

KINGDOM OF THAILAND

**MODEL INFRASTRUCTURE IMPROVEMENT WORKS
FOR LAND AND WATER CONSERVATION CENTER PROJECT
IN THE EAST OF THAILAND**

REPORT ON DETAILED DESIGN STUDY

FEBRUARY 1994

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

Based on the Record of Discussion (R/D) of the Implementing Organizations in Thailand, the Japan International Cooperation Agency (JICA) is implementing a five year program of technical cooperation in the Land and Water Conservation Center Project in the East of Thailand starting from June 1993, and linked with this technical cooperation activity, it has been decided to set up a pilot farm to prepare technical criteria.

JICA dispatched a study team to conduct the final design of this pilot farm led by Mr. Tsuneo Matsutomi, Deputy Director, Design Division, Construction Department, Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries, from 15 November to 14 December 1993, and the required site investigations were carried out.

This report collects together the results from these site investigations and the work in Japan, and it is considered that in principle the experimental farm may be practically implemented henceforth.

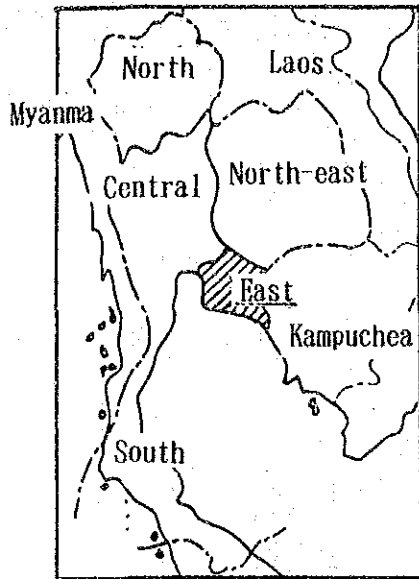
In conclusion, many thanks to everyone in Japan and Thailand who helped with this investigation.

February 1994

Michiyo ARIKAWA

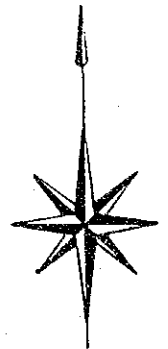
Managing Director

Agricultural Development Cooperation Department
JAPAN INTERNATIONAL COOPERATION AGENCY



LOCATION MAP

EAST OF THAILAND



BANGKOK



約 100km

Chachoengsao Province

Chonburi Province

Siracha

LDRO II

Chanthaburi Province

KAMPUCHEA

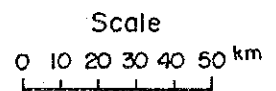
Pattaya

Rayong Province

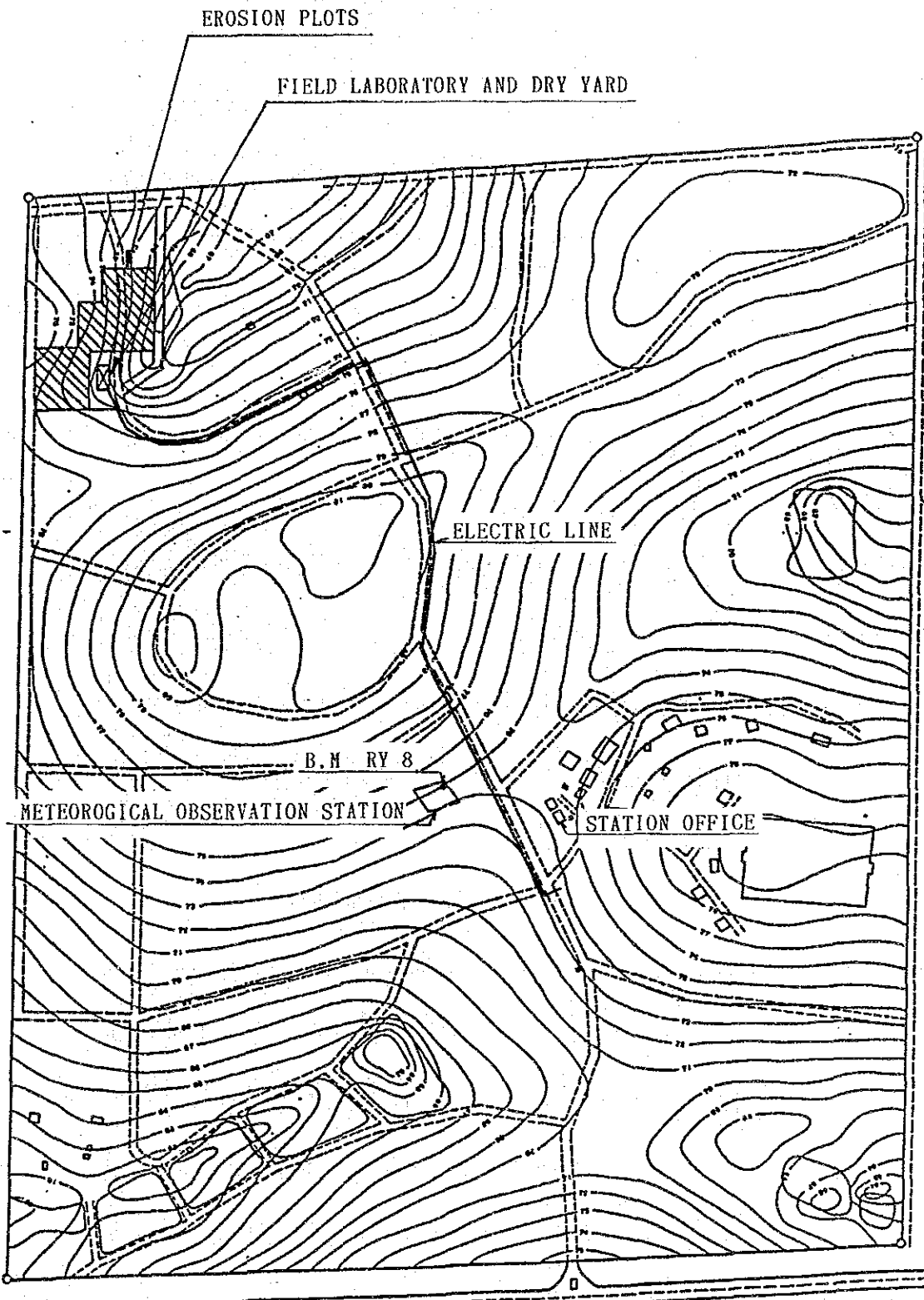
Trat Province

PROJECT SITE
(Rayong DLD Station)

- DLD Headquarters
- Pilot Area
- Provincial Boundary
- Provincial Headquarters
- L.D. Regional Office II
- ⊙ L.D. Station
- ▲ Land and Water Conservation Center



LOCATION MAP (RAYONG STATION)



GRID RTSO THAILAND 1:50,000
 SHEET 5234 IV SERIES L7017
 POINT A. N. = 1422420 M.
 E. = 741520 M.
 BENCH MARK (B.M.) DOPLER RY8 @ = 75.020 M.

- LEGEND
- STATION BOUNDARY
 - LOOSE OR LIGHT SURFACE
 - CONTOUR INTERVAL 10 METER

SITE PHOTOGRAPH



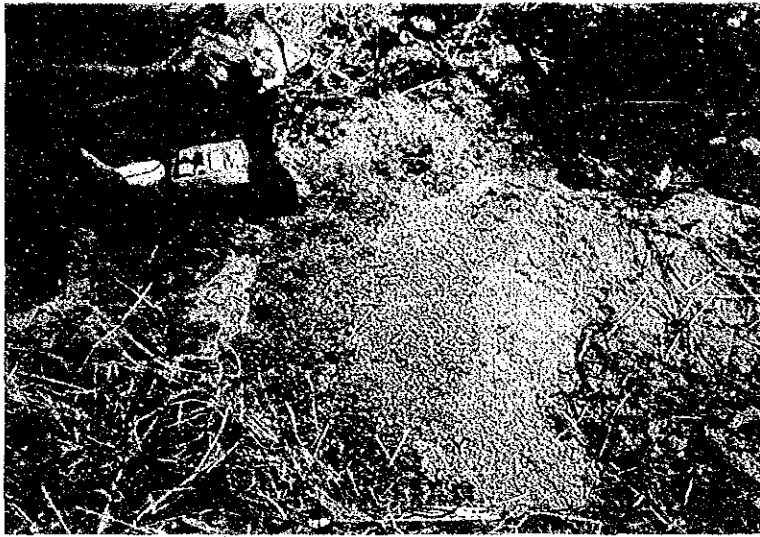
RAYONG STATION ENTRANCE



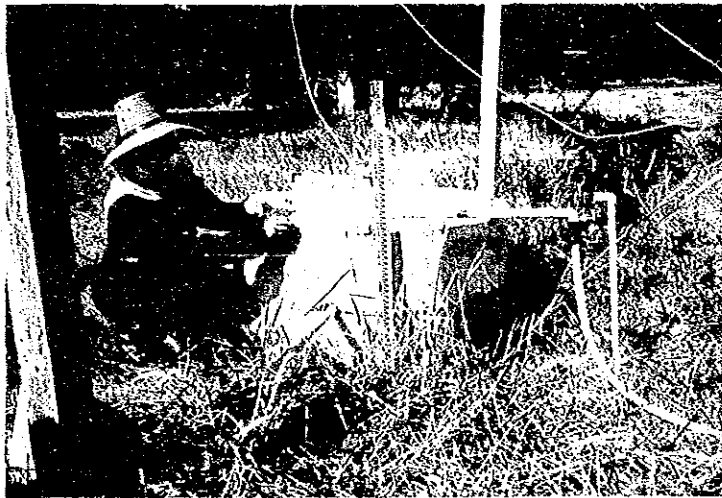
PROJECT SITE



SOIL SURVEY (TEST PIT)



SOIL ANALYSIS



WELL SURVEY



TOPOGRAPHIC SURVEY

PREFACE

LOCATION MAP

SITE PHOTOGRAPH

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1. DISPATCH OF STUDY TEAM

1.1 Background and Objectives for Dispatch of Study Team

In Thailand in recent years forest stripping and poorly disciplined land development has caused serious soil erosion and drought damage, and the rise in agricultural production is barely more than twenty years ago.

