | Ballistic Pendulum Shock Pendulum | 5 |
| 4 | | | Hooke's Hook's Law | 5 |
| 5 | | | Inclined Incline Plane Deluxe | 5 |
| 6 | | | Deluxe Air Track Complete Set, Track, Air Source & Timer | 5 |
| 7 | | | Deluxe Free Fall Apparatus with Pendulum with Digital Timer | 5 |
| 8 | | | Gyroscope With Counterpoise | 5 |
| 9 | | | Oscillation of a simple pendulum | 5 |
| 10 | | | Resonance of circuit R,L,C | 5 |
| 11 | | | Charge and discharge capacitor | 5 |
| 12 | | | Measurement of unknown Resistancs | 5 |
| 13 | | | Boyle's Gas Law Apparatus Advanced | 5 |
| 14 | | | Experiment of optic' s light | 5 |
| 15 | | | Photocopier | 2 |

ANNEX-3

Request on facility and utility for ITC

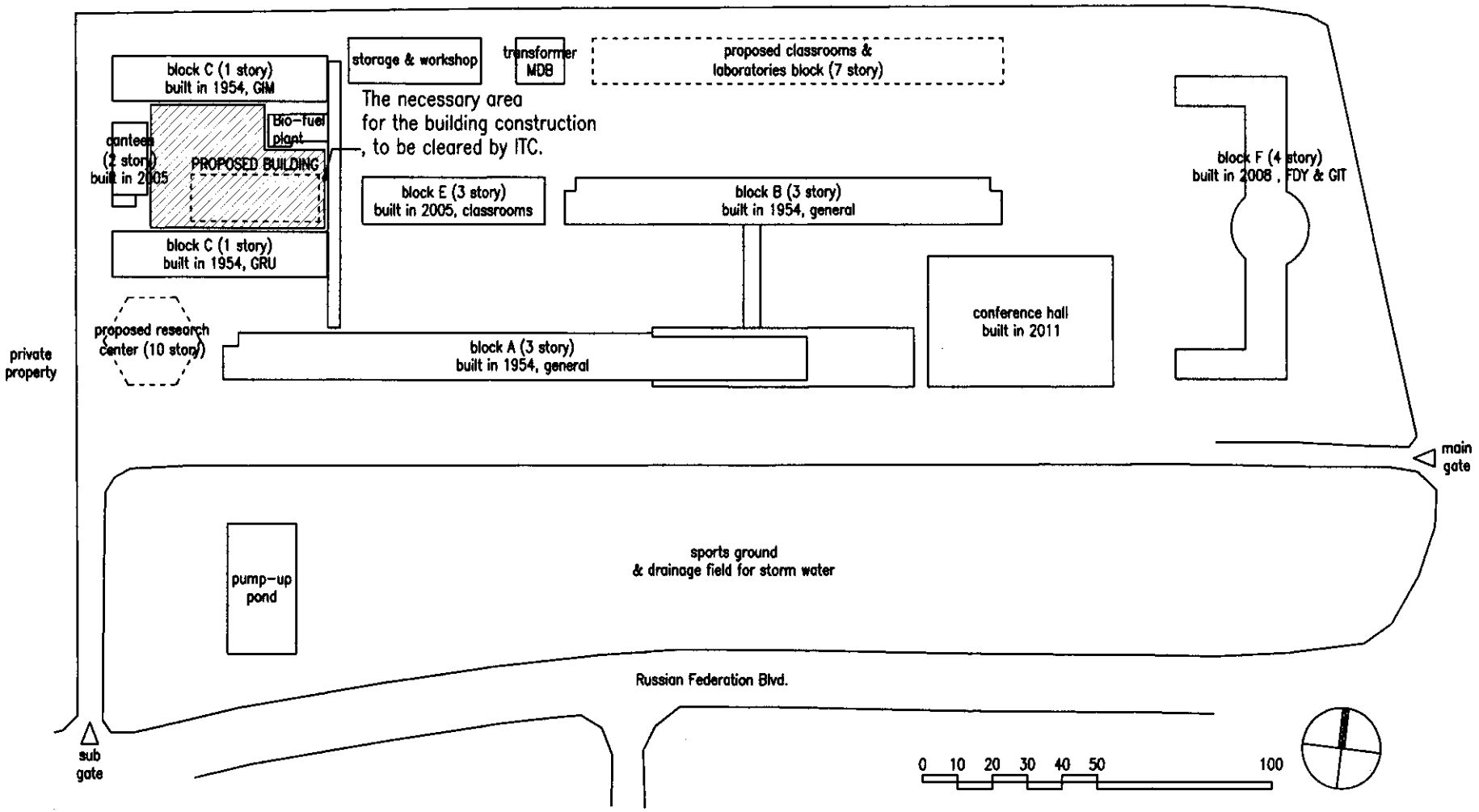
The Team has confirmed the following eight laboratories and toilets for each floor are required to provide spaces for educational activity using the procured equipment on this project through the discussions with each department.

| | Department | Name of Room |
|---|---|---|
| 1 | GEE | Control & Automatic Laboratory |
| 2 | GEE | Workshop |
| 3 | GEE | Renewable Energy Laboratory |
| 4 | GEE | Industrial Electronic Laboratory |
| 5 | GCA | Food Processing Laboratory |
| 6 | GGG | Geotechnology Laboratory |
| 7 | GGG | Petroleum Laboratory |
| 8 | GGG | PC Room |
| 9 | - | Storage for consumable and spare parts, manuals |

The Team also has confirmed the following requirement by the instutute.

- The roof shall be used for photovoltaic generating exercise.
- Air conditioners shall be installed on laboratories to prevent damage to electrical devices due to heat.
- Sun shades shall be properly designed to control direct sunlight into the buildings.

ANNEX 3-2. SITE LOCATION




A21

# JAPAN'S GRANT AID

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

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

## 1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures :

- Preparatory Survey
  - The Survey conducted by JICA
- Appraisal &Approval
  - -Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - -The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - -Agreement concluded between JICA and a recipient country
- Implementation
  - -Implementation of the Project on the basis of the G/A

## 2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of a outline design of the Project.
- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

**3. Japan's Grant Aid Scheme**

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N")

will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority 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, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) 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 JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by 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 Annex.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA 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 JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

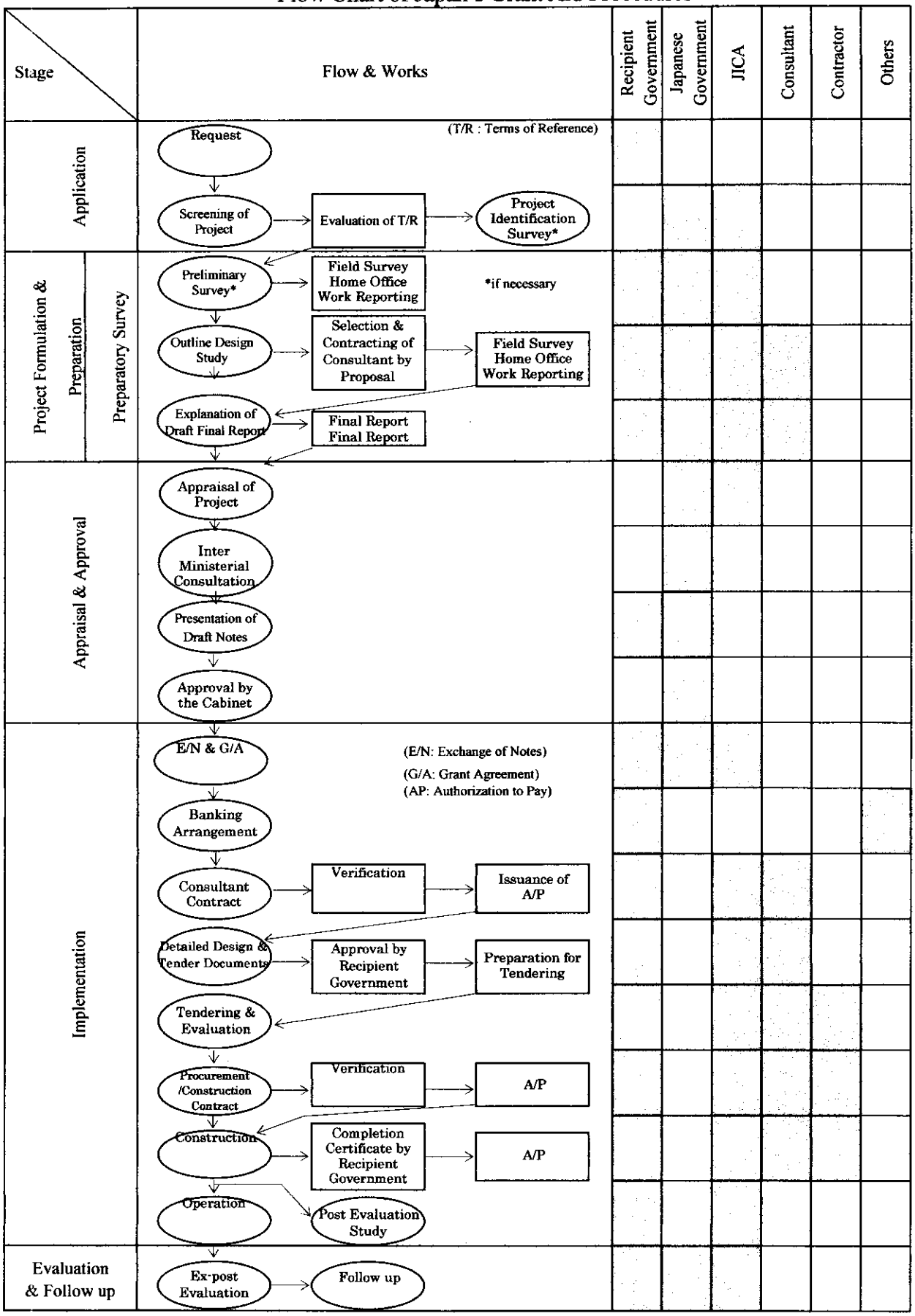
The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

# Grant Aid Procedures

## Flow Chart of Japan's Grant Aid Procedures



Major Undertakings to be taken by Each Government

| No. | Items | To be covered by Grant Aid | To be covered by Recipient Side |
|---|---|---|---|
| 1 | To secure land | | ● |
| 2 | To clear and level within the area where the construction machine and temporary structures are placed.<br>- Demolish of temporary structures attached canteen building<br>- Grass cutting and trees, removal of roots of trees<br>- Rerouting of existing underground cables and pipes. | | ● |
| 3 | To construct the building | ● | |
| 4 | To extend service cables and wires to the proposed building and modify the existing utilities. | | |
| | 1) Electricity | | |
| | a. Modifying the existing MDB in the electrical room and installing power cables from the existing MDB to the designated point. | | ● |
| | b. Installing a main circuit breaker of the proposed building. | ● | |
| | 2) Water Supply | | |
| | a. Sizing up the connecting pipe diameter and extending the water supply pipe to the designated point and installing a connecting valve. | | ● |
| | b. Installing a water supply system from the connecting valve. | ● | |
| | 3) Drainage for toilet sewer, ordinary waste, storm water | | |
| | a. Modifying the existing drainage system and extending the pipe to the designated point and installing pits for connection. | | ● |
| | b. Installing drainage system beyond the designated point. | ● | |
| | 4) Telephone System (if necessary) | | |
| | a. Replacing the existing PBX and installing telephone wires from the PBX to the terminal board of the proposed building, providing handsets and fax. | | ● |
| | b. Installing terminal boards, empty conduits, and outlets within the proposed building without wires. | ● | |
| | 5) Internet System (if necessary) | | |
| | a. Modifying the existing network system in the server room and installing communication cables, providing devices within the proposed building. | | ● |
| | b. Installing empty conduits and outlets within the proposed building. | ● | |
| | 6) Furniture and Equipment | | |
| | a. General furniture | | ● |
| | b. Project equipment | ● | |
| 5 | To bear the following commissions to the Japanese bank for banking services based upon the B/A | | |
| | 1)Advising commission of A/P | | ● |
| | 2)Payment commission | | ● |
| | To ensure unloading and customs clearance at port of disembarkation in recipient country | | |
| 6 | 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 | ● | |
| | To accord Japanese nationals, whose services may be required in connection with the supply of the products and the services under the verified contact, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work. | | ● |
| 7 | 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. | | ● |
| 8 | To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant | | ● |
| 9 | To bear all the expenses, other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment | | ● |

(B/A: Banking Arrangement, A/P: Authorization to pay)

# MINUTES OF DISCUSSIONS
# ON THE OUTLINE DESIGN STUDY
# ON THE PROJECT FOR IMPROVEMENT OF FACILITY AND LABORATORY EQUIPMENT IN THE INSTITUTE OF TECHNOLOGY OF CAMBODIA
# (EXPLANATION OF DRAFT REPORT)

In October 2012, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Preparatory Survey team on the Project for Improvement of Facility and Laboratory Equipment in the Institute of Technology of Cambodia (hereinafter referred to as "the Project") to the Kingdom of Cambodia (hereinafter referred to as "Cambodia"), and through discussion, field survey and technical examination of the survey results in Japan, JICA prepared the draft report on the survey.

In order to explain and to consult the Government of Cambodia on the components of the draft report, JICA sent to Cambodia the Draft Report Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Tanaka Tsutomu, Director, Technical and Higher Education Division, Higher Education and Social Security Group, Human Development Department, JICA Headquarters and scheduled to stay in Cambodia from December 16th to 21st, 2012.

In the course of explanation of draft report, both parties confirmed the main items described on the attached sheets.

Phnom Penh, December 21, 2012

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**H.E. Dr. Sackona PHOEURNG**
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ATTACHMENT

1. Components of the Draft Report

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

2. Japan's Grant Aid scheme

The Government of Cambodia understands the Japan's Grant Aid scheme and the necessary measures to be taken by the Cambodian side explained by the Team and described in ANNEX-4, ANNEX-5 and ANNEX-6 of the Minutes of Discussions signed by both sides on October 26th, 2012.

3. Schedule of the Study

JICA will complete the final report in accordance with the confirmed items and send it to the Government of Cambodia by April 2013.

4. Other Relevant Issues

4-1. Modification of the Name of the Project

Both sides agreed modifying the name of the Project since the outline of the project became specified by the Minutes of Discussions through the preparatory survey signed by both sides on October 26th, 2012. The name of the Project was modified from "The Project for Development of Human Resource and Laboratory Equipment in the Institute of Technology of Cambodia, Svay Rieng University and University of Battambang" to "the Project for Improvement of Facility and Laboratory Equipment in the Institute of Technology of Cambodia".

4-2. Confidentiality of the Project Design

Both sides confirmed that all information related to the Project design including detailed specifications of facility and equipment and other technical information shall not be released to any outside parties before the signing of all the Contract(s) for the Project.

4-3. Confidentiality of the Project Cost Estimation

The Team explained the cost estimation of the Project as described in ANNEX-1. Both sides agreed that the Project Cost Estimation SHALL NOT be duplicated or released to any outside parties before signing of all the Contract(s) for the Project. The Government of Cambodia understands that the Project Cost Estimation described in ANNEX-1 is not final and is subject to change.

4-4. Outline of Facility and Equipment Provisions

Based on the result of the Previous Survey and the following analyses in Japan, the facility and equipment became more specified. However, both sides agreed that the equipment and the facility specified in ANNEX-2 and ANNEX-3 are the tentative plan and final decision on the specification of equipment and facility will be made in the final report. On the other hand,

the government of Cambodia and Institute of Technology of Cambodia shall take it into the consideration to avoid the overlap of facility and equipment by the support from the government or other donor agencies hereafter.

4-5. Undertakings by the Cambodian side

The Cambodian side will take every necessary measure to conduct the following undertakings according to the estimation of expense borne by the Cambodian side in ANNEX-1, tentative schedule described in ANNEX-4. Also, the Cambodian side agreed to secure and allocate necessary budget and appropriate staff members for the proper operation and maintenance of the equipment and facilities to be provided by the Project.

ANNEX-1 Project Cost Estimation

ANNEX -2 Tentative List of Equipment

ANNEX -3 Tentative Plan of Facility

ANNEX -4 Tentative Schedule of the Project

ANEEX-1 Project Cost Estimation

(1) Costs to be borne by the Japanese Side

This Part is closed due to the confidenciality.