This is not because crop productivity has increased, it is due to the increase in the area under cultivation. This agricultural land has a shallow depth because it was developed on steeply sloping land, the volume of soil loss has gradually increased, and even with the application of fertilizers the productivity has not risen. This has brought about a drop or stagnation in Thailand's agricultural productivity recently.

To resolve the above problems and to increase agricultural productivity, the Department of Land Development (DLD) is actively promoting soil and water preservation by the use of small storage reservoirs and farm ponds in the Agricultural Community Development Program of the 6th and 7th National Economic Development Plan.

In East Thailand, the area of farmland has enlarged rapidly due to various reasons, and soil loss has occurred because there has been almost no consideration of the preservation of agricultural land. The volume of soil loss is estimated at 34 ton/ha/year from the farm land in East Thailand (880,000 ha), a total of 30 million tons, and preservation measures are becoming urgent.

In the 7th National Five Year Plan the Thai Government is continuing the implementation of agricultural land preservation measures in this region, but on the Thai side technical know-how is not so advanced. The training of engineers in this field is urgent, and therefore in May 1991 to implement a technology transfer concerning methods of agricultural land preservation planning techniques, project type technical cooperation was requested from the Japanese government by the Thai government.

Upon this request on 26 March 1993 the Japanese and Thai Governments signed and exchanged Minutes of Discussion (R/D) and TSI, and from 10 June 1993 a five year technical cooperation agreement was implemented for the points below.

1. Preparation of Technical Standards for Preservation of Agricultural Land and Water Supply

2. Management of Preservation of Agricultural Land and Water Supply Projects
3. Cultivation for Preservation of Agricultural Land and Water Supply and Preparation of Soil Management Manuals
4. Training in Preservation of Agricultural Land and Water Supply

The aim of the operation of this project is to introduce the practical results attained from implementation of pilot projects conducted by the Department of Land Development (DLD) in the field of technical demonstration (displays), but in order to establish suitable technology on site with various trial measures, it will be necessary to construct the facilities for a pilot farm separately on private farm land in order to examine the technology for the project concerned.

At the R/D discussion stage, a Model Infrastructure Construction Project regarding soil erosion at a pilot farm, was requested by the Thai government. After the arrival of the experts, a Plan of Operation for cooperation with the Thai government was drawn up, and the Japanese government dispatched a study team for the final design.

The purpose of the Model Infrastructure Construction Project is to prepare design criteria to be applied to agricultural land preservation planning in East Thailand in the future, and to establish the required experiments and measurement facilities for the operational criteria.

The main contents of the plan are forming and setting up of erosion plots and construction of the field laboratory (one building).

1.2 Study Team Members

Name	Speciality	Organization
Tsuneo MATSUTOMI	Team Leader	Deputy Director, Overseas Land Improvement Cooperation Office, Design Division, Agricultural Structure Improvement Bureau, MAFF
Hirofumi HAYASHI	Cordinator	Staff, Planning Division, Agricultural Development Cooperation Department, JICA

Ryosuke SAKANASHI	Field Design	Taiyo Consultants Co., Ltd.
Noriyasu SHIMIZU	Irrigation Facilities Design	Taiyo Consultants Co., Ltd.

1.3 Schedule for Site Investigations

The site investigations were conducted over thirty days, from 15 November to 14 December 1993.

No.	Date	Day	Member	City	Work Schedule
1.	Nov. 15	Mon.	4	Bangkok	Arrive in Bangkok from Japan
2.	16	Tue.	4	"	Courtesy call at DLD, JICA
3.	17	Wed.	4	"	Meeting with project members concerned
4.	18	Thu.	4	Sriracha/Rayong	Field reconnaissance and discussion
5.	19	Fri.	4	Chachoengsao	"
6.	20	Sat.	4	Bangkok	Preparation for letter of team leader
7.	21	Sun.	4	"	"
8.	22	Mon.	3	"	Meeting with project members concerned
			1	Sriracha/Rayong	Preparation for topo-survey
9.	23	Tue.	4	Bangkok	Submission of letter, reporting to JICA
10.	24	Wed.	4	"	Courtesy call at DLD, JICA
11.	25	Thu.	2	Sriracha/Rayong	Investigation of present condition
12.	26	Fri.	2	"	"
13.	27	Sat.	2	"	"
14.	28	Sun.	2	"	Data Arrangement
15.	29	Mon.	2	Bangkok	Data collection
16.	30	Tue.	2	Sriracha/Rayong	Investigation of present condition
17.	Dec. 1	Wed.	2	"	"
18.	2	Thu.	2	"	"
19.	3	Fri.	2	"	"
20.	4	Sat.	2	"	Data Arrangement
21.	5	Sun.	2	Sriracha	"

22.	6	Mon.	2	Sriracha/Rayong	Investigation of present condition
23.	7	Tue.	2	"	Reporting to LDRO2
24.	8	Wed.	2	"	Site meeting with electric surveyors
25.	9	Thu.	2	Bangkok	Report/Discuss with project members
26.	10	Fri.	2	"	Data Arrangement
27.	11	Sat.	2	"	Preparation of field report
28.	12	Sun.	2	"	Preparation of field report
29.	13	Mon.	2	"	Reporting to DLD, JICA, EOJ and DTEC
30.	14	Tue.	2		Leave Bangkok for Japan

1.4 Visited Agency and Concerned Persons

Main concerned persons we met in this study period are as below ;

•Embassy of Japan

First Secretary

Hinomori KUROKI

•JICA Thailand Office

Resident Representative

Shinichiro OMOTE

Assistant Resident Representative

Toshio ASANO

Assistant Resident Representative

Naoto HATTORI

•JICA Expert

DLD Advisor

Hiroyasu KOBAYASHI

•JICA Expert / LWCC Project

Team Leader

Yasuhiko MISHIMA

Cordinator

Yoshinori TAKAHASHI

Planning and Design Criteria

Akira MIYAZAKI

Construction and Monitoring

Tumunari SAGAWA

Cultivation and Soil

Hiro moto INOUE

Monitoring and Verification Study

Tamotsu FURUYA

(Short Period)

Covercrop Cultivation

Kazumi MAEDA

(Short Period)

•Department of Land Development

Director General	SITILARP Vasuvat
Deputy Director General	BOONYARAK Suebsiri
Director, Planning Division	UPATHAM Potisuwan
Director, Engineering Division	CHAIRAT Seniwongse
Director, Regional Office 2	PADEGE Kanchanakool
Chief Engineer, Engineering Div.	TAKAPONG Hunpitukyarp
Chief of Technical Section, LDRO2	PORNCHAI Suthathorn
Soil and Water Censervation Div.	SUTHAM Paladsongkram
Planning Division	PHACHONGCHIT Boonyarach

2. OUTLINE OF EXPERIMENTAL FARM PROJECT

2.1 Location

Based on the implementation survey conducted by JICA in May 1993, the location of the pilot farm was by mutual agreement a plot to the south west of Rayong DLD station in Rayong province.

Rayong Station is located in Mab Sub-district. Ban Kai district, Rayong Province, and is under the management of the Land Development Regional Office2 (LDRO2).

2.2 Contents of the Experiments

With the purpose of measuring and collecting basic data for the technical criteria of soil and water conservation, a soil loss experimental farm will be established and data collected under various conditions in order to analyse the soil loss mechanism. With the cooperation of the experts from Japan and the representatives from the Thai government, it is planned to conduct measurements of the quantity of soil loss from the 17 plots in the experimental farm with different conditions such as topography, slope and vegetation. The layout of the 17 plots is as shown in Table 2.1.

2.3 Field Laboratory

To deal with the data and soil samples collected from the 17 plots of the pilot farm on site, an field laboratory building will be established. The field laboratory will have four rooms, the soil experiments room, the data collection and analysis room, the soil

Table 2-1 Plot Layout and Arrangement

Symbol ○ : the item of investigation

Plot No.	Purpose of Plots	Introduced Crop		Cultivation Method	Remarks	soil loss	har-vest	USLE factor		
		(Main)	(Sub)					K	L	C P
1	Traditional farming	cassava	-	up and down ploughing	rainy season	5m × 22.1m	○	○	○	○
2		cassava	-	-ditto-	dry season	-ditto-	○	○	○	○
3	Intercrop farming test	cassava	peanut	Contour ploughing		-ditto-	○	○	○	○
4		cassava	mungbean	-ditto-		-ditto-	○	○	○	○
5		cassava	cowpea	-ditto-		-ditto-	○	○	○	○
6		cassava	blackgram	-ditto-		-ditto-	○	○	○	○
7	Soil erosion test (trial)	(bare land)		up and down ploughing		5m × 22.1m × 2.5%	○	○	○	○
8		-ditto-	-ditto-	-ditto-		5m × 44.2m × 1.5%	○	○	○	○
9		-ditto-	-ditto-	contour ploughing with deep tillage		5m × 22.1m × 2.5%	○	○	○	○
10		-ditto-	-ditto-	-ditto-		5m × 44.2m × 1.5%	○	○	○	○
11	Soil erosion test 5%	-ditto-	-ditto-	vertical drain method		5m × 22.1m × 2.5%	○	○	○	○
12		(bare land)		up and down ploughing		1.83m × 22.1m	○	○	○	○
13		-ditto-	-ditto-	-ditto-		-ditto-	○	○	○	○
14		-ditto-	-ditto-	-ditto-		-ditto-	○	○	○	○
15	Soil erosion test 9% (Standard)	(bare land)		up and down ploughing		1.83m × 22.1m	○	○	○	○
16		-ditto-	-ditto-	-ditto-		-ditto-	○	○	○	○
17		-ditto-	-ditto-	-ditto-		-ditto-	○	○	○	○

sample storage room and the equipment room, and display space etc. In addition, on the south of the field laboratory an open area with a roof will be built as a drying area for the soil samples. The size of the building is to be about 150 m².

2.4 Other Facilities

Accompanying the construction of the experimental farm and the field laboratory, a road will be rebuilt, and drainage channels, a well, electricity connections and safety measures will be implemented.

3. INVESTIGATIONS INTO EXISTING CONDITIONS

3.1 Topographical Survey

From the results of the site survey, it was decided to confirm the topography of the pilot farm and the planned site of the field laboratory, and a topographical survey was conducted over about 4 ha in the area of the planned site. The bench mark for the elevation datum near the Rayong Station Administration Offices was at an elevation of 75.020 m (BM:RY8).

The scale of the surveyed drawing was 1:500, completed with traverse measurements on the site and mesh measurements (20m x 20m mesh) in the area.

The survey showed that the planned site is located at an elevation of between 69.5 and 76.0 m. Most of the area is presently uncultivated farmland, but part is used for the cultivation of mangoes. The connecting road within the area will be used as the access road after completion of the experimental farm.

3.2 Soil Survey

From the results of the site surveys, it was decided that about 1.5 ha in the west tip of Rayong Station would be the planned site for the soil loss pilot farm. In order to confirm the soil cross-section conditions in this area six soil pits (SP) and five auger borings (AB) were carried out.

From the soil pit investigations the area has an almost uniform soil structure, except for SP1 (top soils a little thick, and gravel layers deeper) and SP6 (top soil especially thin, bottom layers are higher). The same results were obtained from the auger

boring. With this, the area was selected as the planned site for the soil loss pilot farm, with the exclusion of SP1 and SP6. SP1 will be the site for the experimental laboratory building, and SP6 is a reserve.

The positions and the results of the soil investigations are shown in Figure 3.1 and in the Appendices.

3.3 Weather and Water Quality Survey

(1) Weather

A meteorological observatory station was established at the Rayong Station, and the temperature, rainfall, and evaporation etc. were being measured; however the equipment broke several years ago and measuring has been interrupted up to now.

The measured data (daily rainfall 1983-1987) from Rayong Station is not considered to be good enough, so data (temperature, rainfall, evaporation, humidity etc.) from both the neighbouring meteorology department (Huai-Pon Station) and the Ministry of Agriculture Testing Authority was collected.

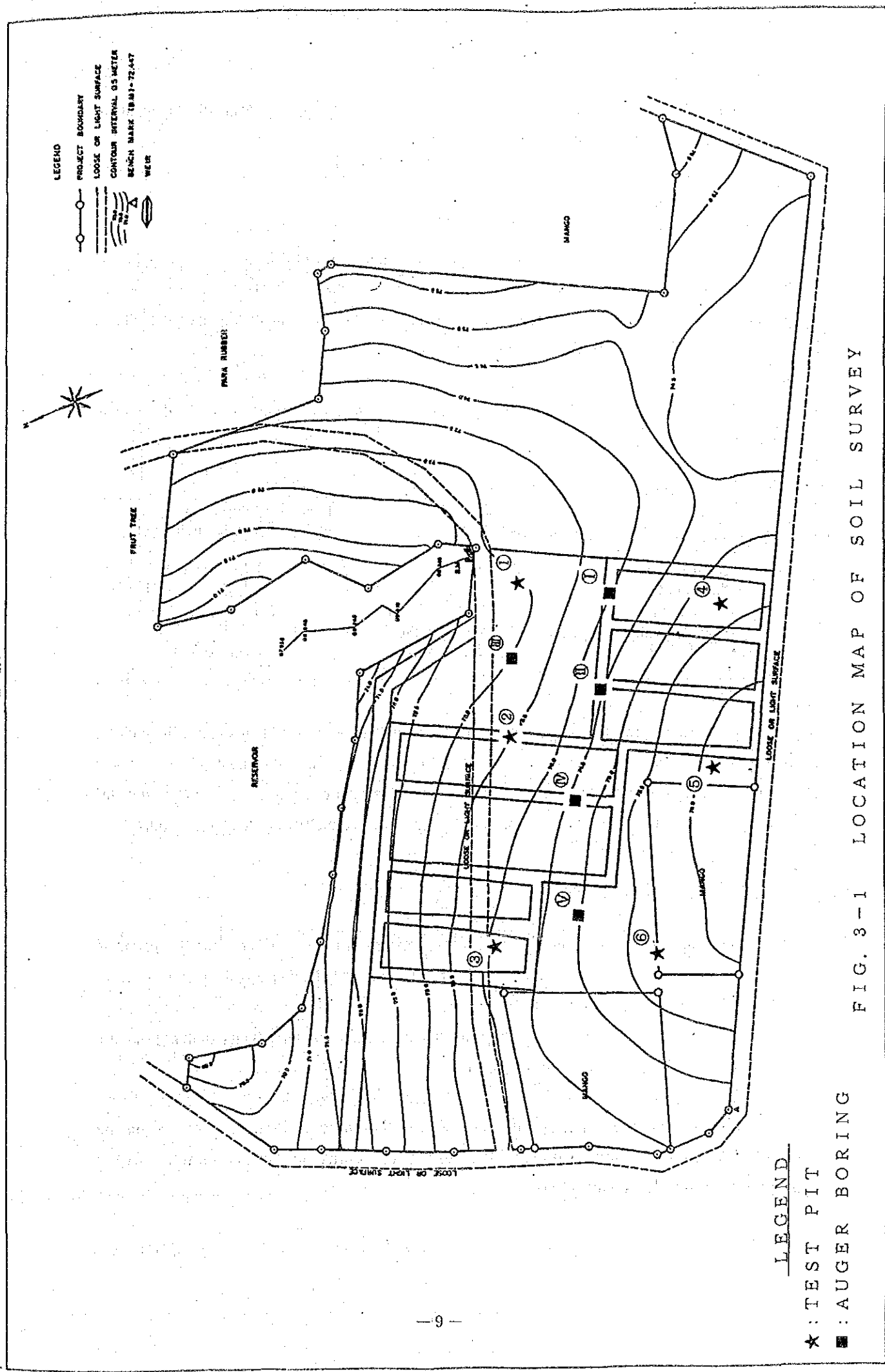
The monthly temperature and rainfall is as shown below.

ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVE/Y
MaxTemp (°C)	31.6	31.5	32.5	33.1	32.7	31.8	32.0	31.4	31.2	31.2	31.4	31.8	31.3
MinTemp (°C)	19.9	22.4	23.5	25.1	24.8	24.9	24.3	24.4	23.5	23.2	21.9	20.5	23.2
Rainfall (mm)	18	46	36	79	207	135	129	133	256	241	110	14	1402
Day of Rain	1.6	3.4	3.4	7.4	13.8	14.7	13.5	14.5	17.8	16.4	7.4	1.2	15.3

(Source) Huai-Pon Station, Meteorology Dept. : 20 years data (1969 - 1988)

In East Thailand the rainy season starts around May and continues for about eight months until November, and during the rainy season there is about 1,400 mm of rain. The annual rainfall varies, but ranges between 900 and 2,000 mm (1983-1992).

The rainy season shows two peaks, in the first half of June and from September to October.



LEGEND
 PROJECT BOUNDARY
 LOOSE OF LIGHT SURFACE
 CONTOUR INTERVAL 0.5 METER
 BENCH MARK (B.M.) 72.447
 WEIR

LEGEND

- ★ : TEST PIT
- : AUGER BORING

FIG. 3-1 LOCATION MAP OF SOIL SURVEY

The daily rainfall data from Rayong Station and the Ministry of Agriculture Testing Authority data are shown in the Appendices.

(2) Water Quality

There is no drinking water pipe supply at Rayong Station. Using ground water as drinking and miscellaneous use water for the experimental laboratory was considered, and changes in water level and water quality were investigated at two existing wells in Rayong Station. The well positions are shown in Figure 3.2.

The existing wells are shallow and were excavated by hand. The results of the investigations are as follows.

Item	Well No1	Well No2
Place	Near Adoministoration offices	Near the Proposed Field Laboratory
Elevation		
•Ground Elevation	76.5m	72.5m
•Well Bottom	66.8m	65.2m
Water Level	66.8m - 69.4m	65.2m - 66.7m
Water Quarity		
•EC	16 micromoh	21 micromoh
•pH	7.0	7.0

As may be seen from the above values, since the water level in the shallow wells during the dry season falls to near the bottom of the wells, the volume of pumped water becomes correspondingly smaller. Much water may be used at the experimental laboratory, and therefore it is planned to obtain ground water from a deep well source.