(2) Costs to be borne by the Cambodian Side

| Item | Estimated cost | |
|---|---|---|
| | (thousands USD) | (million JPY) |
| [4] Banking Arrangement | 7.4 | 0.6 |
| [6] Removal of the existing structures and cables within the site | 6.2 | 0.5 |
| [14]-[16] Extension of services to the building and connecting | 12.4 | 1.0 |
| [17] Other necessary preparation to start of the use | 12.4 | 1.0 |
| [18] Building the communication system and installing on the building | 12.4 | 1.0 |
| Total | 50.9 | 4.1 |

(3) Conditions for Estimate

1) Time of Estimation : October 2012
2) Exchange Rate : 1USD = 80.40 JPY
3) Implementation Period : Approx.20 months
4) Other Conditions : Project implementation intended to be in compliance with the Japan's Grant Aid scheme

Obligations of Recipient Country

| item | responsible organization | target time |
|---|---|---|
| [1] Exchange of Note | MOFAIC | (within 1 month after Cabinet Approval) |
| [2] Grant Agreement | MOEF | ditto |
| [3] Consultancy Agreement | ITC, MOEYS | within 2 weeks after [2] |
| [4] Banking Arrangement | MOEF | within 2 weeks after [3] |
| [5] Issuance of Authorization to Pay | ITC | within 2 weeks after [3] |
| [6] Removal of the existing structures and underground cable and pipes within the construction site | ITC | before the notification of the tender |
| [7] Approval of tender documents | ITC, MOEYS | after completion of tender docs. |
| [8] Acquisition of building permit | ITC, MOEYS | before the notification of the tender |
| [9] Notice of Commencement of Work | ITC, MOEYS | within 2 weeks after conclusion of contract |
| [10] Approval of Master list for exempted items | ITC, MOEYS, MOEF and CDC | within 1 month after submission of list |
| [11] Exemption of duties and VAT | ITC, MOEYS | timely upon the request from the Contractor |
| [12] Support to the contractors for unloading and custom clearance | ITC, MOEYS | ditto |
| [13] Support to obtain permits for Japanese nationals and nationals of third countries who work for this Project to stay and work | ITC, MOEYS | ditto |
| [14] Extension of power cable and connect to the distribution board of the building | ITC | three months before the completion |
| [15] Extension of water pipe and installation of valve | ITC | three months before the completion |
| [16] Extension of black wastewater drainage pipe and installation of underground pit for connection | ITC | three months before the completion |
| [17] Other necessary preparation to start of the use of the equipment and building | ITC | After the handover of the building |
| [18] Building the communication system and installing on the building | ITC | ditto |
| [19] Budgeting of necessary expense and assignment of personnel for operation of the equipment and the building to be procured on this Project. | ITC | ditto |

ANNEX-2

# Tentative List of Equipment

| No. | Code No. | Name of Equipment | Q'ty |
|---|---|---|---|
| 1 | EE-02 | Optical Comunication Training Set | 2 |
| 2 | EE-03 | Optical Splicer | 1 |
| 3 | NREL-01 | Universal Relay Trainer | 1 |
| 4 | NREL-02 | Deferential Relay Trainer | 1 |
| 5 | NREL-03 | Frequency Relay Trainer | 1 |
| 6 | NREL-06 | PSCAD | 1 |
| 7 | NREL-07 | Solar Panel | 20 |
| 8 | NREL-08 | Pyranometer | 1 |
| 9 | NREL-09 | Solar Reference Cell | 1 |
| 10 | NREL-10 | Photovoltaic Inverter Set | 1 |
| 11 | NREL-12 | Programmable Electronic Load | 1 |
| 12 | NREL-13 | Electrical Network Analyzer | 1 |
| 13 | NREL-14 | Power Quality Analyzer | 1 |
| 14 | NREL-15 | Electrical Safety Checker | 1 |
| 15 | NREL-16 | Clamp Wattmeter | 2 |
| 16 | NREL-17 | Portable Multimeter | 2 |
| 17 | NREL-18 | Clamp Measurement of Earth and Leakage Current | 1 |
| 18 | NREL-19 | Multifunction HVAC and IAQ Meter | 1 |
| 19 | NREL-20 | Temperature/Humidity Tester | 1 |
| 20 | NREL-21 | Laptop PC | 1 |
| 21 | NREL-22 | Desktop PC | 2 |
| 22 | CAL-01 | Building Management System & Energy Audit tool | 1 |
| 23 | CAL-02 | PC set | 1 |
| 24 | CAL-03 | Data Acquisition set for Control System Lab. | 1 |
| 25 | CAL-04 | Research Oscilloscope | 1 |
| 26 | CAL-05 | Student Oscilloscope | 8 |
| 27 | CAL-06 | Mordem Control Experimental Set | 1 |
| 28 | CAL-07 | Autonomous Mobile Robot for Teaching | 5 |
| 29 | CAL-08 | 2 DOF Planar Robot | 1 |
| 30 | CAL-09 | Autonomous Robot | 1 |
| 31 | CAL-10 | Humanoid Robot | 1 |
| 32 | CAL-11 | Quadrotor for Indoor Unmanned Aerial Vehicle | 1 |
| 33 | CAL-12 | Control System Production Kit & Small Mobile Robot Experimental Kit | 1 |
| 34 | CAL-13 | Lathe Machine | 1 |
| 35 | CAL-14 | Milling Machine | 1 |
| 36 | CAL-15 | Drilling Machine | 1 |
| 37 | CAL-16 | Tooling Machine Set | 1 |
| 38 | CAL-18 | Automation Control Kit Lab | 1 |
| 39 | CAL-19 | Mechatronic Control Kits | 1 |
| 40 | CAL-20 | Hydraulic Training Systems | 1 |
| 41 | IEL-02 | PCB Making Machine & 5 Extra Tool Set | 1 |
| 42 | IEL-03 | CNC Laser Cutting Machine | 1 |
| 43 | IEL-04 | Microprocessor Experimental Set | 1 |
| 44 | IEL-05 | Network Development Kit | 5 |
| 45 | IEL-06 | Development Board for Open Source OS | 1 |
| 46 | IEL-07 | Workshop Tool Set | 1 |
| 47 | GIM-01 | Torsion Testing Machine | 1 |
| 48 | GIM-03 | Centrifugal Pump Module | 1 |
| 49 | GIM-04 | Two-stage Pumps | 1 |
| 50 | GIM-06 | Environmental Applications Learning System | 1 |
| 51 | GIM-07 | Refrigerant & Combustible Gas Leak Detector | 1 |
| 52 | GIM-08 | IEQ Checker | 1 |
| 53 | GIM-09 | Infrared Thermometer | 5 |
| 54 | GIM-10 | Diagnostic Refrigerant Analyzer | 1 |
| 55 | GIM-11 | Recovery Machine | 1 |
| 56 | GIM-12 | Air Velocity Meter | 2 |
| 57 | GIM-13 | Precision Balance A | 1 |
| 58 | GIM-14 | Precision Balance B | 1 |
| 59 | GIM-15 | Heating/Refrigerated Circulator | 1 |
| 60 | GIM-16 | Fuel Analyzer | 1 |
| 61 | GIM-18 | Machine Tool Set | 1 |
| 62 | GIM-19 | Desktop PC | 4 |
| 63 | GIM-21 | Laptop PC | 4 |
| 64 | GIM-22 | Color Laser Printer | 1 |

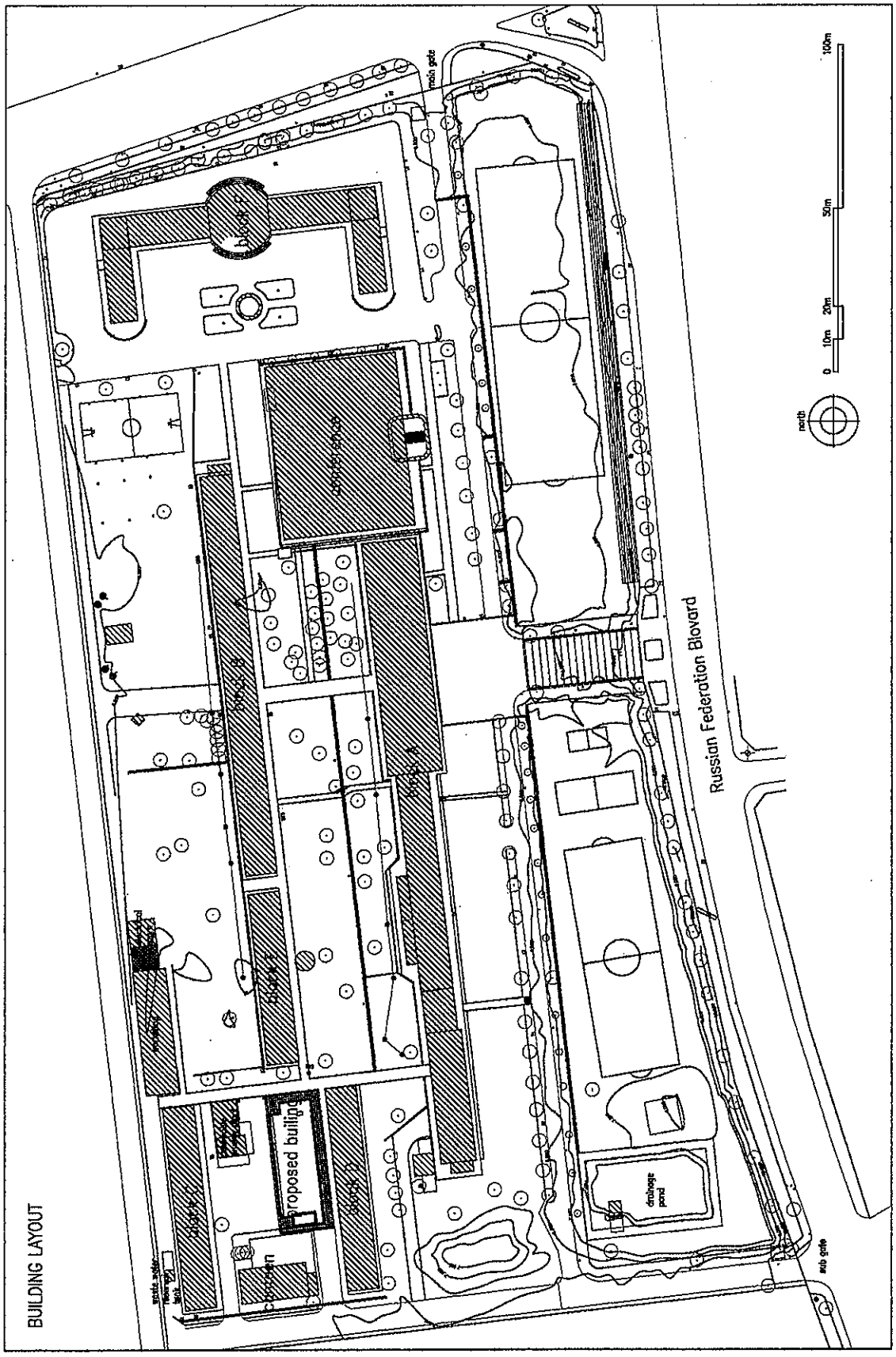
| No. | Code No. | Name of Equipment | Q'ty |
|---|---|---|---|
| 65 | GIM-23 | Monochrome Laser Printer | 2 |
| 66 | GIM-24 | Titrator | 1 |
| 67 | GIM-25 | Flash Point Tester | 1 |
| 68 | GIM-26 | Cloud Point and Pour Point Tester | 1 |
| 69 | GIM-27 | Oxidation Stability Testing Machine | 1 |
| 70 | GGG-01 | X-ray Fluorescence (XRF) | 1 |
| 71 | GGG-02 | Trinocular Optical Polarizing Microscope | 2 |
| 72 | GGG-03 | Heating/Freezing Stage Apparatus | 1 |
| 73 | GGG-04 | Total Station | 5 |
| 74 | GGG-05 | Hand Auger Equipment | 2 |
| 75 | GGG-06 | Automatic Polishing Machine for Thin Section | 1 |
| 76 | GGG-07 | Electric Furnace | 1 |
| 77 | GGG-08 | Precision Electric Balance | 1 |
| 78 | GGG-09 | Electrical Oven | 1 |
| 79 | GGG-10 | Agate Mortar, small size | 3 |
| 80 | GGG-11 | Agate Mortar, large size | 3 |
| 81 | GGG-12 | Magnetometer | 1 |
| 82 | GGG-13 | Floor Stand Manual Drill Press | 1 |
| 83 | GGG-14 | Instructional Gas Permeameter | 1 |
| 84 | GGG-15 | Instructional Helium Porosimeter | 1 |
| 85 | GGG-16 | Instructional Gravimetric Capillary Pressure System | 1 |
| 86 | GGG-17 | Bench Top Liquid Permeability Measurement System | 1 |
| 87 | GGG-18 | Micro-Deval Apparatus | 1 |
| 88 | GGG-19 | Unconfined Compression Tester | 5 |
| 89 | GGG-20 | Hydrometer Analyser | 1 |
| 90 | GGG-21 | Liquid Limit Apparatus | 5 |
| 91 | GGG-22 | Plotter | 1 |
| 92 | GGG-23 | Desktop PC Set | 1 |
| 93 | GGG-24 | Laptop PC | 2 |
| 94 | GCI-01 | Direct Shear Test Apparatus | 1 |
| 95 | GCI-02 | CBR Test Apparatus | 1 |
| 96 | GCI-03 | Plate Test Apparatus | 1 |
| 97 | GCI-04 | Ductility Test Apparatus | 1 |
| 98 | GCI-05 | Triaxial Test Apparatus | 1 |
| 99 | GCA-01 | Microwave Digestion Apparatus | 1 |
| 100 | GCA-02 | HPLC System | 1 |
| 101 | GCA-03 | Smasher for Sample Preparation in Microbiology | 1 |
| 102 | GCA-04 | Filter Press | 1 |
| 103 | GCA-05 | Press Hydrolic | 1 |
| 104 | GCA-06 | Laboratory Juicer | 1 |
| 105 | GCA-07 | Filling Machine | 1 |
| 106 | GCA-08 | Freezer | 1 |
| 107 | GCA-09 | Ion Chromatography | 1 |
| 108 | GCA-10 | Gas Chromatograph Mass Spectrometer (GCMS) | 1 |
| 109 | GCA-11 | Viscosimeter | 1 |
| 110 | GCA-12 | Bioreactor | 1 |
| 111 | GCA-13 | Biogas Analyzer | 1 |
| 112 | GIC-01 | Equipment for Computer Networking Lab | 1 |
| 113 | GIC-02 | Equipment for Android Mobile Application Development Lab | 1 |
| 114 | GIC-03 | Equipment for iOS Mobile Application Development Lab | 1 |
| 115 | GIC-04 | Equipment for Multipurpose Development Lab | 1 |
| 116 | FDY-01 | Equipment for Computer Lab | 1 |
| 117 | FDY-02 | Experimental Kit for Physics | 5 |
| 118 | FDY-03 | Ballistic Pendulum Apparatus | 5 |
| 119 | FDY-04 | Experimental Kit for Hook's Law | 5 |
| 120 | FDY-05 | Inclined Plane Apparatus | 5 |
| 121 | FDY-06 | Air Track Complete Set | 5 |
| 122 | FDY-07 | Free Fall Apparatus | 5 |
| 123 | FDY-08 | Gyroscope | 5 |
| 124 | FDY-09 | Oscillation of Simple Pendulum Apparatus | 5 |
| 125 | FDY-10 | Circuit Experimental Set | 5 |
| 126 | FDY-13 | Boyle's Gas Law Apparatus | 5 |
| 127 | FDY-14 | Photocopier | 2 |