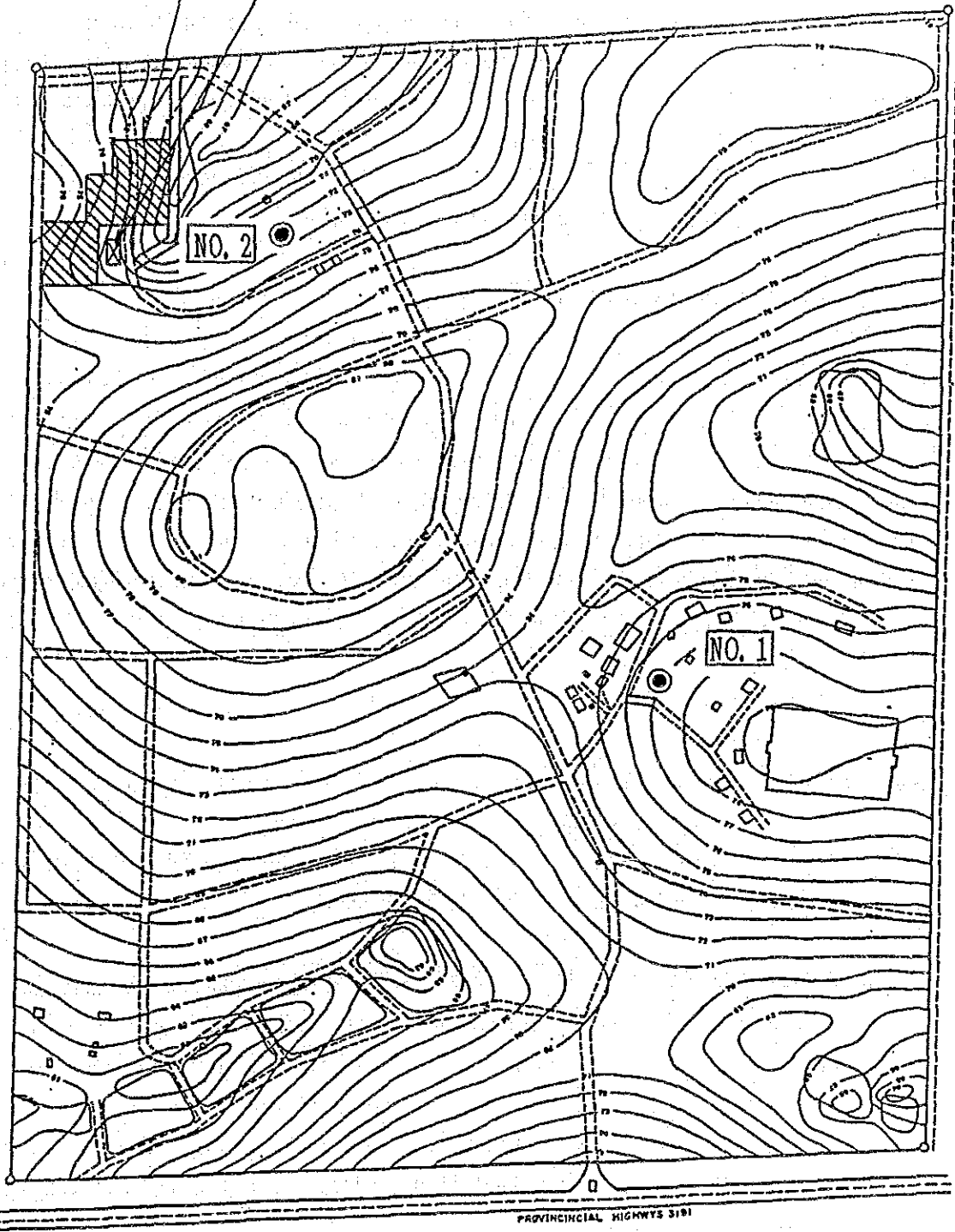
3.4 Electrical Power Survey

Household use 5 A power lines go to a laborers lodging house near the planned site of the pilot farm, but as it is 200 m from the planned site of the field laboratory, an extension to the power line would be required. However 20 A is considered necessary, so it is planned to install a new separate high power line from the transformer near the administration offices to the field laboratory.

The Provincial electricity Authority staff will conduct a site survey regarding the required length of the power line and the number of pylons etc., and an estimate of the project costs should be submitted.

EROSION PLOTS

FIELD LABORATORY AND DRY YARD



LEGEND




-  STATION BOUNDARY
-  LOOSE OR LIGHT SURFACE
-  CONTOUR INTERVAL 10 METER

FIG. 3-2 LOCATION MAP OF WELL SURVEY

3.5 Unit Costs of Construction Study

Data related to project cost calculations, such as the unit costs of construction materials, labour and construction works, has been collected by the DLD Engineering Department and for some things investigations into market prices have been carried out in Thailand.

4. DESIGN OF THE EXPERIMENTAL FARM

4.1 Design Conditions for the Experimental Farm

(1) Soil Loss Formula

The experimental farm is to be established with the purpose of analyzing the mechanism of soil loss. However as a basic soil loss equation, the USLE (Universal Soil Loss Equation) agricultural land preservation criteria established by the Land Preservation Bureau of the US Department of Agriculture will be used, as shown below.

$$A = R \times K \times L \times S \times C \times P$$

where

A : The annual average loss weight per unit are. (tf/ha)

R : Coefficient of Rainfall. Having obtained the annual average value of the Rainfall Erosion Index, EI, for each region. (tf•m³/ha•hr)

K : Soil Coefficient. Having obtained the coefficient for the loss per unit rainfall, it is the coefficient of the natural soil characteristics of a particular region in a standard farm (slope length 20 m, incline 5% (9%), flat furrowed fallow land). (ha/m²)

L : Coefficient of Slope Length. With the coefficient taken from the ratio of standard slope length (20 m), at the standard slope length L = 1.0. The soil loss is in proportion to this value.

S : Coefficient of Slope. For the function of the slope inclination, at the standard slope (5%) S = 1.0, and the weight of loss is in proportion to this coefficient.

C : Crops Coefficient. The coefficient is fixed for different crops and state of development, and at the standard value ($C = 1.0$) for the fallow state it is in proportion to the soil loss.

P : Preservation Coefficient. The coefficient shows the results of preservation farming for furrow direction and contour lines of cultivation, and for flat furrowed land and above and below the arable land it is in proportion to the soil loss for the standard value ($P = 1.0$).

(2) Configuration and Number of Plots on Pilot Farm

The plots in the experimental farm will be divided into five large groups for experimental purposes. The standard plot will be 5 m x 22.1 m x 5%, and they will be established at different separations and widths. For comparison with the USLE standard plot (1.83 m x 22.1 m x 9%), plots of this size and slope will also be established, taking into account the standard slope of the area.

With different crops and cultivation methods there will be 17 experimental plots. The configuration and number of plots according to experimental purpose, are shown below.

Plot No	Purpose of Plots	Plot Dimension	No. of Plot
No. 1 ~ 2	Traditional Farming	5m x 22.1m x 5%	2
No. 3 ~ 6	Intercrop Farming Test	5m x 22.1m x 5%	4
No. 7 ~ 11	Soil Erosion Test (Trial)	5m x 44.2m x 5%	5
No.12 ~ 14	" (5%)	1.83m x 22.1m x 5%	3
No.15 ~ 17	" (9%)	1.83m x 22.1m x 9%	3

The specification of plot division is as shown in Table 2.1

4.2 Experimental Farm Layout

(1) Plot Layout

The planned site of the experimental farm slopes downwards from the south to the north, the south side will be for cultivation, and the north side for sediment measurement. The 17 plots are in the area chosen from the soil investigations, and are numbered in sequence from the east.

The plots are to be partitioned with steel plate, and should be encircled by a works road 3 m wide.

(2) Soil Retaining and Measurement

Soil retaining and sediment measurement will be established at the lower end of the plots. With cooperation between the Japanese experts and the Thai staff, those structure will be implemented in the same way as in the Construction Work of the Demonstration Farm on the Agricultural Development Research Project Phase II in North-East Thailand.

The plot configuration is shown in Figure 4.1.

4.3 Road Works

Accompanying the experimental farm layout, an existing farm road will be moved to the north side. The structure of the new road will be the same as that of the existing road; total width 5 m, effective width 4 m, paved simply with a layer of sand. The works road surrounding the plots will have a total width of 3 m and will also be paved with a layer of sand. The length of the new road will be about 190 m, and the length of works road will be about 660 m.

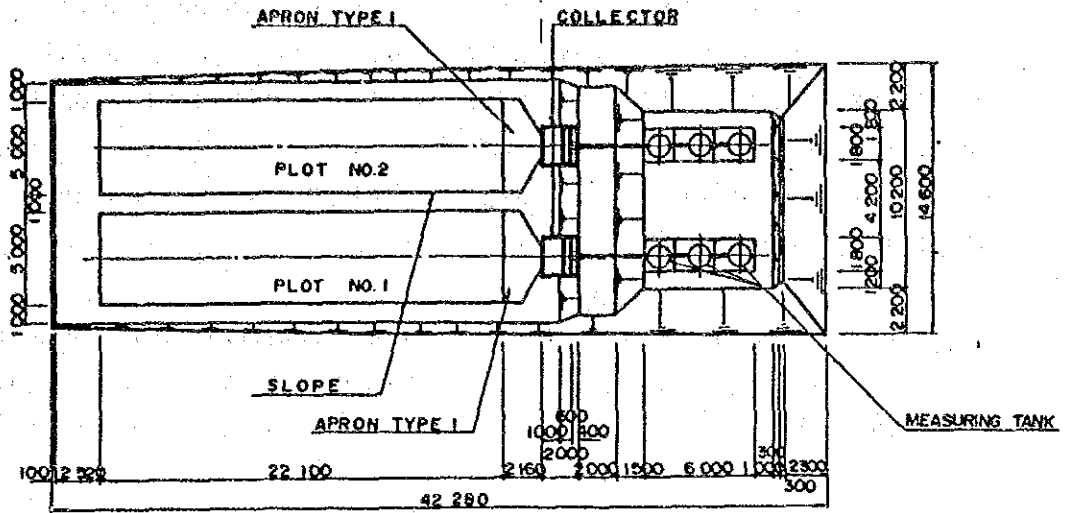
4.4 Drainage Works

Drainage canals will be established for the waste water from the experimental farm and the rain water from the works road and other spaces. The No. 1 drainage canal will be on the east side, and the No. 2 drainage canal on the west side. The No. 1 drainage canal will be 66 m long, and the No. 2 drainage canal will be 84 m long.

The canals should be at a 10% incline (cut earth drainage canal). The No. 1 drainage canal will discharge into an existing drainage box, and the No. 2 drainage canal will discharge into an adjacent pond in the north. As additional drainage works, there will be flow connecting leaders in eight places, connecting pipes in three places and five discharges to the pond. Concrete pipes will be used in the ducted sections, and for maintenance and control purposes they will be 600 mm in diameter. Gabions will be installed at the entrance to the pond to protect the whole pond.

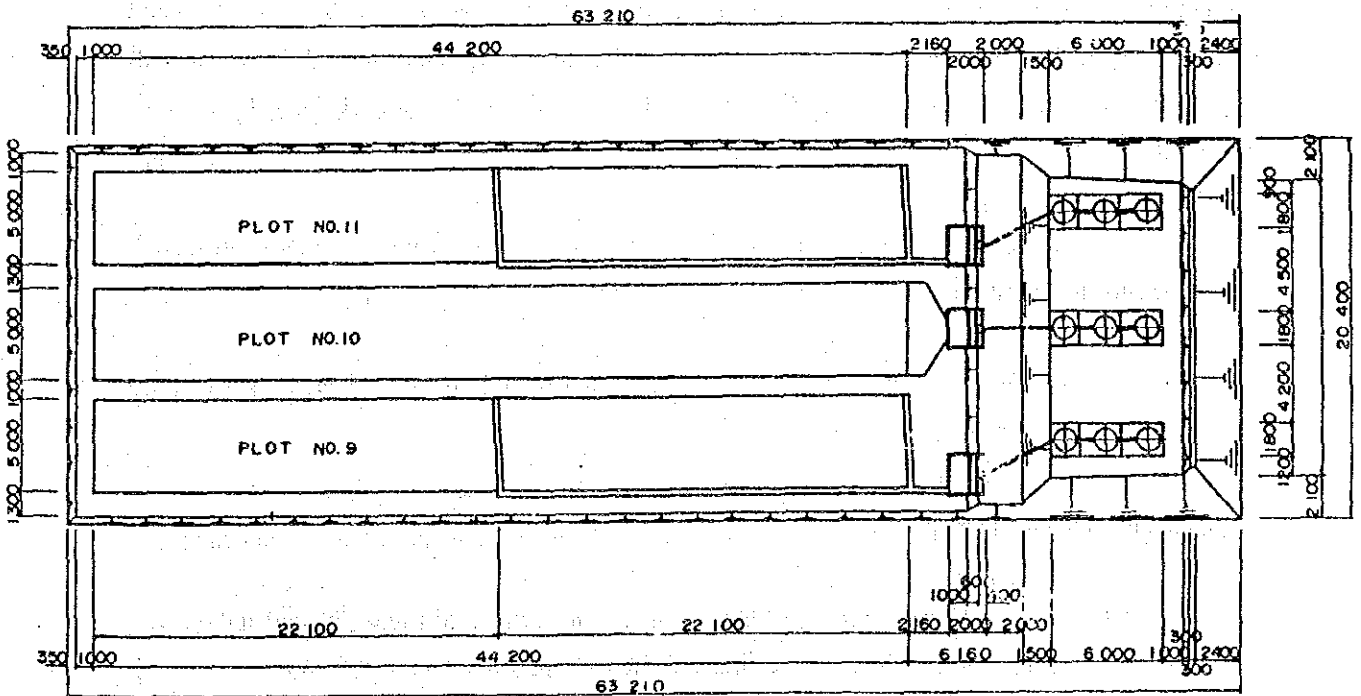
Fig.4-1 Demension of Test Plots

PLOT NO.1,2



PLAN

PLOT NO.9,10,11



PLAN

4.5 Field Laboratory Works

An field laboratory will be constructed on site, with facilities to manage, measure and analyse the soil sediment retained in the soil retaining sections of the 17 plots and the measurement water tank. The field laboratory will consist of four main rooms, the soil experiments room, the data collection and analysis room, the soil sample storage room, and the equipment room, as well as display space, a toilet and hot water service room. The building will be about 150 m² in area.

The building will have columns and beams of reinforced concrete, and the walls will be of block construction. The roof will be built with zinc roofing plates on lightweight steel trusses.

In addition, the sample drying area will be on the south of the building, roofed with a concrete floor and an area of 60 m².

4.6 Water Works

A deep well will be excavated for drinking and miscellaneous use water for the field laboratory. There are no deep wells in the vicinity of the Rayong Station, so following the advice of the station staff it is planned to excavate deeper than the estimated 30 m depth ground water level. Water will be extracted using a pump, and the water will be stored in a tank. The water will be circulated to the field laboratory with a small electric pump.

The casing of the deep well will be 100 mm in diameter, and the water pump will be 50 mm in diameter.

The storage tank will be on adjacent high ground. It should be of reinforced concrete with a volume of 10 m³.

4.7 Electric Line Works

Electricity will be connected to the field laboratory and the electrical measuring devices in the test plots. The electric line will be extended by about 800 m from the high voltage transformer at the Rayong Station Administration Offices.

It is considered that 20 A is needed for the constant temperature drying machines and measuring devices in the experimental laboratory, and for the operation of measuring devices such as rain and water level gauges in the test plots.

The electric line works include pylons, cabling and transformer works.

Rayong Station is on public land and as there is no one in the area who can connect it up, the regional offices of the provincial electricity authority will do this work. An estimation of the costs has been requested based on site consultation with the staff of the provincial electricity authority

The estimate has arrived at the time of writing (27 January 1994), and the costs are clear.

4.8 Other Works

Construction of a fence surrounding the pilot farm and gates. The fence will be 500 m long and 1.5 m high, while the gates, at two places crossing the connection road will be 4 m wide.

5. SELECTION OF MEASURING EQUIPMENT

For the soil loss etc., the measuring equipments below will be installed to collect various data.

5.1 Rain Gauge

In order to investigate the relationship between the soil loss and the rainfall, a rain gauge will be set up at a suitable location within the experimental farm site.

The annual rainfall in East Thailand is not so great at 1,400 mm, but the rainfall is concentrated in the rainy season and there are many occasions when in squalls much rain falls in a short time. Accordingly, it is desirable to have a rain gauge able to cope with concentrated rain bursts.

The siphon and tipping bucket (large volume bucket) types are considered suitable. In addition, to ensure the rainfall is measured accurately and to verify the data an automatic recorder type rain gauge should be selected.

A recorder (data logger) which can collect data with electric signalling should be installed, and a system should be considered that would treat the data rapidly.

The reference specifications of the automatic recorder rain gauges are as follows.

Siphon Automatic Recorder Rain Gauge, THIES Co. Ltd., Germany

Tipping Bucket Sensor Rain Gauge, Ohta Instruments Co. Ltd., Japan

5.2 Run-off Measuring Device

In order to measure the surface run-off including the soil discharging from the plots when it rains, partial flumes will be installed to measure the discharge at the bottom of the fixed plots. With regard to the size of the pilot farm they will be established at seven places.

With the estimated discharge, a six inch frame was selected for the partial flume. As it is also necessary to measure the discharge accurately even during dry days, differential manometer gauges capable of measurement even when the depth of water in the partial flume is low will be installed, and in addition automatic recording will be conducted with a data logger.

Treatment of the measured data will be carried out rapidly with a personal computer in the same way as for the rain gauge.

The reference specifications of the partial flumes are as follows.

Partial Flume/6 Inch Gauge, Ikeda Instruments Co. Ltd.

Water Level Gauge: Differential Manometer Gauge (for water depths of 0-20 cm)

5.3 Soil Moisture Content Gauge

Soil moisture content gauge will be used to measure the changes in the moisture content of the soil on the test plot. In general soil moisture content gauges are extremely sensitive devices, and as the changes in the water table height are large in East Thailand, the measurement width of the method commonly used in Japan "pressure measurement in proportion to soil moisture content tension" is too narrow. In addition this method needs a periodic water supply, and therefore it was considered inappropriate.

A method of calculating the soil water content from the thermal conductivity was considered appropriate for this region. The operation and maintenance of these measuring devices are easy, and data collection can also be conducted electrically.

Accordingly, soil water content gauges using the thermal conductivity measurement method were selected. The reference specifications of the gauges are as follows.

Soil Moisture Content Gauge and Sensor (with optional data logger), North Hi-Tech Co. Ltd.

Type: Thermal Conductivity Measurement Method

The seventeen test plots are divided into five groups, and there will be a complete set of soil moisture content measurements (sensors at the top, middle and bottom of the plots) for each group. Due to the limit to the sensor cord lengths, recorders (data loggers) will be established in two places. Recorder No. 1 connected to six sensors on the east side (two groups), and Recorder No. 2 connected to nine sensors on the west side (three groups). The sensors used in each block are applicable for the changes in the conditions.

The rain gauge will be connected to Recorder No. 2.

5.4 Data Management

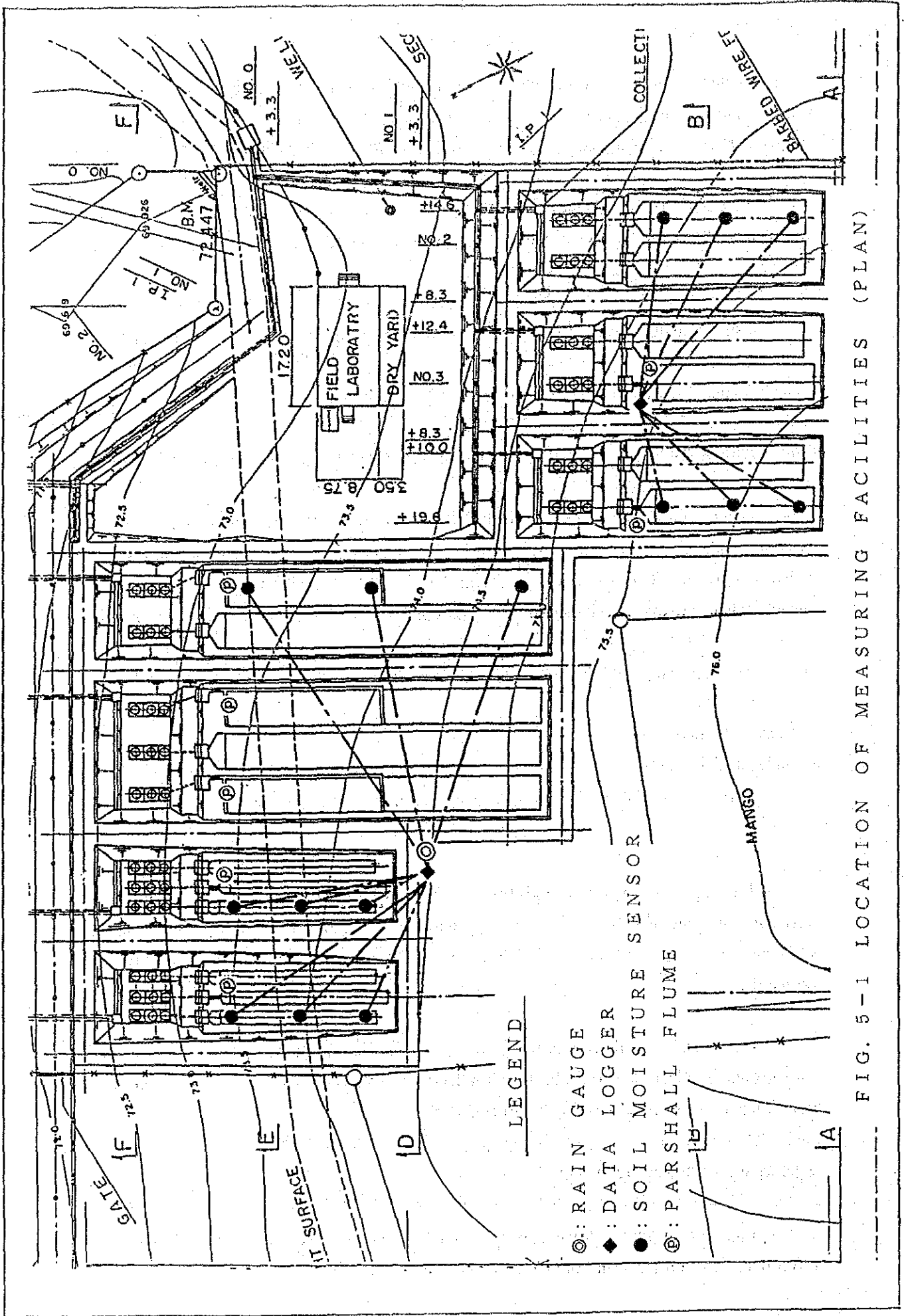
The data from all the data loggers can be managed on personal computers.