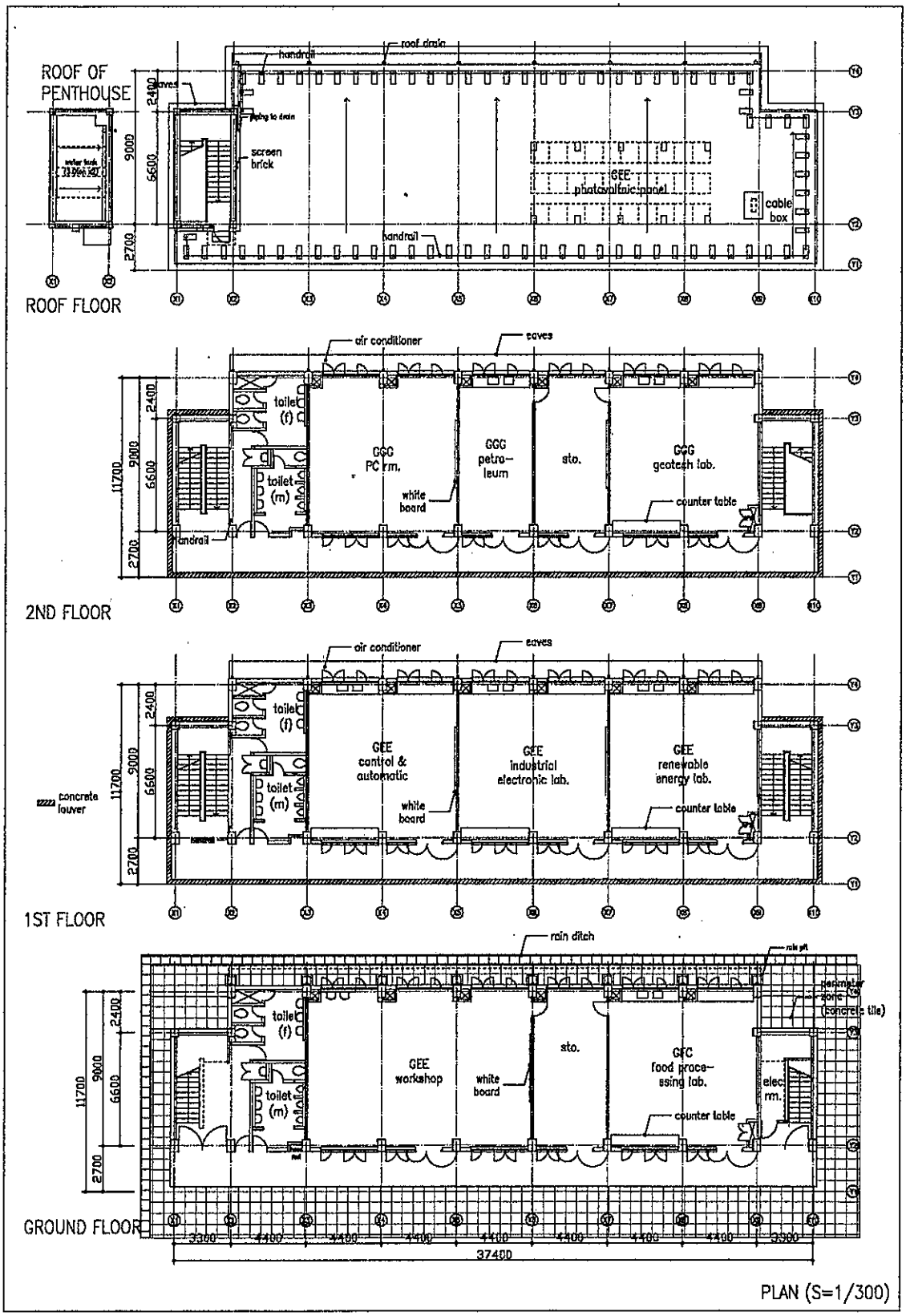
ANNEX-3 Components of Facility

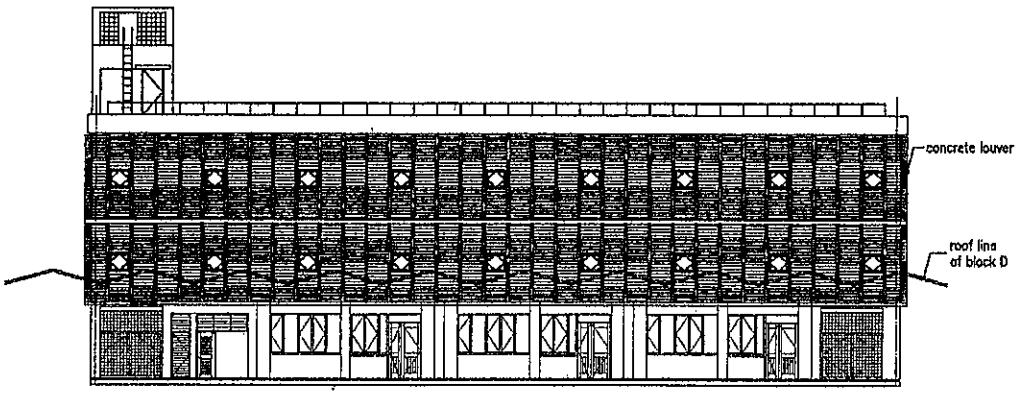
| Name of Room |
|---|
| -Control & Automation Laboratory of GEE |
| - Workshop of GEE |
| - Power System Laboratory of GEE |
| - Industrial Electronic Laboratory of GEE |
| - Food Processing Laboratory of GCA |
| - Geotechnology Laboratory of GGG |
| - Petroleum Laboratory of GGG |
| - PC Room of GGG |
| - Storage, Toilets |
| - Power supply, light fixture, water supply, drainage, ventilation & air-conditioning within the building |

GGG=Génie géoressources et géotechnique
GEE=Génie électrique et énergétique
GCA=Génie chimique et alimentaire

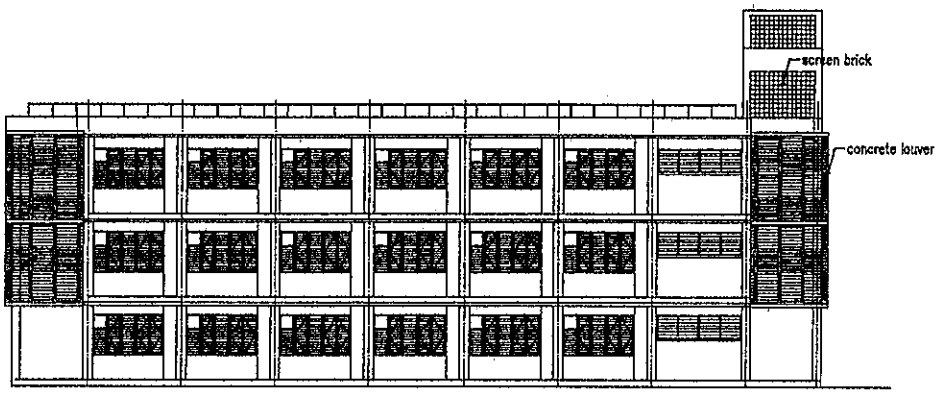
Outline Design Drawing



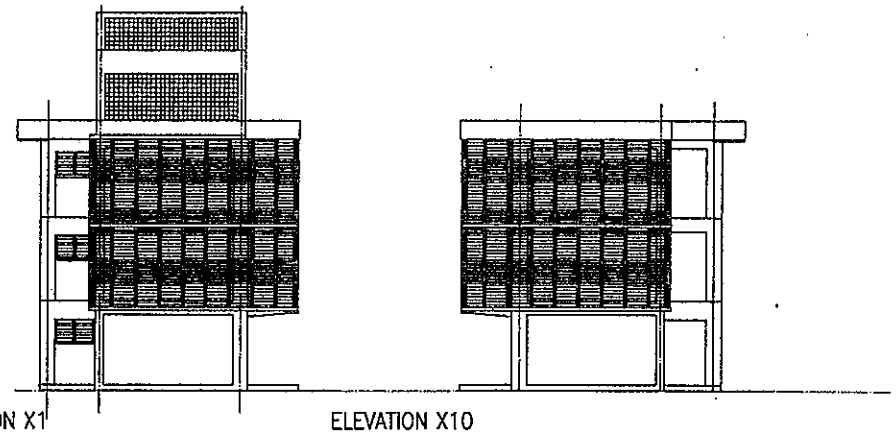

ROOF OF PENTHOUSE
handrail
roof drain
eaves
piping to drain
screen brick
water tank
GEE photovoltaic panel
cable box
handrail
ROOF FLOOR
air conditioner
eaves
toilet (f)
toilet (m)
GGG PC rm.
GGG petro-leum
sto.
GGG geotech lab.
white board
counter table
handrail
2ND FLOOR
air conditioner
eaves
toilet (f)
toilet (m)
GEE control & automatic
GEE industrial electronic lab.
GEE renewable energy lab.
white board
counter table
concrete louver
1ST FLOOR
rain ditch
rain pit
toilet (f)
toilet (m)
GEE workshop
white board
sto.
GFC food proce-ssing lab.
elec. rm.
counter table
ceramic tile zone (concrete tile)
GROUND FLOOR
3300
4400
4400
4400
4400
4400
4400
4400
3300
37400
PLAN (S=1/300)




ELEVATION Y1



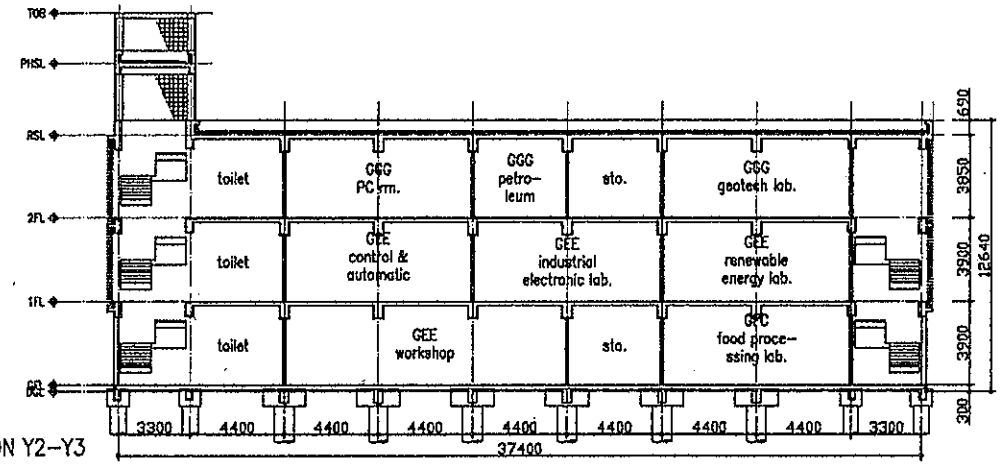

ELEVATION Y4



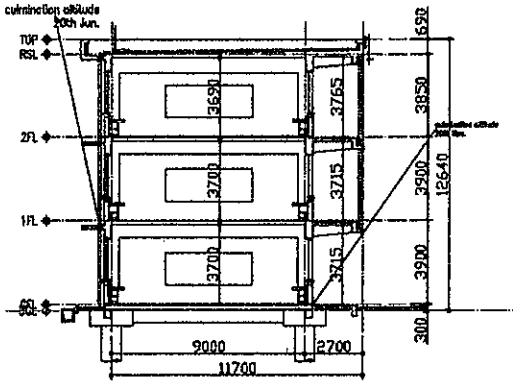
ELEVATION X1

ELEVATION X10

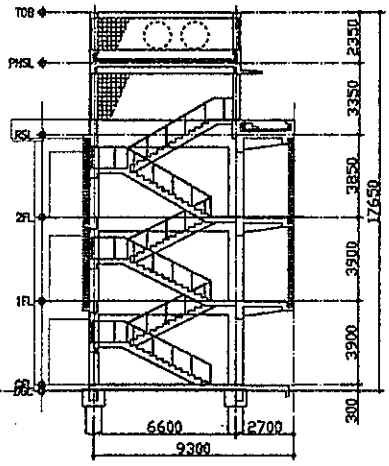
ELEVATION (S=1/300)




SECTION Y2–Y3




SECTION X4–8




SECTION X4–8

SECTION (S=1/300)



9.7

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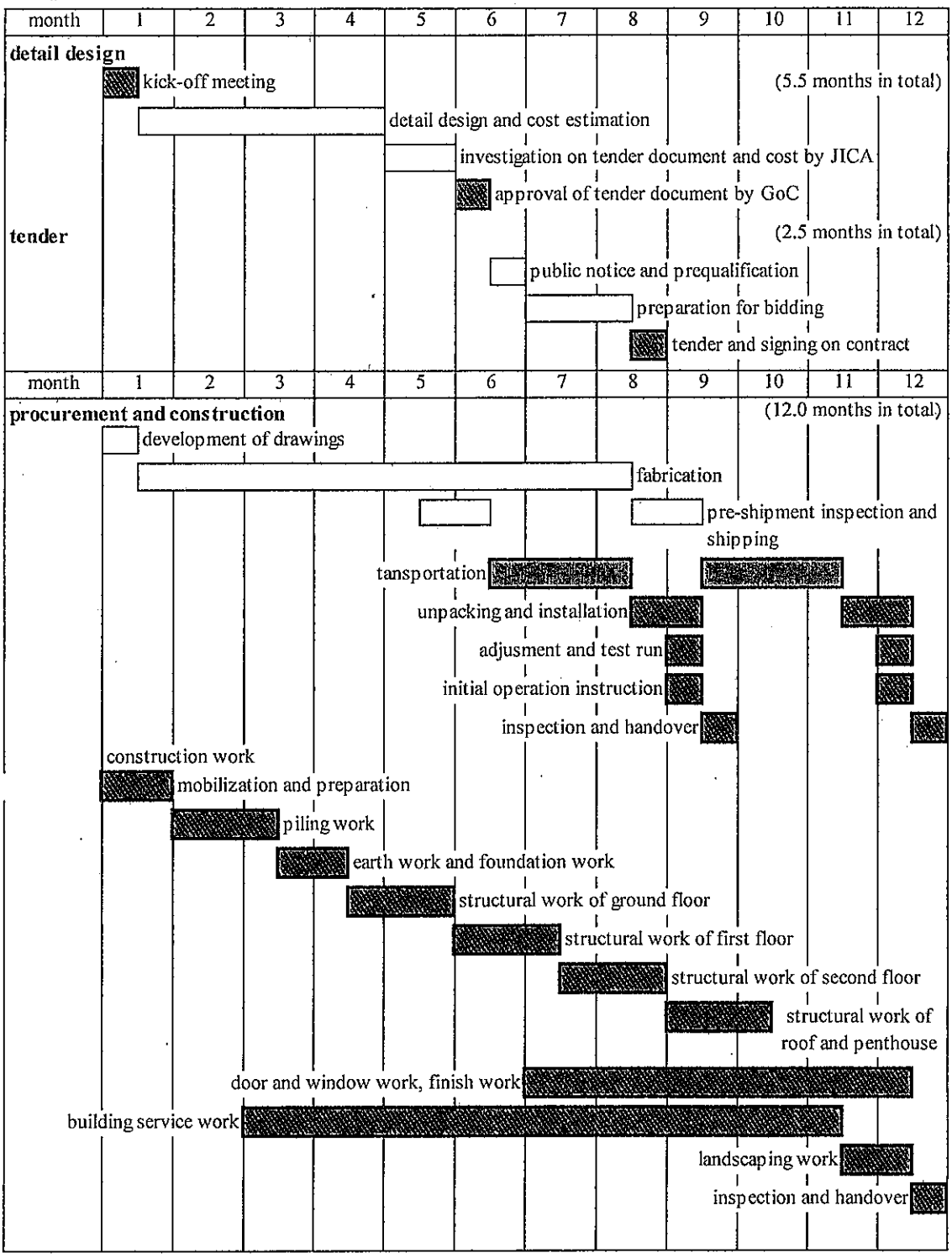
ANNEX-4 Tentative Schedule of the Project

The implementation schedule of the Project consists of detail design stage, tender stage and procurement and construction stage.

The table below shows the processes in the Project after the conclusion of E/N to the completion.



## Appendix 5 Other Relevant Data

| No | Name of Document | Type | Original Copy | Issued by | Date |
|---|---|---|---|---|---|
| 1 | Education Staff Indicators 2010-11 | Book | Copy | MoEYS | 2011 |
| 2 | Education Staff Statistics by Current Status, Cadre, Qualification and Age Group 2010-11 | Book | Copy | MoEYS | 2011 |
| 3 | Education Statistics & Indicators 2010-11 | Book | Copy | MoEYS | 2011 |
| 4 | Education Statistics & Indicators 2011-12 | Book | Copy | MoEYS | 2012 |
| 5 | Education Strategic Plan 2009-13 | Book | Copy | MoEYS | 2010 |
| 6 | Master Plan for Research Development in the Education Sector 2011-15 | Book | Copy | MoEYS | 2011 |
| 7 | Policy on Research Development in the Education Sector | Book | Copy | MoEYS | 2010 |
| 8 | General Population Census 2008 | Book | Copy | MoP/NIS | 2008 |
| 9 | Summary report on the education, youth and sport performance in the academic year 2009-2010 and the academic year 2010-2011 goals | Book | Copy | MoEYS | 2011 |
| 10 | Education Congress Report on the Education, Youth and Sport Performance in the Academic Year 2009-2010 and the Academic year 2010-2011 goals | Book | Copy | MoEYS | 2011 |
| 11 | National Strategic Development Plan update 2009-2013 | Book | Copy | GoC | 2010 |
| 12 | The rectangular Strategy for Growth, Employment, Equity and Efficiency in Cambodia | Book | Copy | GoC | 2004 |
| 13 | “Rectangular Strategy” for Growth, Employment, Equity and Efficiency in Cambodia Phase II | Book | Copy | GoC | 2008 |
| 14 | Higher Education in South-East Asia | Book | Copy | UNESCO | 2006 |

| | | | | | |
|---|---|---|---|---|---|
| 15 | Labour and Social Trends in Cambodia 2010 | Book | Copy | ILO | 2010 |
| 16 | Human Capital Implications of Future Economic Growth in Cambodia | Book | Copy | UNDP | 2011 |
| 17 | Project appraisal document for Higher Education Quality and Capacity Improvement Project | Book | Copy | WB | 2010 |
| 18 | Assistance for Japanese Enterprises by JETRO and JBAC | Presentation Document | Copy | JETRO Phnom Penh | 2012 |
| 19 | Investment Guide/Cambodia | Book | Copy | CDC | 2012 |
| 20 | ITC Academic Calendar 2012/2013 | Leaflet | Copy | ITC | 2012 |

# SOIL TESTING LABORATORY

## REPORT

## ON GEOLOGYCAL INVESTIGATION

Project: **THE DEVELOPMENT OF HUMAN RESOURCES AND LABORATORY EQUIPMENT IN THE ITC**

Located: **PHNOM PENH CITY**

**November-2012**

**Prepared by:**

**S.O.M CORPORATION., LTD**

**Address: #15 A, St 47, Sangkat Sras Chark, Khan Daun Penh,**

**Phnom Penh, Cambodia**

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2.1 General
2.2 Boring testing and sampling
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Particle size distribution charts
Determination liquid & Plastic limit charts
Unconfined compression test charts

# 1. INTRODUCTION

The site to construct new building at Institute of technology of Cambodia, Sangkhat Buengkok, Khan Toulkork, Phnom Penh, Kingdom of Cambodia.

The soil testing Analysis Laboratory Office was request to carry out geotechnical soil investigation using by rotary auger machine Standard Penetration Test (SPT).

Fieldwork was carried out on October 8 to November 2, 2012, finishing prepared this report presents the results of soil investigation, including interpretation of ground condition.

To design a foundation that will support a structure. An engineer must understand the types of soil deposits that the support foundation. Moreover foundation engineers must remember that soil investigation at any site frequently is non-homogeneous that is the soil profile may vary. Soil mechanics theories involve idealized condition, so the application of the theories to foundation engineering problem involves a judicious evaluation of site condition and soil parameters.

## 2. FIELD WORKS

### 2.1 General

A position of borehole and in–situ tests were carried out on the site are shown on the location plan Figure No.1

### 2.2. Boring, Testing and sampling

One borehole is BH No.1, with Standard Penetration Test, nominal diameter 170mm, carried out by Machine model (IVECO-Germany) rotary auger methods. It is top-drive (hydraulically–driven) drill, powered by the diesel engine. The drilling is the mounted on single –axle trailer with alive-actual drum parking brake. SPT tests were carried out inside of the cylinder hole. During the flights of the augers, bring the sampling of soil from the bottom of the hole .

- Undisturbed samples were taken from the borehole by the thin wall tube sampler or the coring –barrel sampler.
- Disturbed samples were taken from the borehole by the standard split spoon tube sampler.

### 2.3. Standard Penetration Test (SPT)

The standard penetration test Twentieth Edition 2000, AASHTO-T206 or ASTM-D1586 seeing 631- 632 pages of Standard Specifications for Transportations Materials and Methods of Sampling and Testing was developed and it is the most popular field test. The SPT is performed by driving a standard split spoon tube has an inside diameter of 34.93mm and an outside diameter of 50.80mm, sampler into the ground by blows an automatic drops hammer of mass 63.5 kg falling freely constancy the hammer drops a height distance of 760 mm. The sampler is driven into the soil by hammer blows to the top of drill rod at the bottom of a borehole, and the number of blows required for spoon penetration of three 150mm intervals total 450mm is recorded. The number of blows required for the last two intervals are drive an additional 300 mm is counted (N) value. The number of blows (N) is called the standard penetration number. The N value is used to estimate the relative density, friction angle. The test is very simple; the results are difficult to interpret. The SPT tests were executed in accordance with ASTM standard. The borehole was drilled maximum to 8.00m depth. Boring and sampling were finished into the soil layer is encountered layer very dense.

## 3. LABORATORY TESTING

Testing of samples were carried out at the soil laboratory of the Soil Quality Testing Office, Phnom Penh. Test procedures for sampling two types of soil sample can be obtained during subsurface exploration disturbed and undisturbed, sampling can generally be used for following physics-mechanical tests were carried out in the laboratory test accordance with **ASTM** Standard in order to determination the characteristics of the soil:

- Natural moisture content
- Determination of atterberg, Liquid and plastic limit tests (ASTM Test Designation D-4318)
- Determination of Particle–size distribution (Sieve ASTM standard, Hydrometer Test ASTM Designation D-422)
- Wet unit weight and dry unit weight density
  void ratio and porosity
- Specific gravity of soil solids Gs (ASTM D-854)
- Classification of soil (ASTM reference to USCS standard)
- Unconfined compressive test (ASTM Test Designation D-2166)
- Direct shear test (ASTM D-3080)

## 4. GEOTECHNICAL CHARACTERISTICS OF SOIL

### 4.1. General

Ground conditions at the site consist of generally as following 4.2

## 4.2. DESCRIPTION OF SOIL STRATA

According to the soil investigated data from boring at the site and the soil condition can be divided into 2 layers as follows:

BOREHOLE BHNO.1 GROUND ELEVATION

| No. Layer | Thickness of deposit (m) | Depth of Boring (m) | Description of Strata | SPT Resistance **(Blows / 300 mm)** |
|---|---|---|---|---|
| 1 | 3.10m | From 0 to 3.10m | medium stiff brown light gray lean and fat clay with some sand [CL]&[CH] | 6<br>8<br>7<br>10 |
| 2 | 3.00m | From 3.10m to 6.10m | stiff to very stiff gray brown lean clay and fat clay with some sand [CL] | 14<br>20<br>19<br>20<br>22 |
| 3 | 2.00m | From 6.10 to 8.10m | stiff dark brown fat clay and lean clay with some gravel blows [CL] | 17<br>13<br>14 |
| 4 | 3.00m | From 8.10 to 11.10m | medium dense light yellow gray lean clayey sand with gravel [CL] | 24<br>21<br>42<br>16<br>20<br>21 |
| 5 | 4.30m | From 11.10 to 15.40m | medium dense to very dense light yellow gray lean clayey sand with gravel [CL] | 29<br>67<br>37<br>61 rest of 38cm<br>61 rest of 44cm<br>61 |
| 6 | 4.60m | From 15.40 to 20.00m | medium dense to very dense light gray sandy lean clay with some gravel [CL] | 37<br>45<br>53<br>52<br>59 rest of 8cm<br>60<br>61<br>52<br>51 |

## 5- GROUNDWATER TABLE

Groundwater table was'nt encountered water inflow level in hole all deposit of layers in rainy season . No groundwater table in borehole of 20m depth.

## 6. ENGINEERING CONSIDERATION

Relevant design parameters for each stratum assessed on the basis of in-situ and laboratory test results, are presented as summary table of tests.
Number detailed design information on the proposed structure, and therefore the following remarks are of general nature only.
Design of foundation will depend on consideration of the structure.
Ground conditions of the upper stratum are good ground with regard to very good the foundation for construction. Careful design of foundation will be necessary. In order to constructing the needed stable foundation of the building, It would be necessary to pile deep for foundation to different layers of the ground.

- Ground condition for BH No.1 at the upper strata from 0 to 3.10mm below ground level to have a thickness 3.10m, SPT tested 6, 8, 7, 10 blows per 300mm of medium stiff brown light gray lean and fat clay with some sand of deposit layer.
- From 3.10m to 6.10m below ground level to have a thickness 3.00m, SPT tested 14, 20, 19, 20, 22 blows per 300mm of stiff to very stiff gray brown lean clay and fat clay with some sand of deposit layer.
- From 6.10m to 8.10m below ground level to have a thickness 2.00m, SPT tested 17, 13, 14 per 300mm of stiff dark brown fat clay and lean clay with some gravel blows of deposit layer.
- From 8.10m to 11.10mbelow ground level to have a thickness 3.00m, SPT tested 24, 21, 42, 16, 20, 21 per 300mm of medium dense light yellow gray lean clayey sand with gravel of deposit layer.
- From 11.05m to 15.55m below ground level to have a thickness 4.30m, SPT tested 29, 67, 37, 61, 61, 61, 37 per 300mm of medium dense to very dense light yellow gray lean clayey sand with gravel of deposit layer.
- From 15.30m to 20.00m below ground level to have a thickness 4.60m, SPT tested 45, 53, 52, 59, 60, 61, 52, 51 per 300mm of medium dense to very dense light gray sandy lean clay with some gravel of deposit layer.

## 4.2. DESCRIPTION OF SOIL STRATA

According to the soil investigated data from boring at the site and the soil condition can be divided into 6 layers as follows:

BOREHOLE BHNO.2 GROUND ELEVATION

| No. Layer | Thickness of deposit (m) | Depth of Boring (m) | Description of Strata | SPT Resistance **(Blows / 300 mm)** |
|---|---|---|---|---|
| 1 | 2.70m | From 0 to 2.70m | soft to stiff light gray lean & fat clay with sand[CL]& [CH] | 4<br>5<br>7<br>9 |
| 2 | 3.40m | From 2.70m to 6.10m | stiff light gray lean & fat clay with sand [CL]&[CH] | 14<br>12<br>19<br>19<br>15 |
| 3 | 2.60m | From 6.10 to 8.70m | stiff light gray brown lean & fat clay with sand [CL]&[CH] | 12<br>17<br>15<br>14 |
| 4 | 2.90m | From 8.70 to 11.60m | medium dense yellow light gray with some gravel [SC] | 12<br>20<br>21<br>23<br>19 |
| 5 | 4.50m | From 11.60 to 16.10m | dense to medium dense light yellow gray clayey sand with some gravel [SC] | 45<br>25<br>44<br>33<br>23<br>32<br>35 |
| 6 | 3.90m | From 16.10 to 20.00m | very dense yellow light gray sand with some gravel [SC] | 51 rest of 15cm<br>47<br>54 rest of 7cm<br>57<br>56<br>59<br>54<br>54 |

## 5. ENGINEERING CONSIDERATION

Relevant design parameters for each stratum assessed on the basis of in-situ and laboratory test results, are presented as summary table of tests.
Number detailed design information on the proposed structure, and therefore the following remarks are of general nature only.
Design of foundation will depend on consideration of the structure.
Ground conditions of the upper stratum are good ground with regard to very good the foundation for construction. Careful design of foundation will be necessary. In order to constructing the needed stable foundation of the building, It would be necessary to pile deep for foundation to different layers of the ground.

- Ground condition for BH No.2 at the upper strata from 0 to 2.70mm below ground level to have a thickness 2.70m, SPT tested 4, 5, 7 & 9 blows per 300mm of soft to stiff light gray lean & fat clay with sand of deposit layer.
- From 2.70m to 6.10m below ground level to have a thickness 3.40m, SPT tested 14, 12, 19,19 & 15 blows per 300mm of stiff light gray clayey sand of deposit layer.
- From 6.10m to 8.10m below ground level to have a thickness 2.60m, SPT tested 12,17, 13, and 14 per 300mm of stiff light gray brown fat clay of deposit layer.
- From 8.10m to 11.60mbelow ground level to have a thickness 2.60m, SPT tested 12, 20, 21, 23, 19 per 300mm of medium dense yellow light gray sandy lean clay with some gravel of deposit layer.
- From 11.60m to 16.10m below ground level to have a thickness 4.50m, SPT tested 45,25,44, 33, 23, 32, and 35 per 300mm of medium dense light gray clayey sand with some gravel of deposit layer.
- From 16.10m to 20.00m below ground level to have a thickness 3.90m, SPT tested 51 the rest of 15cm, 47, 54 the rest of 7cm 51,47, 54,57, 56, 59, 54, 54 per 300mm of very dense yellow light gray clayey sand with some gravel of deposit layer.

## 7- CONSISTENCY AND RELATIVE DENSITY

The relationship between Standard Penetration Test results with the consistency of clays, silty clays (cohesive soil), and the relative density of sands (non-cohesive) on the other are respectively in Table No.1

Table No.1: Relationship between SPT results and Consistency for cohesive soil (Clay, Silt, clayey-Silt, Silty-Clay)

| STP Value (blow per 300mm) | CONSISTANCY |
|---|---|
| Less than – 2 | Very soft |
| 2 – 5 | Soft |
| 5 – 10 | Medium stiff |
| 10 – 20 | Stiff |
| 20 – 30 | Very stiff |
| Over > 30 | Hard |

Table No.2: Relationship between SPT results and Relative density for cohesive less soils (Sands or Gravel)

| STP Value (blow per 300mm) | RELATIVE DENSITY |
|---|---|
| Less than – 5 | Very loose |
| 5 – 10 | Loose |
| 10 – 30 | Medium dense |
| 30 – 50 | Dense |
| Over > 50 | Very dense |

# 8 RECOMMANDATION OF PILE FOUNDATION

| Borehole BHNo. | Size of Pile (cm) | Length Of Pile (m) | Allowable Friction of Pile, [KN] Qf | Allowable End Bearing Of Pile, [KN] Qb | Allowable Load Capacity Of Pile, [Ton] Qall |
|---|---|---|---|---|---|
| 1 | 30 | 8 | 347.65 | 71.84 | 41.95 |
| | 40 | 8 | 471.28 | 165.90 | 63.72 |
| 2 | 30 | 8 | 310.27 | 67.37 | 37.76 |
| | 40 | 8 | 421.18 | 145.91 | 56.70 |

**Driven pile from surface into underground 9m depth and digging 1.50m ground.**
**Proposal mixing of concrete for piling need 30Mpa compressive strength concrete**

Phnom Penh November 2, 2012

ANGKOR CONTROLLING FOUNDATION FOR CONSTRUCTION GROUP ACFC

Manager Laboratory
Soil Mechanics and Foundations,
Civil Engineer

## SUMMARY OF LABORATORY TEST RESULTS EXSPLANATION

| | | |
|---|---|---|
| **Sample No.** | | Sample number, U-Undisturbed sample, D-disturbed sample |
| **Depth** | m | Depth of sample |
| $\omega$ | % | Natural moisture content |
| **n** | | Porosity |
| **e** | | Void ratio |
| $\rho_f$ | $T/m^3$ | Bulk density in-situ |
| $\rho_d$ | $T/m^3$ | Dry density in-situ |
| **LL** | % | Liquid Limit |
| **PL** | % | Plastic Limit |
| **Ip** | % | Plasticity Index ( LL-PL) |
| $I_L$ | % | Liquidity Index [ (w-PL)/Ip ] |
| **Soil Class** | | Soil class according to the ASTM system of Classification of soil |
| **Gravel** | % | Percentage passing in 75mm and retained on the 4.75mm size range |
| **Sand** | % | Percentage passing in 4.75mm and retained on the 0.075mm size range |
| **Silt** | % | Percentage passing of particle smaller than 0.075mm - 0.002 mm size range |
| **Clay** | % | Percentage passing of particle smaller than < 0.002 mm size range |
| **<0.425mm** | % | Percent passing 0.425 mm for Liquid limit & plasticity index of the portion soil |
| **Gs** | | Specific Gravity |
| **Mv** | $m^2/MN$ | Coeficient of volume compressibility |
| **Cv** | $m^2/year$ | Coeficient of consolidatoin |
| **K** | m/s | Coeficient of permeability determined in consolidatoin test |
| **Cu** | - | The uniformity coefficient |
| **Cc** | - | The coefficient of gradation or coefficient of curvature |
| **C** | $KN/m^2$ | Apparent cohesoin (Direct Shear test} |
| $\phi$ | °(Degree) | Angle of frictoin (Direct Shear test) |
| **S** | $T/m^3$ | Field Shear Vane Test |
| $q_u$ | Kpa | Unconfined Compressive Strength |

### Typical Liquid Limit Results

A typical plot of the results from a casagrade cup method is shown in the diagram. The abscissa (logarithm scale) is the number of blows, the ordinate (arithmetric scale) is the water content. The best fit straight line, called the liquid state line, is drawn through the data points. The liquit limit is water content at which the groove in the soil closes over a length of 12.7mm under 25 blows

### Plastic Limit

The plastic limit is found dy roller a small clay sample into thread and finding the water content at which threads approximately 3 mm diameter will start to grumble.

### Plasticity Chart

Experimental result show that clays, silts and organic soil fall into distic regions in a graph of liquid limit plasticity index.

The A-line (see graph) separate clays, which lie above the A-line, from silts and organic soils, which lie below A-line.

The chart is particularly useful in determaning whether the results of laboratory test are within the general ranger for soils.

### Description of soil based on Liquidity index:

$I_L < 0$ : Simi-solid state - high strength brittle (sudden) fracture is expacted.

$0 < I_L < 1$ Plastic state - Intermediate strength, soil deforms like a plastic material.

$I_L > 1$ : Liquid state - Low strength, soil deforms like a viscous fluid.

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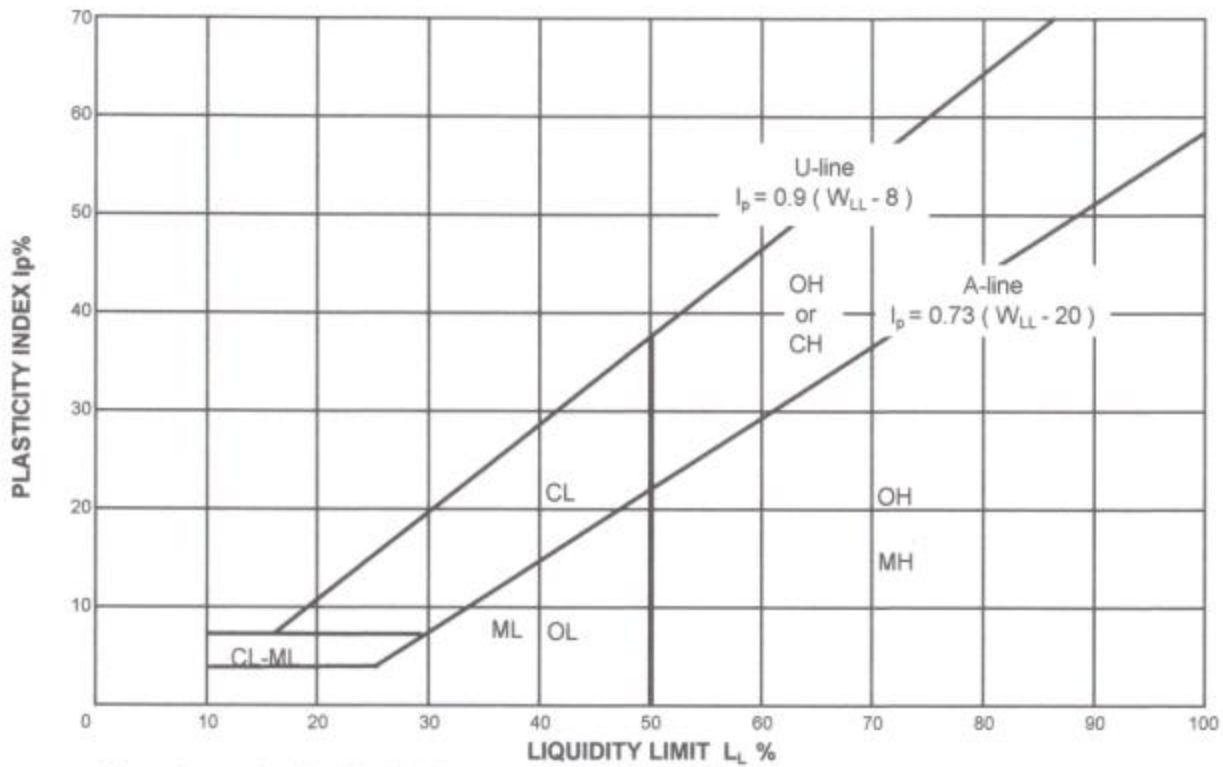
Tel : 011 704 080 & 012 971 532