The Japanese experts are planning to use an IBM/PC with the required English software but because this computer is made for the Japanese market, most of the software concerned runs only with MS-DOS. At the present stage no other software will be used.

If a German-made rain gauge is used (e.g. the Seba Hydrometrie rain gauge and data logger: MSDII), it should be possible to run it with the IBM/PC, but it is necessary that this is reconfirmed by the agent in Bangkok.

5.5 Layout of Measuring Device

The layout of the measuring devices above are shown in Figure 5.1. The references for the measuring devices are also shown as follows:



MAIN OBSERVATION EQUIPMENTS

Equipment	Q'ty	Remarks
1. Soil Moisture Measuring Apparatus	2 Unit	With Data Logger
2. Soil Moisture Measuring Sensor	15 Pieces	Heat Probe Method
3. Hard Box Cover	2 Pieces	Shade Box
4. Rain Gauge	1 Unit	Sensor Type
5. Parshall Measuring Flume	7 Units	With Data Logger
6. Water Level Measuring Apparatus	7 Units	

With a NEC-9801/MS-DOS personal computer it is possible to interface with the data from the data loggers directly, and standard software is also included.

The reference catalogues for the above measuring devices are included with the Appendices.

6. IMPLEMENTATION METHODS AND PROJECT PLANNING

6.1 Implementation Methods

This project includes the main land reclamation works for the experimental farm, and the additional field laboratory building construction.

The work is divided into both the 17 pilot test plots on either 5% or 9% slopes surrounded by partition walls, and the measurement and storage of the water run off and soil loss.

With the scale and content of the work exclude the electric line works, it is possible for a private construction company to carry it out, and with the amount and time scale of the work it is also judged that the construction equipment can be supplied by private companies. However since the water level in the deep well is unconfirmed sufficient construction time should be allowed. The electricity connection works are to be executed safely by the public electricity company, however care should be taken with the necessary procedures and construction time.

It will be necessary to have resident engineers with sufficient experience of project supervision permanently stationed on site to ensure the quality and contents of the experimental farm facilities.

6.2 Project Planning

(1) Experimental Farm Land Reclamation Works

After removing weeds and bushes over about 1.5 ha, land reclamation works will be carried out; excavation works for the fixed slope inclines for each plot group will be carried out, followed by the plot framework and measuring section works.

The 17 plot framework walls will be of corrugated steel with steel angles as supports.

In the measuring sections, a two stage sediment storage section built of concrete blocks will be constructed, with both flow volume measuring devices and suspended sediment measuring devices using concrete pipes.

(2) Road Works

The existing connecting road will be moved north because of the experimental farm plot layout. Cut and fill, rolling compaction and simple paving works will be carried out over about 190 m.

Rolling compaction and simple paving works will be carried out for the on-farm roads (total length about 660m).

(3) Drainage Works

Drainage chanals will be established at the bottom of the plots to remove rainwater from the farm area. These chanals will discharge either into existing drainage works or to an adjacent pond. Their length will be 150 m.

(4) Field Laboratory Works

The foundations will be a continuous concrete footing, and the columns and beams will be constructed of reinforced concrete. The walls will be of concrete blocks, with a number of windows and doors.

The roof will be constructed of wood trusses and galvanized zinc roofing plates.

(5) Water Works

Design and construction of a deep well will be carried out based on the results of a trial excavation. The work includes a water pump installation for use in the well. It is estimated that the depth of the well will be 30 m.

In addition, a reinforced concrete construction storage tank will be established next to the well to store the extracted water. A small pump will be put in the storage tank to circulate the water to the field laboratory.

(6) Electric Line Works

The electricity line will be extended by about 840 m from the transformer near the administration offices to the field laboratory. The provincial electricity authority have been requested to carry out the high voltage transformer connection work.

(7) Other Works

A fence will be built around the experimental farm site to ensure the safety of the facilities. In addition, gates will be installed at the crossing with the connecting road. They will be locked except in the rainy season so that nobody can pass through the site. The fence will be 500 m long.

6.3 Construction Work Schedule

The time scale for the implementation of this project is shown in Figure 6.1. Construction work schedules in the rainy season are unclear, but it is thought that in the dry season the experimental farm works will be completed in around three months, and the field laboratory building in four months. Accordingly, with the addition of one month for drawing up contracts, a total of five months will be necessary for all of the construction works.

Work Item	Month	First month		Second month		Third month		Fourth month		Fifth month		Remarks
		10	20	10	20	10	20	10	20	10	20	
1. Preparation Works												
2. Experimental Plots Works												
(1) Earth Works												
(2) Plot Flame works												
3. Road Works												
4. Drainage Works												
(1) Attached D. Canal Works												
(2) Branch D. Canal Works												
(3) Outlet Pipe Works												
(4) Confluence Works												
(5) Confluence Box Works												
5. Field Laboratory Works												
6. Water Works												Well and Tank
7. Electric Line Works												
8. Other Works												Fence and Gete
9. Clearing Works												

Fig. 6-1 CONSTRUCTION SCHEDULE

7. ESTIMATION OF CONSTRUCTION WORK COSTS

7.1 Conditions for Estimation of Construction Work Costs

The construction costs were estimated under the conditions below.

(1) Scope of the Estimation of Construction Work Costs

Does not include land acquisition costs (it is on public land) and project supervision costs (Ministry concerned and DLD).

(2) Unit Costs of the Project

The unit costs of the materials, labour and construction machinery have been confirmed from investigations on site. In addition, the unit costs from a similar project, the "Construction Work of the Demonstration Farm on the Agricultural Development Research Project Phase II in North-East Thailand" have been consulted.

(3) Scope of the Construction

a) Project Preparation Includes the Following.

Site Preparation and Cleaning Up Afterwards
Site Surveying

b) Experimental Farm Construction

Vegetation Removal, Cut and Fill, Construction of the Plot Framework, Soil Retaining Works
Sediment Discharge Measuring Works (Installation of Partial Flumes and Suspended Sediment Measuring Equipment)

c) Road Works

Cut and Fill, Rolling Compaction and Simple Paving Works

d) Drainage Works

Cut and Fill, Construction of Horizontal Section and Additional Works

e) Field Laboratory Works

Soil Experiments Room, Data Analysis Room, Soil Sample Storage Room, Equipment Room, Toilet and Outside Drying Area

- f) Water Works
Well Drilling, Water Pump and Storage Tank Works
- g) Electric Line Works
Transformer, Pylon, and Supply Line Works
- h) Other Works
Fence and Gates

7.2 Project Costs

(1) Unit Costs

Having collected and confirmed them at the time of the site investigations (December 1993) the construction costs were estimated using material and labour unit costs, machinery expenditure and work unit costs. For comparison, the unit costs from a similar project, the "Construction Work of the Demonstration Farm on the Agricultural Development Research Project Phase II in North-East Thailand" were consulted. In addition some of the material costs were investigated in the market place.

(2) Expenses

Included in the following are estimates of the work to be undertaken by private companies, 20% of the direct work costs.

- Temporary Site
- Temporary Building
- Equipment Transportation Costs
- Insurance Costs
- Site Personnel Costs
- Head and Branch Office Expenses
- Taxes
- Profit

(3) Contingencies

Due to discrepancies in the cost estimate stage and well construction stage, the increased expenses and unexpected works at each construction stage can not be estimated. For contingencies, add 10% of the direct construction costs and expenses.

(4) Total Estimation Cost

The total estimation cost is shown as follows:

Total Estimation Cost

I. Direct Cost

(1) Experimental Plots Work	Area : 1.5 ha plots : 17 pls.	1,140,000 Baht
(2) Road Work	Length : 850 m	145,000 Baht
(3) Drainage Work	Length : 150 m	207,000 Baht
(4) Field Laboratory Work	Area : 150 m ² Dry yard : 60 m ²	1,450,000 Baht
(5) Water Work	Depth of Well : 30 m	274,000 Baht
(6) Electric Line Work	Length : 840 m	785,000 Baht
(7) Other Work	Fence : 500 m	43,000 Baht
<hr/>		
Sub Total		4,044,000 Baht
II. In-direct Cost	20 %	808,000 Baht
III. Contingency	(I+II) x 10%	485,000 Baht
IV. Other Expense	(I+II+III) x 5 %	266,000 Baht
<hr/>		
TOTAL		5,603,000 Baht

CHAPTER 8. BID DOCUMENT

8.1 Tender Document (Draft)

8.2 Specification Document (Draft)

8.3 Design Drawings

8.1 Tender Document (Draft)

**BID DOCUMENTS
(DRAFT)**

FOR

**CONSTRUCTION WORK OF THE MODEL
INFRASTRUCTURE IMPROVEMENT WORKS**

FOR

THE LAND AND WATER CONSERVATION CENTER PROJECT

IN

THE EAST OF THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY

THAILAND OFFICE

CONTENTS

- * **Invitation for Bids**
- * **Instruction to Bidders**
- * **Proposal**
- * **Terms and Conditions of this Contract**
- * **Pledge Agreement**
- * **Contract**
- * **Technical Specifications**
- * **Drawings**

JAPAN INTERNATIONAL COOPERATION AGENCY

THAILAND OFFICE

INVITATION TO BID NO. _____

The Japan International Cooperation Agency, Thailand Office hereby invites sealed written bids for the Construction Work of The Model Infrastructure Improvement Works for the Land and Water Conservation Center Project in the East of Thailand (hereinafter referred to as "the Project"). The project has a total area of about 1.5 ha.