L-Low plasticity ( Liquid Limit less than 50 )
H-High plasticity ( Liquid Limit more than 50 )




CL - Inorganic , LL < 50 , PI> 7
ML - Inorganic LL< 50 , PI<4
OL - Organic ( LL - Oven-dried ) / (LL - not-dried )<0.75, LL<50
CH - Inorganic LL > 50 , PI plots on or above A-line
MH - Inorgabic LL > 50 ,PI plots below A-line
OH - Organic (LL - Oven-dried) / (LL - not-dried) < 0.75 , LL>50
CL-ML- Inorganic

## PLASTICITY CHART

**Figure**

The Unified System the following symbols for identification

**Symbol and Description**

G - Gravel
S - Sand
M - Silt
C - Clay
O - Organic silts and clay
Pt - Peat and highly organic soils
H - High plasticity
L - Low plasticity
W - Well-graded
P - Poorly graded

ASTM, SOIL CLASSIFICATION SYSTEM
FOR ENGINEERING PURPOSES

CL - Low plasticity clay
ML - Low plasticity silt
OL - Low organic plasticity silt
CH - Hihg plasticity clay
MH - High plasticity silt
OH - High oganic plasticity clay

**Unified Soil Classification Chart (after ASTM, 2000)**

| Criteria for Assinging Group Symbols and Group Names Using Laboratory Tests[a] | | | | | Group Symbol | Group Name[b] |
|---|---|---|---|---|---|---|
| **Coarse-grained soils** More than 50% retained on No.200 sieve | **Gravels** More than 50% of coarse fraction retained on No.4 sieve | Clean Cravels | $C_u \geq 4$ and $1 \leq C_c \leq 3^e$ | | GW | Well-graded gravel[f] |
| | | Less than 5% fines[c] | $C_u < 4$ and/or1 $> C_c > 3^e$ | | GP | Poorly graded gravel[f] |
| | | Gravels with Fines | Fines classify as ML or MH | | GM | Silty gravel [f,g,h] |
| | | More than 12% fines[c] | Fines classify as CL or CH | | GC | Clayey gravel [f,g,h] |
| | **Sands** 50% or more of coarse Fraction passes No.4 seive | Clean Sands | $C_u \geq 6$ and $1 \leq C_c \leq 3^e$ | | SW | Well-graded sand[i] |
| | | Less than 5% Fines[d] | $C_u < 6$ and/or1 $> C_c > 3^e$ | | SP | Poorly graded sand[i] |
| | | Sands with fines | Fines classify as ML or MH | | SM | Silty sand [g,h,i] |
| | | More than 12% fines[d] | Fines classify as CL or CH | | SC | Clayey sand[i] |
| **Fine-grained soils** 50% or more passes the No.200 seive | **Silts and Clays** Liquid limit less than 50 | inorganic | PI>7 and plots on or above "A" line[j] | | CL | Lean clay[k,l,m] |
| | | | PI<4 or plots on or below "A" line[j] | | ML | Silt[k,l,m] |
| | | organic | Liquid limit - oven dried / Liquid limit - not dried | <0.75 | OL | Organic clay [k,l,m,n] / Organic silt [k,l,m,o] |
| | **Silts and Clays** Liquid limit 50 or more | inorganic | PI plots on or above"A" line | | CH | Fat clay [k,l,m] |
| | | | PI plots below "A" line | | MH | Elatic silt [k,l,m] |
| | | organic | Liquid limit - oven dried / Liquid limit - not dried | <0.75 | OH | Organic clay[l,m,p] / Organic silt [k,l,m,q] |
| **Highly organic soils** | | Premarily organic matter, dark in color, and organic oder | | | PT | Peat |

[a] Based on the material passing the 75-mm.(3-in)sieve

[b] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both"to group name

[c] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt; GW-GM well-graded gravel with clay; GP-GM poorly graded gravel with silt; GP-GC poorly graded gravel with clay

[d]Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt; SW-SC well graded sand with clay: SP-SM poorly graded sand with silt; SP-SC poorly graded sand with clay

[e] $C_u = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[f]If soil contains ≥15% sand, add "with sand" to group name

[g]If fines classify as CL-ML, use dual symbol GC-GM or SC-SM

[h]If fine are organic, add "with organic fines"group name

[i]If soil contains ≥ 15% gracvel, add "with gravel" to group name

[j]If Atterg limits plot in hatched are, soil is a CL-ML, silty clay

[k]If soil contains 15 to 29% plus No.200, and "with sand "or "with gravel,"whichever is predominant

[l]If soil contains ≥ 30% plus No.200 predominantly sand, add "sandy " to group name.

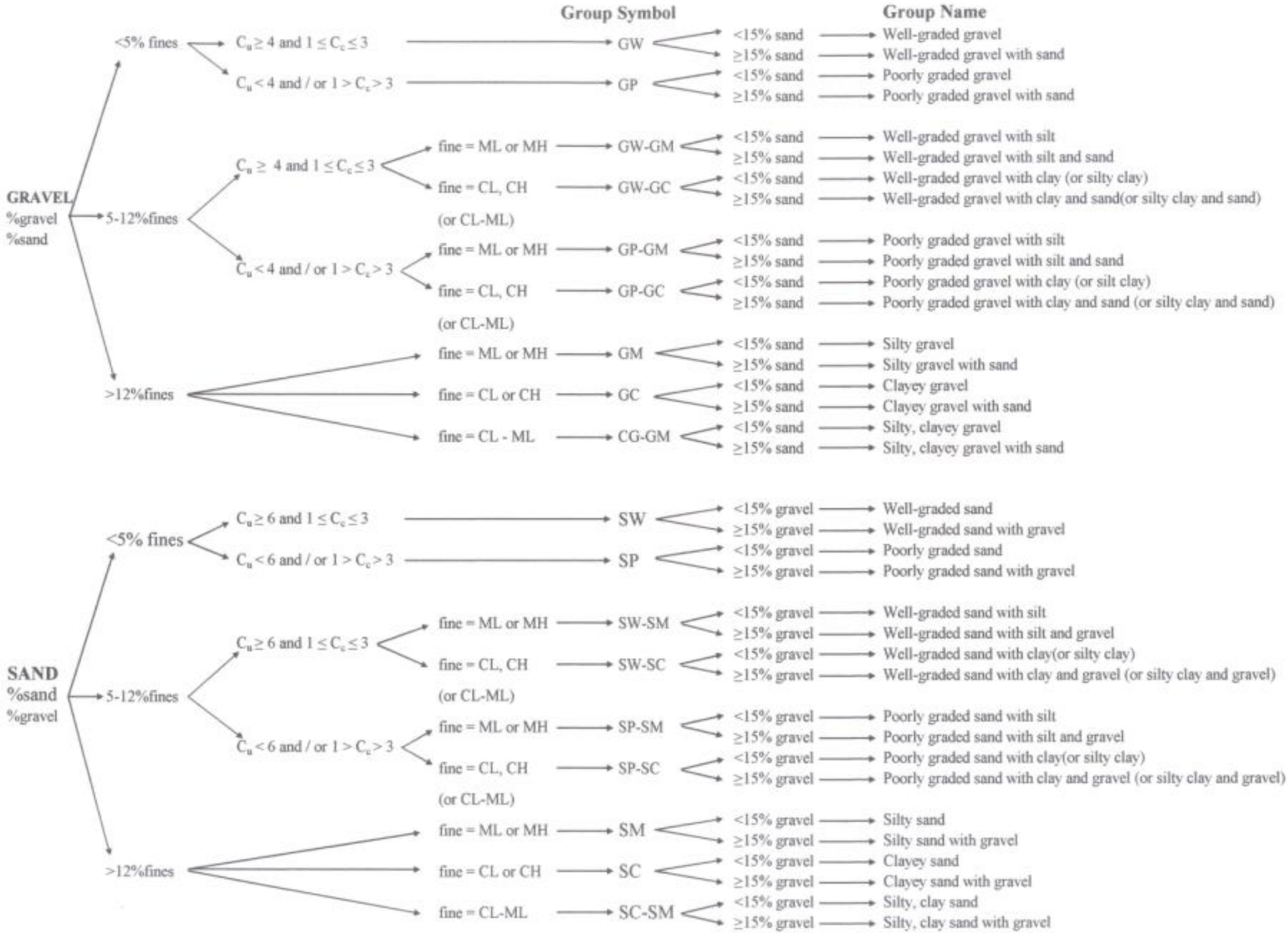
[m]If soil contains ≥ 30% plus No.200 predominantly gravel, add "gravelly" to group name

[n]PI ≥ 4 and plots on or above "A" line

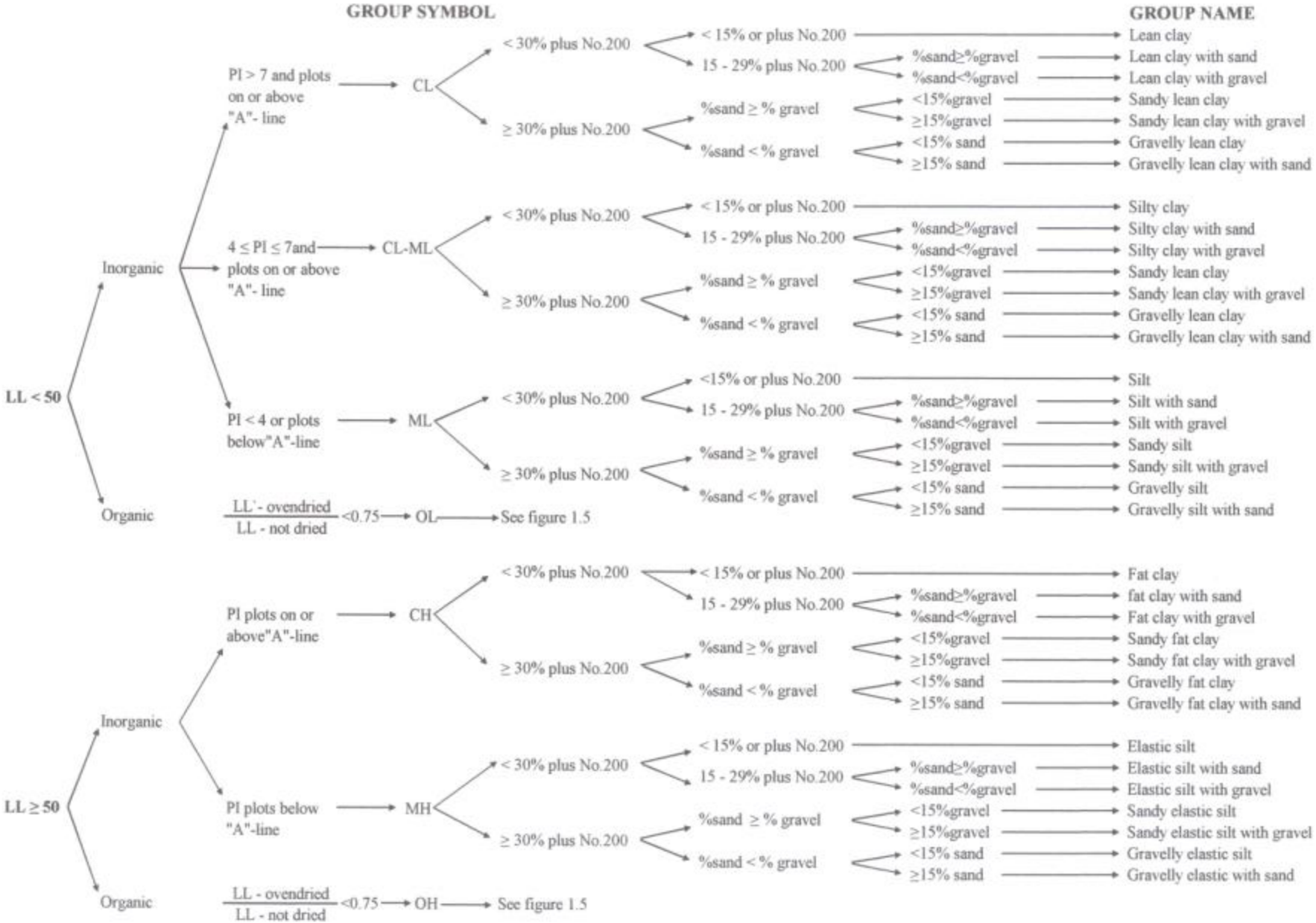
[o]PI < 4 or plots below "A" line

[p]PI plots on or above "A" line

[q]PI plots below "A" line




Flowchart for Classifying Coarse-Grained Soil (More than 50% Retained on No. 200 Sieve) (after ASTM,2000)




Flowchart for classifying Fine-Grained Soil (50% or More Passes No. 200 Sieve) (after ASTM,2000)

# STANDARD PENETRATION TEST

**SOIL QUALITY ANALYSIS OFFICE**

**( Soil Testing Laboratory )**

BHNo.1

Project : The D.H.R & L.E of The Institute of Technology

Site name : Institute of Technology

Location : Khan Toul Kok, Phnom Penh.

Elevation: m Sheet-1

Depth to Water inflow: ▼ m Started Date: Dctor. 8, 2012

Depth to Water level: ▼ m Finished Date: Octor.10, 2012

| No. | Types | From - To | $N_0$ | $N_1$ | $N_2$ | N-v | DESCRIPTION OF STRATA |
|---|---|---|---|---|---|---|---|
| | | Depth & Type Samples, (m) | Recorded field test (SPT) (SPT) Blows/300mm | | | | |
| 1 | D0 | 0 0 | 0 | 0 | 0 | 0 | Medium stiff brown light gray lean & fat clay with some sand |
| | D1 | 0.55 - 1.00 | 2 | 3 | 3 | 6 | |
| | D2 | 1.05 - 1.50 | 2 | 3 | 5 | 8 | |
| | D3 | 1.55 - 2.00 | 2 | 3 | 4 | 7 | |
| | D4 | 2.05 - 2.50 | 4 | 4 | 6 | 10 | |
| | U1 | 2.55 - 3.00 | - | - | - | - | |
| 2 | D6 | 3.05 - 3.50 | 5 | 6 | 8 | 14 | Stiff to very stiff light gray brown lean & fat clay with some sand |
| | D7 | 3.55 - 4.00 | 6 | 8 | 12 | 20 | |
| | D8 | 4.05 - 4.50 | 6 | 8 | 11 | 19 | |
| | D9 | 4.55 - 5.00 | 6 | 8 | 12 | 20 | |
| | D10 | 5.05 - 5.50 | 5 | 9 | 13 | 22 | |
| | U2 | 5.55 - 6.00 | - | - | - | - | |
| 3 | D12 | 6.05 - 6.50 | 6 | 8 | 9 | 17 | Stiff dark brown fat & lean clay with some sand |
| | D13 | 6.55 - 7.00 | 5 | 5 | 8 | 13 | |
| | D14 | 7.05 - 7.50 | 5 | 6 | 8 | 14 | |
| | U3 | 7.55 - 8.00 | - | - | - | - | |
| 4 | D16 | 8.05 - 8.50 | 10 | 12 | 12 | 24 | Medium dense light yellow gray lean clayey sand with gravel |
| | D17 | 8.55 - 9.00 | 6 | 8 | 13 | 21 | |
| | D18 | 9.05 - 9.50 | 10 | 18 | 24 | 42 | |
| | D19 | 9.55 - 10.00 | 7 | 7 | 9 | 16 | |
| | D20 | 10.05 - 10.50 | 7 | 9 | 11 | 20 | |
| | D21 | 10.55 - 11.00 | 7 | 9 | 12 | 21 | |
| 5 | U4 | 11.05 - 11.50 | - | - | - | - | Medium dense to very dense light yellow gray lean clayey sand with gravel |
| | D23 | 11.55 - 12.00 | 8 | 14 | 15 | 29 | |
| | D24 | 12.05 - 12.50 | 20 | 32 | 35 | 67 | |
| | D25 | 12.55 - 13.00 | 12 | 16 | 21 | 37 | |
| | U5 | 13.05 - 13.50 | - | - | - | - | |
| | D27 | 13.55 - 14.00 | 9 | 21 | 40 | 61 | |
| | D28 | 14.05 - 14.50 | 10 | 25 | 36 | 61 | |
| | D29 | 14.55 - 15.00 | 21 | 29 | 32 | 61 | |
| 6 | D30 | 15.05 - 15.50 | 9 | 16 | 21 | 37 | Medium dense to very dense light gray sandy lean clay with some gravel |
| | U6 | 15.55 - 16.00 | - | - | - | - | |
| | D32 | 16.05 - 16.50 | 11 | 19 | 26 | 45 | |
| | D33 | 16.55 - 17.00 | 20 | 25 | 28 | 53 | |
| | D34 | 17.05 - 17.50 | 15 | 32 | 20 | 52 | |
| | D35 | 17.55 - 18.00 | 15 | 26 | 33 | 59 | |
| | D36 | 18.05 - 18.50 | 16 | 27 | 33 | 60 | |
| | D37 | 18.55 - 19.00 | 19 | 27 | 34 | 61 | |
| | D38 | 19.05 - 19.50 | 15 | 22 | 30 | 52 | |
| | D39 | 19.55 - 20.00 | 17 | 22 | 29 | 51 | |

Legend Boring depth (m)

Graphical N -Value

0 10 20 30 40 50 60 70 80

Thickness 3.10m

Thickness 3.00m

Thickness 2.00m

Thickness 3.00m

Thickness 4.30m

Thickness 4.60m

END OF DRILLING MAXIMUM 20m

| Constancy of Fine-Grained Soils, N | Soft | Med.Stiff | Stiff | V.Stiff | Hard |
|---|---|---|---|---|---|
| No.Blows, N (SPT) | 2 - 5 | 5 - 10 | 10 - 20 | 20 - 30 | >30 |
| Correlation of Coarse-grained Soils, N | Loose | M.Danse | Dense | V.Dense | |
| No.Blows, N (SPT) | 5 - 10 | 10 - 30 | 30 - 50 | >50 | |

-Silty Sand
-Clayey Sand with gravel
-Sands Stone
-Silts

-Sandy fat clay
-Silty fine Sand
-Hard Clays
-Clays

-Silty Clay
-Sandy lean clay
-Sandy lean clay with gravel
-Sands

Tel: 012 971 532, 011 704 080 (ACFC) Group by SPT, BH No.1_00591

# LOG OF BORING

**SOIL QUALITY ANALYSIS OFFICE**
**( Soil Testing Laboratory )**

BHNo.1

Project : The D.H.R & L.E of The Institute of Technology
Site name : Institute of Technology
Location : Khan Toul Kok, Phnom Penh.

Depth to Water inflow: m ▼
Depth to Water level: m ▼

Sheet-1
Started Date: Dctor. 8, 2012
Finished Date: Octor.10, 2012

| Type Sample No. | Type | Depth Tested From - To | Water con. | Liquid limit | Plastic limit | Soil class | DESCRIPTION OF STRATA | Legend Boring depth (m) | Graphical N -Value & moisture content % (0 10 20 30 40 50 60 70) |
|---|---|---|---|---|---|---|---|---|---|
| | D0 | 0 - 0 | | | | | | | 0 |
| | D1 | 0.55 - 1.00 | 17.51 | 37.24 | 15.52 | CL | | | 1 6 17.51 |
| 1 | D2 | 1.05 - 1.50 | 21.75 | 52.33 | 17.20 | CH | Medium stiff brown light gray lean & fat clay with some sand | | 8 21.75 |
| | D3 | 1.55 - 2.00 | 20.13 | 34.25 | 12.56 | CL | | | 2 7 20.13 |
| | D4 | 2.05 - 2.50 | 18.33 | 32.31 | 14.80 | CL | | | 18.33 |
| | D5 | 2.55 - 3.00 | 24.58 | 40.59 | 11.96 | CL | | | 3 24.58 |
| | D6 | 3.05 - 3.50 | 23.94 | 38.97 | 13.76 | CL | | | 23.94 |
| | D7 | 3.55 - 4.00 | 21.36 | 36.70 | 11.76 | CL | | | 4 |
| 2 | D8 | 4.05 - 4.50 | 21.64 | 34.62 | 14.57 | CL | Stiff to very stiff light gray brown lean & fat clay with some sand | | |
| | D9 | 4.55 - 5.00 | 21.91 | 42.03 | 13.71 | CL | | | 5 |
| | D10 | 5.05 - 5.50 | 21.67 | 42.70 | 16.89 | CL | | | |
| | D11 | 5.55 - 6.00 | 21.54 | 50.88 | 14.40 | CL | | | 6 21.54 |
| | D12 | 6.05 - 6.50 | 22.30 | 52.46 | 13.48 | CL | | | 22.3 |
| 3 | D13 | 6.55 - 7.00 | 23.01 | 47.28 | 14.49 | CL | Stiff dark brown fat & lean clay with some sand | | 7 23.01 |
| | D14 | 7.05 - 7.50 | 25.13 | 46.57 | 12.22 | CL | | | 25.13 |
| | D15 | 7.55 - 8.00 | 13.29 | 41.72 | 14.46 | SC | | | 8 13.29 |
| | D16 | 8.05 - 8.50 | 13.49 | 40.94 | 11.03 | SC | | | |
| | D17 | 8.55 - 9.00 | 16.98 | 56.39 | 16.88 | SC | | | 9 |
| 4 | D18 | 9.05 - 9.50 | 11.28 | 50.81 | 13.79 | SC | Medium dense light yellow gray lean clayey sand with gravel | | 11.28 42 |
| | D19 | 9.55 - 10.00 | 13.13 | 30.46 | 12.84 | SC | | | 10 |
| | D20 | 10.05 - 10.50 | 13.79 | 33.43 | 10.98 | SC | | | |
| | D21 | 10.55 - 11.00 | 13.79 | 22.48 | 12.70 | SC | | | 11 |
| | D22 | 11.05 - 11.50 | 11.37 | 29.30 | 10.91 | SC | | | 11.37 |
| | D23 | 11.55 - 12.00 | 11.37 | 29.30 | 10.91 | SC | | | 12 11.37 29 |
| | D24 | 12.05 - 12.50 | 9.92 | 29.35 | 13.91 | SC | | | 9.92 67 |
| | D25 | 12.55 - 13.00 | 12.26 | 36.55 | 14.41 | SC | | | 13 12.26 37 |
| 5 | D26 | 13.05 - 13.50 | 14.16 | 40.23 | 12.77 | SC | Medium dense to very dense light yellow gray lean clayey sand with gravel | | 14.16 |
| | D27 | 13.55 - 14.00 | 14.00 | 40.22 | 12.77 | SC | | | 14 14 61 |
| | D28 | 14.05 - 14.50 | 12.73 | 42.38 | 14.59 | SC | | | 12.73 61 |
| | D29 | 14.55 - 15.00 | 10.28 | 22.33 | 15.98 | SC | | | 15 10.28 61 |
| | D30 | 15.05 - 15.50 | 13.10 | 40.64 | 11.90 | SC | | | 13.1 37 |
| | D31 | 15.55 - 16.00 | 16.00 | 40.69 | 11.91 | SC | | | 16 16 |
| | D32 | 16.05 - 16.50 | 12.64 | 22.67 | 13.76 | SC | | | 12.64 45 |
| | D33 | 16.55 - 17.00 | 11.29 | 30.98 | 19.70 | SC | | | 17 11.29 53 |
| | D34 | 17.05 - 17.50 | 10.36 | 31.43 | 14.47 | SC | Medium dense to very dense light gray sandy lean clay with some gravel | | 10.36 52 |
| 6 | D35 | 17.55 - 18.00 | 12.94 | 54.25 | 13.63 | SC | | | 18 12.94 59 |
| | D36 | 18.05 - 18.50 | 14.37 | 41.80 | 18.20 | SC | | | 14.37 60 |
| | D37 | 18.55 - 19.00 | 12.81 | 34.65 | 12.88 | SC | | | 19 12.81 61 |
| | D38 | 19.05 - 19.50 | 11.62 | 42.54 | 15.22 | SC | | | 11.62 52 |
| | D39 | 19.55 - 20.00 | 10.68 | 29.86 | 18.28 | SC | | | 20 10.68 51 |

END OF DRILLING MAXIMUM 20m

| Constancy of Fine-Grained Soils, N | Soft | Med.Stiff | Stiff | V.Stiff | Hard |
|---|---|---|---|---|---|
| No.Blows, N (SPT) | 2 - 5 | 5 - 10 | 10 - 20 | 20 - 30 | >30 |
| Correlation of Coarse-grained Soils, N | Loose | M.Danse | Dense | V.Dense | |
| No.Blows, N (SPT) | 5 - 10 | 10 - 30 | 30 - 50 | >50 | |

-Silty Sand
-Clayey Sand with gravel
-Sands Stone
-Silts

-Sandy fat clay
-Silty fine Sand
-Hard Clays
-Clays

-Silty Clay
-Sandy lean clay
-Sandy lean clay with gravel
-Sands

Tel: 012 971 532, 011 704 080 (ACFC) Group by SPT, BHNo.1_00591

# SUMMARY OF LABORAIORY TEST RESULTS

SOIL QUALITY ANAL YSIS OFFICE
(Soil Testing Laboratory)

BOREHOLE BHNo.1 ELEVATION :
PROJECT: : The D.H.R & L.E of The Institute of T LOCATION : : Institute of Technology
: Khan Toul Kok, Phnom Penh.

Sheet-1

| DESCRIPTION OF STRATA | | | | BULK & D DENSITY | | | | ATTEBERG LIMIT | | | | | PARTICLE SIZE | | | | | UNDR. SHEAR ST. | | | | CONSOLLIDATION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Layers No. | Sample No | Depth (m) | Type of Soils | ρf (T/m³) | ρd (T/m³) | Gs | e | W (%) | LL (%) | PL (%) | IP (%) | IL | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | Soil Class | C (KN/m²) | ø (o) | Qu(Kpa) | Cu (Kpa) | Mv (m²/MN) | Cv (m²/year) | E | SPT |
| 1 | D1 | 0.55 - 1.00 | Medium stiff brown light gray lean & fat clay with some sand | 2.04 | 1.84 | 2.58 | - | 17.51 | 37.24 | 15.52 | 21.72 | 0.09 | 1.32 | 54.79 | 43.89 | | CL | - | - | - | - | - | - | - | 6 |
| | D2 | 1.05 - 1.50 | | 2.01 | 1.92 | 2.64 | - | 21.75 | 52.33 | 17.20 | 35.13 | 0.13 | 0.26 | 13.85 | 85.89 | | CH | - | - | - | - | - | - | - | 8 |
| | D3 | 1.55 - 2.00 | | 2.05 | 1.86 | 2.58 | - | 20.13 | 34.25 | 12.56 | 21.69 | 0.35 | 1.34 | 11.93 | 86.74 | | CL | - | - | - | - | - | - | - | 7 |
| | D4 | 2.05 - 2.50 | | 2.01 | 1.87 | 2.65 | - | 18.33 | 32.31 | 14.80 | 17.51 | 0.20 | 0.44 | 13.31 | 86.25 | | CL | - | - | - | - | - | - | - | 10 |
| | D5 | 2.55 - 3.00 | | 1.99 | 1.78 | 2.64 | - | 24.58 | 40.59 | 11.96 | 28.63 | 0.44 | 0.00 | 12.50 | 87.50 | | CL | 16.8 | 20 | - | - | - | - | - | U1 |
| 2 | D6 | 3.05 - 3.50 | Stiff to very stiff light gray brown lean & fat clay with some sand | 2.03 | 1.94 | 2.62 | - | 23.94 | 38.97 | 13.76 | 25.21 | 0.40 | 0.00 | 7.38 | 92.62 | | CL | - | - | - | - | - | - | - | 14 |
| | D7 | 3.55 - 4.00 | | 2.05 | 1.68 | 2.64 | - | 21.36 | 36.70 | 11.76 | 24.94 | 0.38 | 0.00 | 8.05 | 91.95 | | CL | - | - | 167.9 | 84.0 | - | - | - | 20 |
| | D8 | 4.05 - 4.50 | | 2.02 | 1.65 | 2.61 | - | 21.64 | 34.62 | 14.57 | 20.05 | 0.35 | 0.15 | 4.68 | 95.16 | | CL | - | - | - | - | - | - | - | 19 |
| | D9 | 4.55 - 5.00 | | 2.05 | 1.69 | 2.64 | - | 21.91 | 42.03 | 13.71 | 28.32 | 0.29 | 0.00 | 1.87 | 98.13 | | CL | - | - | 249.6 | 124.8 | - | - | - | 20 |
| | D10 | 5.05 - 5.50 | | 2.06 | 1.68 | 2.62 | - | 21.67 | 42.70 | 16.89 | 25.81 | 0.19 | 0.32 | 2.53 | 97.16 | | CL | - | - | - | - | - | - | - | 22 |
| | D11 | 5.55 - 6.00 | | 2.07 | 1.65 | 2.65 | - | 21.54 | 50.88 | 14.40 | 36.48 | 0.20 | 0.59 | 2.39 | 97.01 | | CL | 57.4 | 40 | - | - | - | - | - | U2 |
| 3 | D12 | 6.05 - 6.50 | Stiff dark brown fat & lean clay with some sand | 2.09 | 1.76 | 2.63 | - | 22.30 | 52.46 | 13.48 | 38.98 | 0.23 | 0.00 | 4.40 | 95.60 | | CL | - | - | - | - | - | - | - | 17 |
| | D13 | 6.55 - 7.00 | | 2.12 | 1.73 | 2.61 | - | 23.01 | 47.28 | 14.49 | 32.79 | 0.26 | 0.00 | 6.12 | 93.88 | | CL | - | - | 142.0 | 71.0 | - | - | - | 13 |
| | D14 | 7.05 - 7.50 | | 2.04 | 1.75 | 2.64 | - | 25.13 | 46.57 | 12.22 | 34.35 | 0.38 | 0.00 | 4.83 | 95.17 | | CL | - | - | - | - | - | - | - | 14 |
| | D15 | 7.55 - 8.00 | | 2.03 | 1.72 | 2.67 | - | 13.29 | 41.72 | 14.46 | 27.26 | -0.04 | 0.00 | 51.51 | 48.49 | | SC | 26.1 | 46 | - | - | - | - | - | U3 |
| 4 | D16 | 8.05 - 8.50 | Medium dense light yellow gray lean clayey sand with gravel | 2.06 | 1.77 | 2.68 | - | 13.49 | 40.94 | 11.03 | 29.91 | 0.08 | 1.33 | 62.01 | 36.66 | | SC | - | - | - | - | - | - | - | 24 |
| | D17 | 8.55 - 9.00 | | 2.02 | 1.72 | 2.66 | - | 16.98 | 56.39 | 16.88 | 39.51 | 0.00 | 0.50 | 55.20 | 44.30 | | SC | - | - | - | - | - | - | - | 21 |
| | D18 | 9.05 - 9.50 | | 2.02 | 1.71 | 2.69 | - | 11.28 | 50.81 | 13.79 | 37.02 | -0.07 | 1.25 | 70.05 | 28.70 | | SC | - | - | - | - | - | - | - | 42 |
| | D19 | 9.55 - 10.00 | | 2.21 | 2.05 | 2.67 | - | 13.13 | 30.46 | 12.84 | 17.62 | 0.02 | 4.44 | 50.84 | 44.72 | | SC | - | - | - | - | - | - | - | 16 |
| | D20 | 10.05 - 10.50 | | 2.22 | 2.07 | 2.68 | - | 13.79 | 33.43 | 10.98 | 22.45 | 0.13 | 0.85 | 31.64 | 67.51 | | SC | - | - | - | - | - | - | - | 20 |

Prepared by : NOURN SARETH

# SUMMARY OF LABORAIORY TEST RESULTS

SOIL QUALITY ANAL YSIS OFFICE
(Soil Testing Laboratory)

BOREHOLE BHNo.1 ELEVATION :
PROJECT: : The D.H.R & L.E of The Institute of TLOCATION : : Institute of Technology
: Khan Toul Kok, Phnom Penh.