This Contract will include, among others, the following;

1. Terms and Conditions of this Contract
2. Pledge Agreement
3. Technical Specifications
4. Bill of Quantities
5. Drawings

Bid shall be addressed to _____, Resident Representative, Japan International Cooperation Agency, Thailand office, 1674/1, New Petchburi Road Bangkok 10310, Thailand, and marked "Sealed proposal, LWCC PROJECT"

The date for the opening of bids will be held at _____ o'clock p.m. / a.m., Thailand Standard Time on _____, 1994 at the JICA, Thailand Office.

A pre-bidding conference will be scheduled on _____, 1994 at _____ o'clock p.m. / a. m. at _____. Attendance for bidders is desirable.

Resident Representative of JICA
Thailand Office

INSTRUCTION TO BIDDERS

IB-01 PREPARATION OF BIDS

All bids shall be submitted in an original and three (3) copies on or before the hour and date fixed for receipt of bids, in accordance with the Invitation for Bids, and shall conform to the following requirements;

- a) One copy of proposal shall be marked "original". The original and copies of bids shall be submitted in its entirety with all banks in the proposal properly filled in.
- b) Bids prices shall be written in words as well as in figures. In case of discrepancy between the words and figures, the price in words shall prevail.
- c) The proposal must be signed by the Bidder with his usual signature and shall show his full business address.

IB-02 BASIS ON WHICH BIDS ARE REQUESTED

The form of the Contract to be awarded is on fixed unit price basis of payment to the Contractor, as specifically set forth in these Contract Documents. Bids are requested on the above basis and a proposal which is on any other basis will not be considered.

Quotation of prices shall be made in Thai Baht and the Contractor shall be paid in Local Currency.

IB-03 BID SECURITY

The original, but not the copies of each bid, shall be accompanied by a proposal bond in an amount equivalent to ten (10)% of the total bid price in the form of cash or certified check, as a guarantee that the successful bidder will, with % of the total bid price in the form of cash or certified check, as a guarantee that the successful bidder will, within ten (10) days from receipt of the notice of award, enter into Contract with the Japan International Cooperation Agency, Thailand Office, and complete faithful performance of the work specified in these Contract documents. In case the successful bidder fails for any

reason to execute such contract within the stipulated time, the bid security shall be forfeited to the Japan International Cooperation Agency, Thailand office as liquidated damages.

The bid securities will be returned without interest after the successful bidder has signed the Contract.

IB-04 DELIVERY OF BIDS

Bids shall be directly delivered to the Japan International Cooperation Agency, Thailand office,
_____ on or before the hour and date set for the opening of bids.

IB-05 WITHDRAWAL OF BIDS

A bidder will be allowed to withdraw his bid prior to the time set for the opening of bids if he communicates his purpose in writing to the Japan International Cooperation Agency, Thailand office, and his bid shall be returned to him unopened. No bid can be withdrawn for any reason whatsoever after the opening of bids has been made.

IB-06 BIDDER'S RESPONSIBILITY

The bidders shall be responsible for having taken steps to carefully examine all of the Contract Documents and also to have fully informed themselves as to all conditions, locality and otherwise, affecting the carrying out the Contract Works. Failure to do so will be at the Bidder's risk.

IB-07 DATA TO BE SUBMITTED WITH PROPOSAL

All proposal shall contain the following documents:

- a) A construction schedule showing the detailed proposal plan of operation and construction of each main item in the Bill of Quantities from start to completion of the Contract work. The schedule shall be in a bar chart form with weeks shown as the least unit of time and each main item on a separate

horizontal line. The schedule shall also show expected monthly accomplishment and financial requirements based on the Bill of Quantities.

- b) A list of equipment proposed to be used for the performance of the Contract Work. This list shall specifically enumerate the number, type and capacity.

IB-08 INTERPRETATION OF CONTRACT DOCUMENTS

If the prospective Bidder is in doubt as to the true meaning of any part of the Contract Documents, the Bidder may submit to the Japan International Cooperation Agency, Thailand office, a written request for interpretation allowing sufficient time for a reply to reach him before submission of his bid. Any interpretation of the proposed documents will be made only by a supplemental Notice duly issued.

IB-09 PRE-BIDDING CONFERENCE

A pre-bidding conference will be schedule on _____ 1994 at _____ o'clock p.m./a.m. at _____. Attendance for Bidders is desirable.

IB-10 COMPARISON OF BIDS

In making its selection, the Japan International Cooperation Agency, Thailand Office will not be bound to award a Contract to the bidder submitting the Bid with the lowest indicated cost, but will take into consideration the bid prices, unbalanced bid, guaranteed completion time and other relevant consideration.

IB-11 AWARD OF CONTRACT

Bids will be opened in the presence of the Bidders who may desire to attend such opening by the Japan International Cooperation Agency, Thailand Office, at ___ o'clock p.m./a.m. Thailand Standard Time on _____, 1994.

Promptly after the opening of the bids the Japan International Cooperation Agency, Thailand office will undertake a detailed study and appraisal of the proposal submitted. The

Contract will be awarded to the Bidder whose proposal is considered to be the most advantageous to the Japan International Cooperation Agency, Thailand office. The Japan international Cooperation Agency, Thailand Office reserves the right to reject any and all bids received.

IB-12 BID DOCUMENTS

Bid documents shall include the following;

- a) Invitation for Bids
- b) Instruction to Bidders
- c) Proposal
- d) Pledge Agreement
- e) Contract
- f) Technical Specifications
- g) Terms and conditions of this Contract
- h) Bill of Quantities
- i) Drawings

PROPOSAL

To: Mr.
The Resident Representative
Japan International Cooperation Agency, Thailand Office
1674/1, New Petchburi Road, Bangkok 10310

P-01 BILL OF QUANTITIES AND BID PRICES

The undersigned Bidder having carefully examined in their entirety the Contract Documents for the Construction Work of The Model Infrastructure Improvement Works for the Land and Water Conservation Center Project in the East of Thailand, hereby offers and proposes to perform all of the construction and services, to furnish all equipments, materials, supplies, labor and other items described in the Contract Documents, all for the unit or lump sum prices stated in words and figures in the following quantities:

Total Price of Estimated Cost
(in words and figures)

- Bill of Quantities to be attached herein.

P-02 GUARANTEE OF COMPLETION

The undersigned Bidder guarantees to effect the commencement, prosecution and completion of the Contract Works.

P-03 BID SECURITY

The undersigned Bidder hereby certifies that all statements herein are made on behalf of _____

Dated this _____ day of _____

Name _____
Title _____
Firm's Name _____
Firm's Address _____

Witness

TERMS AND CONDITIONS OF THIS CONTRACT

Section 1 General Information

1.1 Objective

According to the Record of Discussion signed, technical cooperation concerning the Land and Water Conservation Center Project in the East of Thailand (hereinafter referred to as "the Project") is being carried out.

The objectives of the Model Infrastructure Improvement Works are to construct the Experimental Farm in which the experiments concerning soil conservation will be implemented.

1.2 Location of the site

The work site is located at Rayong Land Development Station in Ampho Bankhai Rayong Province

1.3 Collaboration

JICA assists DLD's activities of LWCC through the project type technical cooperation scheme according to the Record of Discussion. Prior to or during the course of the Works, the Contractor shall make the good relation within the related Organizations *) for the satisfactory implementation of the Works as to secure full collaboration. Should it happen that the relation between these organizations and the Contractor is disturbed, the Contractor shall inform the Inspection Committee who will conciliate the both parties.

- *) LWCC : Land and Water Conservation Center
- DLD : Department of Land Development
- DOA : Department of Agriculture (if necessary)

Section 2 Submission of Notices

2.1 Work schedule

The Contractor shall submit the Work Schedule in following items before the commencement of the Works at the work site. If the Contractor intends to change the Work

schedule, the approval from the Inspection Committee shall be obtained prior to the modification of the schedule.

1. Preparation of facilities and transportation of equipment etc. to the work site
2. Run-off Plots
3. Drainage Canal
4. Farm Road
5. Related Facilities
6. Field Laboratory (Building)
7. Cleaning of Site

Also the Contractor shall submit the machineries scheme including the numbers, kind of machineries and using period of them.

2.2 Notices

The JICA and the Contractor shall submit the notices to each other, as necessary, in accordance with Article 19 in this Contract within reasonable time except the special articles provided in Terms and Conditions of this Contract.

Section 3 Field Test and Inspection

The field tests in accordance with the Technical Specification and the demands from the Inspection Committee shall be the responsibility for the Contractor. The charges for such field test shall be included in the total amount of the construction cost, and the Contractor is not entitled to claim any amount of the field test charges.

Section 4 Modification of Plan

In case the JICA estimate the cost for the modification in accordance with Article, and if there are two portions, one for the increase and the other for the decrease of the construction cost resulting from such modification, the JICA shall have the right to offset them in the payment and pay of claim the difference between the increase and decrease of the construction cost as the case may be.

Section 5 Release from the Works

After the final acceptance of the Works by the JICA, the Contractor shall remove its own temporary facilities, warehouses, construction roads, electric wiring, surplus material debris and so forth which were provided by the Contractor within ten (10) days. Upon approval of the Inspection Committee for the removal of the abovementioned facilities etc. the Contractor will be released from its responsibility of the Works but remains responsible under one (1) year guarantee of the Works as specified in Article 11 in this Contract.

Section 6 General obligations of the Contractor

6.1 Temporary office and residence

In case the Contractor intends to build the temporary office, residence and so forth, the Contractor shall submit the plan to the Inspection Committee for approval at least ten (10) days in advance of the commencement of the Works.

The Contractor is required to always keep the buildings and facilities in good condition and to make proper drainage and sanitary system. Should the Contractor build them outside of the work site, the Contractor shall arrange with the owner of the such land and at its own expense.

6.2 Fuel storage

In area of temporary office and residence, the fuel tank capacity shall not exceed 1,000 liters and shall be far away from the housing area.