Sheet-2

| DESCRIPTION OF STRATA | | | | BULK & D DENSITY | | | | ATTEBERG LIMIT | | | | | PARTICLE SIZE | | | | | UNDR. SHEAR ST. | | | | CONSOLLIDATION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Layers No. | Sample No | Depth (m) | Type of Soils | ρf (T/m³) | ρd (T/m³) | Gs | e | W (%) | LL (%) | PL (%) | IP (%) | IL | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | Soil Class | C (KN/m²) | ø (o) | Qu(Kpa) | Cu (Kpa) | Mv (m²/MN) | Cv (m²/year) | E | SPT |
| 4 | D21 | 10.55 - 11.00 | | 2.24 | 2.11 | 2.67 | - | 13.79 | 22.48 | 12.70 | 9.78 | 0.11 | 0.00 | 45.70 | 54.30 | | SC | - | - | - | - | - | - | - | 21 |
| 5 | D22 | 11.05 - 11.50 | Medium dense to very dense light yellow gray lean clayey sand with gravel | 2.14 | 1.98 | 2.68 | - | 11.37 | 29.30 | 10.91 | 18.39 | 0.03 | 0.00 | 53.19 | 46.81 | | SC | 56.3 | 47 | - | - | - | - | - | U4 |
| | D23 | 11.55 - 12.00 | | 2.11 | 1.92 | 2.67 | - | 11.37 | 29.30 | 10.91 | 18.39 | 0.03 | 0.00 | 53.19 | 46.81 | | SC | - | - | - | - | - | - | - | 29 |
| | D24 | 12.05 - 12.50 | | 2.15 | 1.91 | 2.68 | - | 9.92 | 29.35 | 13.91 | 15.44 | -0.26 | 12.48 | 57.80 | 29.72 | | SC | - | - | - | - | - | - | - | 67 |
| | D25 | 12.55 - 13.00 | | 2.12 | 1.95 | 2.54 | - | 12.26 | 36.55 | 14.41 | 22.14 | -0.10 | 0.00 | 40.08 | 59.92 | | SC | - | - | - | - | - | - | - | 37 |
| | D26 | 13.05 - 13.50 | | 2.07 | 1.95 | 2.65 | - | 14.16 | 40.23 | 12.77 | 27.46 | 0.05 | 0.00 | 33.23 | 66.77 | | SC | 89.3 | 23 | - | - | - | - | - | U5 |
| | D27 | 13.55 - 14.00 | | 2.10 | 1.97 | 2.65 | - | 14.00 | 40.22 | 12.77 | 27.45 | 0.04 | 0.00 | 33.26 | 66.74 | | SC | - | - | - | - | - | - | - | 61 |
| | D28 | 14.05 - 14.50 | | 2.25 | 1.94 | 2.67 | - | 12.73 | 42.38 | 14.59 | 27.79 | -0.07 | 0.00 | 37.17 | 62.83 | | SC | - | - | 572.7 | 286.3 | - | - | - | 61 |
| | D29 | 14.55 - 15.00 | | 2.32 | 2.10 | 2.68 | - | 10.28 | 22.33 | 15.98 | 6.35 | -0.90 | 2.80 | 66.01 | 31.19 | | SC | - | - | 476.8 | 238.4 | - | - | - | 61 |
| | D30 | 15.05 - 15.50 | | 2.30 | 2.10 | 2.66 | - | 13.10 | 40.64 | 11.90 | 28.74 | 0.04 | 0.00 | 32.87 | 67.13 | | SC | - | - | - | - | - | - | - | 37 |
| 6 | D31 | 15.55 - 16.00 | Medium dense to very dense light gray sandy lean clay with some gravel | 2.07 | 1.99 | 2.67 | - | 16.00 | 40.69 | 11.91 | 28.78 | 0.14 | 0.00 | 32.88 | 67.12 | | SC | 98 | 20 | - | - | - | - | - | U6 |
| | D32 | 16.05 - 16.50 | | 2.26 | 2.02 | 2.68 | - | 12.64 | 22.67 | 13.76 | 8.91 | -0.13 | 0.00 | 34.60 | 65.40 | | SC | - | - | 688.9 | 344.5 | - | - | - | 45 |
| | D33 | 16.55 - 17.00 | | 2.20 | 2.02 | 2.65 | - | 11.29 | 30.98 | 19.70 | 11.28 | -0.75 | 0.00 | 49.19 | 50.81 | | SC | - | - | - | - | - | - | - | 53 |
| | D34 | 17.05 - 17.50 | | 2.29 | 2.07 | 2.68 | - | 10.36 | 31.43 | 14.47 | 16.96 | -0.24 | 0.00 | 61.51 | 38.49 | | SC | - | - | 532.7 | 266.4 | - | - | - | 52 |
| | D35 | 17.55 - 18.00 | | 2.21 | 1.97 | 2.63 | - | 12.94 | 54.25 | 13.63 | 40.62 | -0.02 | 0.00 | 31.94 | 68.06 | | SC | - | - | - | - | - | - | - | 59 |
| | D36 | 18.05 - 18.50 | | 2.17 | 1.93 | 2.67 | - | 14.37 | 41.80 | 18.20 | 23.60 | -0.16 | 0.00 | 38.89 | 61.11 | | SC | - | - | - | - | - | - | - | 60 |
| | D37 | 18.55 - 19.00 | | 2.24 | 2.01 | 2.69 | - | 12.81 | 34.65 | 12.88 | 21.77 | 0.00 | 5.41 | 40.82 | 53.77 | | SC | - | - | - | - | - | - | - | 61 |
| | D38 | 19.05 - 19.50 | | 2.25 | 2.05 | 2.70 | - | 11.62 | 42.54 | 15.22 | 27.32 | -0.13 | 0.00 | 51.21 | 48.79 | | SC | - | - | - | - | - | - | - | 52 |
| | D39 | 19.55 - 20.00 | | 2.27 | 2.06 | 2.69 | - | 10.68 | 29.86 | 18.28 | 11.58 | -0.66 | 2.26 | 66.47 | 31.26 | | SC | - | - | 406.4 | 203.2 | - | - | - | 51 |

Prepared by : NOURN SARETH

# STANDARD PENETRATION TEST

**SOIL QUALITY ANALYSIS OFFICE**

**( Soil Testing Laboratory )**

BHNo.2

Project : The D.H.R & L.E of The Institute of Technology

Site name : Institute of Technology

Location : Khan Toul Kok, Phnom Penh.

Elevation: m Sheet-1

Depth to Water inflow: ▼ m Started Date: Dctor. 11, 2012

Depth to Water level: ▼ m Finished Date: Octor.13, 2012

| Depth & Type Samples, (m) | | | Recorded field test (SPT) (SPT) Blows/300mm | | | | DESCRIPTION OF STRATA | Legend Boring depth (m) | Graphical N -Value 0 10 20 30 40 50 60 70 |
|---|---|---|---|---|---|---|---|---|---|
| No. | Types | From - To | $N_0$ | $N_1$ | $N_2$ | N-v | | | |
| 1 | D0 | 0 0 | 0 | 0 | 0 | 0 | Soft to stiff light gray lean clay & fat clay with some sand | | 0 |
| | D1 | 0.55 - 1.00 | 2 | 2 | 2 | 4 | | | 1: 4 |
| | D2 | 1.05 - 1.50 | 2 | 3 | 2 | 5 | | | 5 |
| | D3 | 1.55 - 2.00 | 3 | 4 | 3 | 7 | | | 2: 7 |
| | D4 | 2.05 - 2.50 | 3 | 3 | 6 | 9 | | | 9 Thickness 2.70m |
| 2 | D5 | 2.55 - 3.00 | 4 | 6 | 8 | 14 | Medium dense light gray lean & fat clay with some sand | | 3: 14 |
| | U1 | 3.05 - 3.50 | - | - | - | - | | | |
| | D7 | 3.55 - 4.00 | 4 | 5 | 7 | 12 | | | 4: 12 |
| | D8 | 4.05 - 4.50 | 5 | 8 | 11 | 19 | | | 19 Thickness 3.40m |
| | D9 | 4.55 - 5.00 | 6 | 8 | 11 | 19 | | | 5: 19 |
| | D10 | 5.05 - 5.50 | 3 | 6 | 9 | 15 | | | 15 |
| | U2 | 5.55 - 6.00 | - | - | - | - | | | 6 |
| 3 | D12 | 6.05 - 6.50 | 4 | 5 | 7 | 12 | Stiff light brown lean & fat clay with some sand | | 12 |
| | D13 | 6.55 - 7.00 | 4 | 7 | 10 | 17 | | | 7: 17 |
| | D14 | 7.05 - 7.50 | 4 | 6 | 8 | 14 | | | 14 Thickness 2.60m |
| | D15 | 7.55 - 8.00 | 5 | 6 | 9 | 15 | | | 8: 15 |
| | U3 | 8.05 - 8.50 | - | - | - | - | | | |
| 4 | D17 | 8.55 - 9.00 | 4 | 5 | 7 | 12 | Mediun dense yellow light gray with sandy clay with some gravel | | 9: 12 |
| | D18 | 9.05 - 9.50 | 5 | 9 | 11 | 20 | | | 20 |
| | D19 | 9.55 - 10.00 | 7 | 9 | 12 | 21 | | | 10: 21 |
| | D20 | 10.05 - 10.50 | 9 | 10 | 13 | 23 | | | 23 |
| | D21 | 10.55 - 11.00 | 7 | 9 | 10 | 19 | | | 11: 19 Thickness 2.90m |
| | U4 | 11.05 - 11.50 | - | - | - | - | | | |
| 5 | D23 | 11.55 - 12.00 | 21 | 22 | 23 | 45 | Dence & medium dence light gray clayey sand with some gravel | | 12: 45 |
| | D24 | 12.05 - 12.50 | 10 | 12 | 13 | 25 | | | 25 |
| | D25 | 12.55 - 13.00 | 11 | 17 | 27 | 44 | | | 13: 44 |
| | U5 | 13.05 - 13.50 | - | - | - | - | | | Thickness 4.50m |
| | D27 | 13.55 - 14.00 | 8 | 16 | 17 | 33 | | | 14: 33 |
| | D28 | 14.05 - 14.50 | 5 | 10 | 13 | 23 | | | 23 |
| | D29 | 14.55 - 15.00 | 10 | 14 | 18 | 32 | | | 15: 32 |
| | D30 | 15.05 - 15.50 | 11 | 15 | 20 | 35 | | | 35 |
| | U6 | 15.55 - 16.00 | - | - | - | - | | | 16 |
| 6 | D32 | 16.05 - 16.50 | 20 | 51 | < | 51 | Very dense yellow light gray clayey sand with some gravel | | 51 |
| | D33 | 16.55 - 17.00 | 14 | 22 | 25 | 47 | | | 17: 47 |
| | D34 | 17.05 - 17.50 | 14 | 24 | 30 | 54 | | | 54 |
| | D35 | 17.55 - 18.00 | 16 | 26 | 31 | 57 | | | 18: 57 |
| | D36 | 18.05 - 18.50 | 16 | 26 | 30 | 56 | | | Thickness 3.90m 56 |
| | D37 | 18.55 - 19.00 | 17 | 27 | 32 | 59 | | | 19: 59 |
| | D38 | 19.05 - 19.50 | 15 | 23 | 31 | 54 | | | 54 |
| | D39 | 19.55 - 20.00 | 16 | 22 | 32 | 54 | | | 20: 54 |

END OF DRILLING MAXIMUM 20m

| Constancy of Fine-Grained Soils, N | Soft | Med.Stiff | Stiff | V.Stiff | Hard |
|---|---|---|---|---|---|
| No.Blows, N (SPT) | 2 - 5 | 5 - 10 | 10 - 20 | 20 - 30 | >30 |
| Correlation of Coarse-grained Soils, N | Loose | M.Danse | Dense | V.Dense | |
| No.Blows, N (SPT) | 5 - 10 | 10 - 30 | 30 - 50 | >50 | |

-Silty Sand
-Clayey Sand with gravel
-Sands Stone
-Silts

-Sandy fat clay
-Silty fine Sand
-Hard Clays
-Clays

-Silty Clay
-Sandy lean clay
-Sandy lean clay with gravel
-Sands

Tel: 012 971 532, 011 704 080 (ACFC) Group by SPT, BH No.2_00592

# LOG OF BORING

**SOIL QUALITY ANALYSIS OFFICE**
**( Soil Testing Laboratory )**

BHNo.2

Project : The D.H.R & L.E of The Institute of Technology
Site name : Institute of Technology
Location : Khan Toul Kok, Phnom Penh.

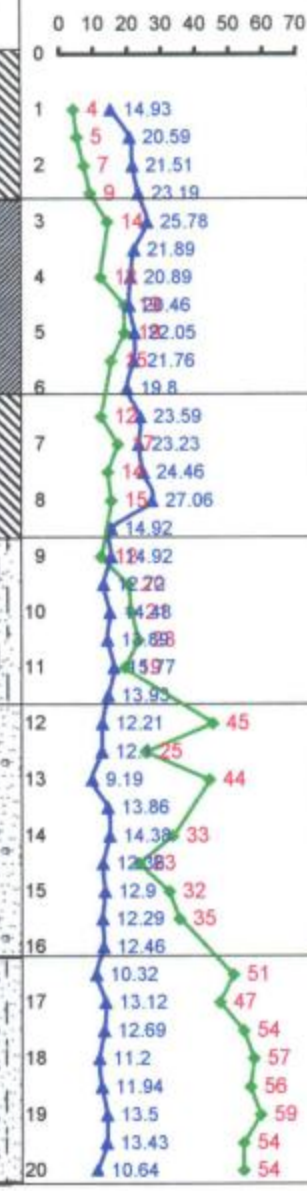
Depth to Water inflow: m ▼
Depth to Water level: m ▼

Sheet-1
Started Date: Dctor. 11, 2012
Finished Date: Octor.13, 2012

| No. | Type Sample | Depth Tested From - To | Water con. | Liquid limit | Plastic limit | Soil class | DESCRIPTION OF STRATA |
|---|---|---|---|---|---|---|---|
| | D0 | 0 - 0 | | | | | |
| 1 | D1 | 0.55 - 1.00 | 14.93 | 34.22 | 16.66 | CL | Soft to stiff light gray lean clay & fat clay with some sand |
| | D2 | 1.05 - 1.50 | 20.59 | 52.82 | 15.26 | CH | |
| | D3 | 1.55 - 2.00 | 21.51 | 63.12 | 16.27 | CH | |
| | D4 | 2.05 - 2.50 | 23.19 | 62.94 | 17.20 | CH | |
| 2 | D5 | 2.55 - 3.00 | 25.78 | 74.79 | 17.10 | CH | Medium dense light gray lean & fat clay with some sand |
| | D6 | 3.05 - 3.50 | 21.89 | 53.72 | 16.91 | CH | |
| | D7 | 3.55 - 4.00 | 20.89 | 42.35 | 17.50 | CL | |
| | D8 | 4.05 - 4.50 | 20.46 | 42.91 | 17.87 | CL | |
| | D9 | 4.55 - 5.00 | 22.05 | 43.28 | 18.05 | CL | |
| | D10 | 5.05 - 5.50 | 21.76 | 42.67 | 17.87 | CL | |
| | D11 | 5.55 - 6.00 | 19.80 | 51.47 | 18.49 | CH | |
| 3 | D12 | 6.05 - 6.50 | 23.59 | 52.50 | 17.34 | CL | Stiff light brown lean & fat clay with some sand |
| | D13 | 6.55 - 7.00 | 23.23 | 52.50 | 16.96 | CH | |
| | D14 | 7.05 - 7.50 | 24.46 | 41.80 | 18.30 | CL | |
| | D15 | 7.55 - 8.00 | 27.06 | 43.14 | 18.64 | CL | |
| | D16 | 8.05 - 8.50 | 14.92 | 51.34 | 17.99 | CH | |
| 4 | D17 | 8.55 - 9.00 | 14.92 | 25.69 | 16.28 | SC | Mediun dense yellow light gray with sandy clay with some gravel |
| | D18 | 9.05 - 9.50 | 12.72 | 34.11 | 14.24 | SC | |
| | D19 | 9.55 - 10.00 | 14.48 | 36.97 | 13.42 | SC | |
| | D20 | 10.05 - 10.50 | 13.89 | 31.28 | 16.95 | SC | |
| | D21 | 10.55 - 11.00 | 15.77 | 31.44 | 15.95 | SC | |
| | D22 | 11.05 - 11.50 | 13.93 | 27.74 | 12.86 | SC | |
| 5 | D23 | 11.55 - 12.00 | 12.21 | 20.85 | 12.76 | SC | Dence & medium dence light gray clayey sand with some gravel |
| | D24 | 12.05 - 12.50 | 12.10 | 25.59 | 16.64 | SC | |
| | D25 | 12.55 - 13.00 | 9.19 | 30.49 | 16.61 | SC | |
| | D26 | 13.05 - 13.50 | 13.86 | 46.61 | 13.95 | SC | |
| | D27 | 13.55 - 14.00 | 14.38 | 40.10 | 12.11 | SC | |
| | D28 | 14.05 - 14.50 | 12.36 | 40.40 | 14.11 | SC | |
| | D29 | 14.55 - 15.00 | 12.90 | 38.14 | 14.05 | SC | |
| | D30 | 15.05 - 15.50 | 12.29 | 38.12 | 13.99 | SC | |
| | D31 | 15.55 - 16.00 | 12.46 | 46.14 | 18.72 | SC | |
| 6 | D32 | 16.05 - 16.50 | 10.32 | 45.26 | 18.26 | SC | Very dense yellow light gray clayey sand with some gravel |
| | D33 | 16.55 - 17.00 | 13.12 | 46.41 | 14.01 | SC | |
| | D34 | 17.05 - 17.50 | 12.69 | 46.50 | 17.31 | SC | |
| | D35 | 17.55 - 18.00 | 11.20 | 36.09 | 19.31 | SC | |
| | D36 | 18.05 - 18.50 | 11.94 | 34.22 | 15.39 | SC | |
| | D37 | 18.55 - 19.00 | 13.50 | 33.89 | 12.95 | SC | |
| | D38 | 19.05 - 19.50 | 13.43 | 26.98 | 12.70 | SC | |
| | D39 | 19.55 - 20.00 | 10.64 | 30.06 | 18.28 | SC | |

Legend Boring depth (m)

Graphical N -Value & moisture content %




END OF DRILLING MAXIMUM 20m

| Constancy of Fine-Grained Soils, N | Soft | Med.Stiff | Stiff | V.Stiff | Hard |
|---|---|---|---|---|---|
| No.Blows, N (SPT) | 2 - 5 | 5 - 10 | 10 - 20 | 20 - 30 | >30 |
| Correlation of Coarse-grained Soils, N | Loose | M.Danse | Dense | V.Dense | |
| No.Blows, N (SPT) | 5 - 10 | 10 - 30 | 30 - 50 | >50 | |

-Silty Sand
-Clayey Sand with gravel
-Sands Stone
-Silts

-Sandy fat clay
-Silty fine Sand
-Hard Clays
-Clays

-Silty Clay
-Sandy lean clay
-Sandy lean clay with gravel
-Sands

Tel: 012 971 532, 011 704 080 (ACFC) Group by SPT, BHNo.2_00592

# SUMMARY OF LABORAIORY TEST RESULTS

SOIL QUALITY ANAL YSIS OFFICE
(Soil Testing Laboratory)

BOREHOLE BHNo.2 ELEVATION :
PROJECT: : The D.H.R & L.E of The Institute of T LOCATION : : Institute of Technology
: Khan Toul Kok, Phnom Penh

Sheet-1

| DESCRIPTION OF STRATA | | | | BULK & D DENSITY | | | | ATTEBERG LIMIT | | | | | PARTICLE SIZE | | | | | UNDR. SHEAR ST. | | | | CONSOLLIDATION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Layers No. | Sample No | Depth (m) | Type of Soils | pf (T/m³) | pd (T/m³) | Gs | e | W (%) | LL (%) | PL (%) | IP (%) | IL | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | Soil Class | C (KN/m²) | ø (o) | Qu(Kpa) | Cu (Kpa) | Mv (m²/MN) | Cv (m²/year) | E | SPT |
| 1 | D1 | 0.55 - 1.00 | Soft to stiff light gray lean clay & fat clay with some sand | 2.09 | 1.95 | 2.63 | - | 14.93 | 34.22 | 16.66 | 17.56 | -0.10 | 0.28 | 44.28 | 55.44 | | CL | - | - | - | - | - | - | - | 4 |
| | D2 | 1.05 - 1.50 | | 2.07 | 1.97 | 2.64 | - | 20.59 | 52.82 | 15.26 | 37.56 | 0.14 | 1.09 | 16.20 | 82.71 | | CH | - | - | - | - | - | - | - | 5 |
| | D3 | 1.55 - 2.00 | | 2.08 | 1.96 | 2.58 | - | 21.51 | 63.12 | 16.27 | 46.85 | 0.11 | 0.33 | 9.12 | 90.50 | | CH | - | - | 124.2 | 62.09 | - | - | - | 7 |
| | D4 | 2.05 - 2.50 | | 2.06 | 1.97 | 2.65 | - | 23.19 | 62.94 | 17.20 | 45.74 | 0.13 | 2.22 | 9.34 | 88.45 | | CH | - | - | - | - | - | - | - | 9 |
| 2 | D5 | 2.55 - 3.00 | Medium dense light gray lean & fat clay with some sand | 2.09 | 1.95 | 2.64 | - | 25.78 | 74.79 | 17.10 | 57.69 | 0.15 | 0.00 | 5.14 | 94.86 | | CH | - | - | - | - | - | - | - | 14 |
| | D6 | 3.05 - 3.50 | | 2.04 | 1.98 | 2.62 | - | 21.89 | 53.72 | 16.91 | 36.81 | 0.14 | 0.00 | 3.10 | 96.90 | | CH | 44.1 | 14 | - | - | - | - | - | U1 |
| | D7 | 3.55 - 4.00 | | 2.07 | 1.96 | 2.64 | - | 20.89 | 42.35 | 17.50 | 24.85 | 0.14 | 0.00 | 4.00 | 96.00 | | CL | - | - | 167.9 | 84.0 | - | - | - | 12 |
| | D8 | 4.05 - 4.50 | | 2.07 | 1.97 | 2.61 | - | 20.46 | 42.91 | 17.87 | 25.04 | 0.10 | 0.00 | 2.74 | 97.26 | | CL | - | - | - | - | - | - | - | 19 |
| | D9 | 4.55 - 5.00 | | 2.09 | 1.95 | 2.64 | - | 22.05 | 43.28 | 18.05 | 25.23 | 0.16 | 0.00 | 4.33 | 95.67 | | CL | - | - | 128.4 | 64.2 | - | - | - | 19 |
| | D10 | 5.05 - 5.50 | | 2.06 | 1.97 | 2.62 | - | 21.76 | 42.67 | 17.87 | 24.80 | 0.16 | 0.00 | 1.90 | 98.10 | | CL | - | - | - | - | - | - | - | 15 |
| | D11 | 5.55 - 6.00 | | 2.05 | 1.98 | 2.65 | - | 19.80 | 51.47 | 18.49 | 32.98 | 0.04 | 0.00 | 1.60 | 98.40 | | CH | 56.3 | 22 | - | - | - | - | - | U2 |
| 3 | D12 | 6.05 - 6.50 | Stiff light brown lean & fat clay with some sand | 2.08 | 1.90 | 2.63 | - | 23.59 | 52.50 | 17.34 | 35.16 | 0.18 | 0.00 | 2.23 | 97.77 | | CL | - | - | - | - | - | - | - | 12 |
| | D13 | 6.55 - 7.00 | | 2.09 | 1.96 | 2.61 | - | 23.23 | 52.50 | 16.96 | 35.54 | 0.18 | 0.00 | 1.54 | 98.46 | | CH | - | - | 249.6 | 124.8 | - | - | - | 17 |
| | D14 | 7.05 - 7.50 | | 2.09 | 1.97 | 2.62 | - | 24.46 | 41.80 | 18.30 | 23.50 | 0.26 | 0.20 | 5.65 | 94.15 | | CL | - | - | - | - | - | - | - | 14 |
| | D15 | 7.55 - 8.00 | | 2.08 | 1.96 | 2.64 | - | 27.06 | 43.14 | 18.64 | 24.50 | 0.34 | 0.00 | 2.42 | 97.58 | | CL | - | - | - | - | - | - | - | 15 |
| | D16 | 8.05 - 8.50 | | 2.03 | 1.98 | 2.65 | - | 14.92 | 51.34 | 17.99 | 33.35 | -0.09 | 0.00 | 1.99 | 98.10 | | CH | 29 | 25 | - | - | - | - | - | U3 |
| 4 | D17 | 8.55 - 9.00 | Mediun dense yellow light gray with sandy clay with some gravel | 2.07 | 1.95 | 2.69 | - | 14.92 | 25.69 | 16.28 | 9.41 | -0.14 | 0.00 | 54.36 | 45.64 | | SC | - | - | - | - | - | - | - | 12 |
| | D18 | 9.05 - 9.50 | | 2.09 | 1.98 | 2.68 | - | 12.72 | 34.11 | 14.24 | 19.87 | -0.08 | 0.66 | 59.79 | 39.54 | | SC | - | - | 263.5 | 131.7 | - | - | - | 20 |
| | D19 | 9.55 - 10.00 | | 2.08 | 1.97 | 2.69 | - | 14.48 | 36.97 | 13.42 | 23.55 | 0.05 | 1.02 | 55.23 | 43.75 | | SC | - | - | - | - | - | - | - | 21 |
| | D20 | 10.05 - 10.50 | | 2.07 | 1.96 | 2.68 | - | 13.89 | 31.28 | 16.95 | 14.33 | -0.21 | 0.00 | 25.02 | 74.98 | | SC | - | - | 251.6 | 125.8 | - | - | - | 23 |

Prepared by : NOURN SARETH

# SUMMARY OF LABORAIORY TEST RESULTS

SOIL QUALITY ANAL YSIS OFFICE
(Soil Testing Laboratory)

BOREHOLE BHNo.2 ELEVATION :
PROJECT: : The D.H.R & L.E of The Institute of T LOCATION : : Institute of Technology
: Khan Toul Kok, Phnom Penh.

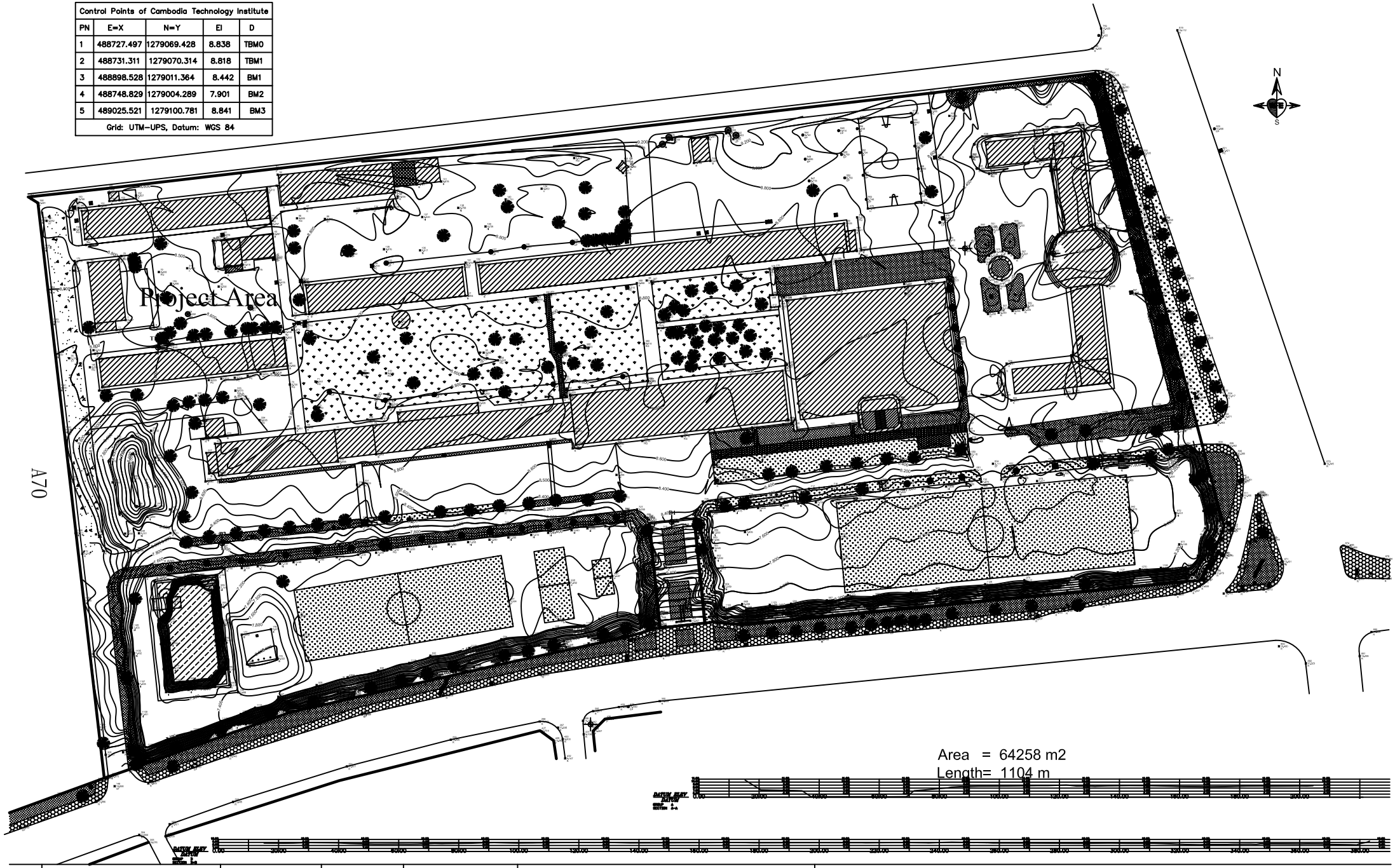
Sheet-2

| DESCRIPTION OF STRATA | | | | BULK & D DENSITY | | | | ATTEBERG LIMIT | | | | | PARTICLE SIZE | | | | | UNDR. SHEAR ST. | | | | CONSOLLIDATION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Layers No. | Sample No | Depth (m) | Type of Soils | pf (T/m$^3$) | pd (T/m$^3$) | Gs | e | W (%) | LL (%) | PL (%) | IP (%) | IL | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | Soil Class | C (KN/m$^2$) | ø (o) | Qu(Kpa) | Cu (Kpa) | Mv (m$^2$/MN) | Cv (m$^2$/year) | E | SPT |
| 4 | D21 | 10.55 - 11.00 | | 2.08 | 1.98 | 2.67 | - | 15.77 | 31.44 | 15.95 | 15.49 | -0.01 | 0.00 | 30.56 | 69.44 | | SC | - | - | - | - | - | - | - | 19 |
| | D22 | 11.05 - 11.50 | | 2.13 | 1.98 | 2.68 | - | 13.93 | 27.74 | 12.86 | 14.88 | 0.07 | 0.00 | 21.42 | 78.58 | | SC | 52.8 | 28 | - | - | - | - | - | U4 |
| 5 | D23 | 11.55 - 12.00 | Dence & medium dence light gray clayey sand with some gravel | 2.09 | 1.97 | 2.66 | - | 12.21 | 20.85 | 12.76 | 8.09 | -0.07 | 0.00 | 56.38 | 43.62 | | SC | - | - | - | - | - | - | - | 45 |
| | D24 | 12.05 - 12.50 | | 2.08 | 1.96 | 2.69 | - | 12.10 | 25.59 | 16.64 | 8.95 | -0.51 | 0.00 | 51.63 | 48.37 | | SC | - | - | 232.4 | 116.2 | - | - | - | 25 |
| | D25 | 12.55 - 13.00 | | 2.07 | 1.97 | 2.67 | - | 9.19 | 30.49 | 16.61 | 13.88 | -0.53 | 0.36 | 56.91 | 42.72 | | SC | - | - | 545.1 | 272.6 | - | - | - | 44 |
| | D26 | 13.05 - 13.50 | | 2.12 | 1.96 | 2.68 | - | 13.86 | 46.61 | 13.95 | 32.66 | 0.00 | 0.00 | 36.88 | 63.12 | | SC | 88.2 | 12 | - | - | - | - | - | U5 |
| | D27 | 13.55 - 14.00 | | 2.21 | 1.95 | 2.67 | - | 14.38 | 40.10 | 12.11 | 27.99 | 0.08 | 0.21 | 42.76 | 57.03 | | SC | - | - | - | - | - | - | - | 33 |
| | D28 | 14.05 - 14.50 | | 2.10 | 1.98 | 2.68 | - | 12.36 | 40.40 | 14.11 | 26.29 | -0.07 | 0.33 | 37.86 | 61.81 | | SC | - | - | - | - | - | - | - | 23 |
| | D29 | 14.55 - 15.00 | | 2.23 | 1.97 | 2.67 | - | 12.90 | 38.14 | 14.05 | 24.09 | -0.05 | 0.00 | 44.31 | 55.69 | | SC | - | - | - | - | - | - | - | 32 |
| | D30 | 15.05 - 15.50 | | 2.11 | 1.96 | 2.68 | - | 12.29 | 38.12 | 13.99 | 24.13 | -0.07 | 0.00 | 44.35 | 55.65 | | SC | - | - | - | - | - | - | - | 35 |
| | D31 | 15.55 - 16.00 | | 2.05 | 1.98 | 2.66 | - | 12.46 | 46.14 | 18.72 | 27.42 | -0.23 | 0.18 | 66.78 | 33.03 | | SC | 71.3 | 20 | - | - | - | - | - | U6 |
| 6 | D32 | 16.05 - 16.50 | Very dense yellow light gray clayey sand with some grave | 2.09 | 1.97 | 2.65 | - | 10.32 | 45.26 | 18.26 | 27.00 | -0.29 | 0.20 | 74.45 | 25.34 | | SC | - | - | - | - | - | - | - | 51 |
| | D33 | 16.55 - 17.00 | | 2.08 | 1.96 | 2.65 | - | 13.12 | 46.41 | 14.01 | 32.40 | -0.03 | 0.26 | 39.08 | 60.66 | | SC | - | - | - | - | - | - | - | 47 |
| | D34 | 17.05 - 17.50 | | 2.09 | 1.95 | 2.66 | - | 12.69 | 46.50 | 17.31 | 29.19 | -0.16 | 0.00 | 44.5 | 55.50 | | SC | - | - | 622.4 | 311.2 | - | - | - | 54 |
| | D35 | 17.55 - 18.00 | | 2.12 | 1.97 | 2.67 | - | 11.20 | 36.09 | 19.31 | 16.78 | -0.48 | 0.00 | 43.48 | 56.52 | | SC | - | - | - | - | - | - | - | 57 |
| | D36 | 18.05 - 18.50 | | 2.18 | 1.96 | 2.68 | - | 11.94 | 34.22 | 15.39 | 18.83 | -0.18 | 0.00 | 31.33 | 68.67 | | SC | - | - | - | - | - | - | - | 56 |
| | D37 | 18.55 - 19.00 | | 2.21 | 1.98 | 2.65 | - | 13.50 | 33.89 | 12.95 | 20.94 | 0.03 | 1.64 | 63.7 | 34.66 | | SC | - | - | - | - | - | - | - | 59 |
| | D38 | 19.05 - 19.50 | | 2.19 | 1.96 | 2.68 | - | 13.43 | 26.98 | 12.70 | 14.28 | 0.05 | 2.15 | 68.45 | 29.40 | | SC | - | - | - | - | - | - | - | 54 |
| | D39 | 19.55 - 20.00 | | 2.23 | 1.97 | 2.63 | - | 10.64 | 30.06 | 18.28 | 11.78 | -0.65 | 2.28 | 66.59 | 31.13 | | SC | - | - | - | - | - | - | - | 54 |

Prepared by : NOURN SARETH

A69

| Control Points of Cambodia Technology Institute | | | | |
|---|---|---|---|---|
| PN | E=X | N=Y | El | D |
| 1 | 488727.497 | 1279069.428 | 8.838 | TBM0 |
| 2 | 488731.311 | 1279070.314 | 8.818 | TBM1 |
| 3 | 488898.528 | 1279011.364 | 8.442 | BM1 |
| 4 | 488748.829 | 1279004.289 | 7.901 | BM2 |
| 5 | 489025.521 | 1279100.781 | 8.841 | BM3 |
| Grid: UTM-UPS, Datum: WGS 84 | | | | |




| Rev.N. | Revision | Approved | Date |
|---|---|---|---|
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| | Name | Signature | Date |
|---|---|---|---|
| Designed by : | HAK NUMAN BORIN | | OCT.08.2012 |
| Studied by : | ..... | | |
| Checked by : | ..... | | |

Drawing Title : Master Plan

Dwg. N. : B

Scale : 0 10m 20m 40m

Sheet N. : B


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