Fuel storage and transportation shall be done with care and shall have a good system of fire prevention. if storage licence is required, the Contractor shall arrange for obtaining it.

6.3 Other facilities

All necessary facilities for the Works and the Contractor's convenience shall be provided and maintained in good condition by the Contractor.

Section 7 General Text

The Contractor shall implement the Works in accordance with the Contract Documents in broad sense and in narrow sense, Terms and Conditions of this Contract, Technical Specifications. Should the events occur that the both parties can not reach agreement on the interpretation of the above-mentioned Contract Documents in broad sense, both parties shall negotiate with sincerity and good faith for settlement of any disagreement, failing with the decision of the JICA shall prevail.

PLEDGE AGREEMENT

To Japan International Cooperation Agency, Thailand Office

Date _____

We _____, the Contractor hereby agree that all equipment, materials and supplies brought to the work site under this Contract made with the JICA date on _____, shall be pledged by us with the JICA as security for our execution of Works, and shall not be removed at any time without prior approval of the JICA in writing.

We further agree that should there be any loss or damage to pledged equipment, materials and supplies kept at the work site, the JICA shall bear no responsibility whatsoever for such loss or damage.

Name _____

Title _____

Firm's Name _____

Firm's Address _____

CONTRACT

FOR

CONSTRUCTION WORK

OF THE MODEL INFRASTRUCTURE IMPROVEMENT WORKS

FOR

THE LAND AND WATER CONSERVATION CENTER PROJECT

IN

THE EAST OF THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY

THAILAND OFFICE

CONTRACT

**CONSTRUCTION WORK OF THE MODEL
INFRASTRUCTURE IMPROVEMENT WORKS FOR THE LAND AND WATER
CONSERVATION CENTER PROJECT**

IN

THE EAST OF THAILAND

This Contract is executed on the _____ day of _____ at the JICA Thailand Office between

The Japan International Cooperation Agency, Thailand Office, by _____, Title _____ s its authorized representative of the JICA Thailand office, hereinafter referred to as "the JICA" of the one part, and

_____ whose office is situated at _____

Tel. _____ Represented by _____

Nationality _____ Title _____ hereinafter referred to as "the Contractor", of the other part.

Both parties mutually agree under the terms of this Contract as follows:-

Article 1 Purpose of Agreement and Contract Price

The JICA agrees to employ the Contractor and the Contractor agrees to perform the Works for the Construction of the Model Infrastructure Improvement Works for the Land and Water Conservation Center Project in the East of Thailand for the total amount of _____ Baht (_____ Baht), hereinafter referred to as "Contract Price".

The following documents shall form integral part of this Contract:-

Terms and conditions of this contract

Pledge agreement

Technical specifications

Bill of Quantities

Drawings

Article 2 Performance Bond

As a security for the faithful performance of the Works under this Contract, the Contractor has on the execution of this Contract deposited a performance bond with the JICA in lieu thereof a Bank guarantee issued by the The Bank of _____ bearing the number _____ and dated on _____ in the amount of _____ Baht (_____ Baht) which represents five (5) percent of the Contract Price, the name of the issuing bank and the form of the bank guarantee are to be approved by the JICA.

The JICA will return the Performance Bond in cash or the Bank Guarantee to the Contractor after final acceptance of the Works by the JICA as stipulated in Article 15 of this Contract, provided that the completed Works shall not show any defect or damage caused through the fault of the Contractor, or through the fault of any new Contractor in the case of termination of Contract by the JICA under Article 4.

Should the Contractor be in default, the JICA shall have the right to demand payment from all or any part of the Performance Bond. In addition, the Contractor shall remain liable for the full loss sustained by the JICA.

Article 3 Payment

The JICA agrees to effect payments for the Works to the Contractor in the following manner:-

- a. Advance Payment, to be effected upon the bringing of part of equipment and materials required for the Works and having stored at the work site by the contractor, and upon the verification of those facts by the Inspection Committee.

_____ Baht (_____ Baht)

which corresponds to Thirty (30) percent of the Contract Price, shall be paid upon signing of this Contract.

- b. Interim Payment, to be effected according to the progress of the Works satisfactorily executed by the Contractor and accepted by the Inspection Committee.

_____ Baht (_____ Baht)

which corresponds to Forty (40) percent of the Contract Price, shall be requested for payment at _____.

- c. Final payment, to be effected upon the satisfactory completion of the Works by the Contractor and accepted by the Inspection committee.

The remainder of _____ Baht

(_____ Baht) which corresponds to Thirty (30) percent of the Contract Price, shall be paid after the Final Certificate by the JICA for payment to the Contractor.

Payment under (b) and (c) shall be effected within ten (10) days after the respective acceptance of the Works by the Inspection Committee.

Taxes payable by the Contractor, if any, shall be deducted at source by the JICA on each payment.

It is expressly understood that payments by the JICA do not mean acceptance responsibilities under this Contract.

Article 4 Completion Time

The Contractor agrees to commence the Works at the site within ten (10) days from the date of signing of this Contract (commencement date) and the Contractor agrees to satisfactorily complete the Works within _____ days (completion time) from the date hereof which will become due on _____ (completion date).

If the Contractor fails to commence the Works by the above commencement date, or should in the course of the construction any event occur which may reasonably cause the JICA to believe that the Contractor will not be able to complete the Works on the completion date, or should the Contractor fail to complete the Works by the completion date, or should the Contractor fail to meet any of the Contract requirement, the JICA shall have the right to terminate this Contract by giving written notice to the Contractor.

However, in case that the Contractor fails to complete the Works by the completion date, or to meet any of the Contract requirement, if the Inspection Committee thinks that the Contractor has the ability for completion of the Works within reasonably extended period, the Contractor may be permitted by the JICA to continue the Works beyond the completion date but within the extended time.

Article 5 Penalty

In case that the Contractor is in default as mentioned in Article 4, the Contractor agrees to be responsible to the JICA as follows:-

5.1 In case of the termination by the default of commencement for the Works, the Contractor shall pay a penalty of _____ Baht (_____ Baht) per day counting from the commencement date until the new Contract is completely executed with a new Contractor for this Works, the period of which is included the time spent for finding the new Contractor and executing the new Contract etc.

5.2 In case the JICA thinks that the Contractor will not be able to complete the Works within the completion time and thereby terminates this Contract, the Contractor shall pay a penalty of _____ Baht (_____ Baht) per day counting the number of days in the same manner as prescribed in 5.1 above. However, the JICA may reduce such number of days according to the ratio between the completed Works and the total Works as may be decided by the Inspection Committee.

5.3 In case the Contractor fails to complete the Works by the completion date or to meet any Contract requirement, the Contractor shall pay a penalty of _____ Baht (_____ Baht) per day counting from the date following the completion date until the Works satisfactorily completed and accepted by the Inspection Committee.

Article 6 Compensation

If the JICA sustains any losses as direct or indirect damages caused by the Contractor's failure, the Contractor shall compensate the JICA for such losses. The parties agree that time is essential for the completion of the Works.

Article 7 The JICA's right for default

The JICA has the sole and absolute right to decide whether to terminate the Contract, to impose only the penalty on the Contractor or to claim the compensation for the damage as stated in Article 5 or Article 6. The money due to the JICA exercising its right under this article shall be retained and deducted from any money due to the Contractor but yet unpaid including from the performance bond. If the total amount of the loss is larger than the money above-mentioned, the Contractor agrees that the JICA has the right to retain the construction equipment, materials and supplies etc. and demand payment of the balance from such equipment etc. or proceeds of sale thereof.

Article 8 Contractor's responsibility on termination of this Contract

After the contract has been terminated in accordance with the foregoing Article 4, the JICA shall have the right to employ another Contractor (hereinafter referred to as "New Contractor") to carry on the remaining parts of the Works, and the payment for the Contractor that fail to complete the work shall be made out of the necessary Contract price for the remaining Works. should the remaining amount after payment of the advance and interim payment from the Contract price, be insufficient to effect payment to the new Contractor, the difference between such remaining amount and actual cost estimated by the JICA for the satisfactory completion Works carried out by the new Contractor, shall be deemed as direct loss sustained by the JICA, and the Contractor shall pay such difference to the JICA within ten (10) days from the date of request by the JICA, failing which interest at the rate of eighteen (18) percent per annum shall be charged thereon.

Article 9 Inspection Committee

The Inspection committee, authorized to act on behalf of the JICA will be appointed by the JICA and the Inspection Committee is entitled to do all things that the JICA may do so. The Inspection Committee shall control and supervise the Works all the times whether it

is in the preparation of implementation of the Works and the Contractor shall promptly furnish all necessary facilities for proper inspections of the Works in accordance with the Inspection Committee's request. At any moment the Inspection Committee can request the Contractor to stop the Works, if necessary and the Contractor shall have no claim on the JICA for extension of the completion time due to such suspension of the Works under this Article.

The inspection will not be deemed as the acceptance of the Works, and the Contractor shall not be relieved from his responsibility to meet the Contract requirements by the fact that the Inspection Committee exercise their duties. Should it be found that the Works have not been satisfactorily performed in the faithful manner, the Contractor shall correct any part of the Works indicated by the inspection Committee within the period specified by the Inspection Committee.

Article 10 Prohibition for the equipment removal

Should the Contractor fail to complete the Works during the completion time or the Inspection Committee thinks that the Contractor will not be able to satisfactorily complete the Works, any equipment and materials brought to the site for use on the Works shall not be removed without the prior approval of the Inspection Committee in writing.

Article 11 Rectification of the defective construction

For a further period of One (1) year after satisfactory completion and final acceptance of the Works by the JICA, whether completed by the Contractor or by the new Contractor in case of termination of Contract under Article 4, any damage to the Works which is caused by the Contractor's fault, either because of defective workmanship or the use of inferior materials or any other cause, shall be made good as necessary by the Contractor to the satisfaction of the JICA at no extra cost.

In case of the termination of the Contract, the JICA may decide which part of the Works should come under the Contractor's responsibility, and requests the Contractor to make good of the damaged Works. Should the Contractor fail to do so within period specified after receipt of written request to do so from the JICA, the JICA shall have the right to employ another Contractor to carry out such work and the Contractor agrees to bear all expenses incurred.

Article 12 Discrepancies among the Contract Documents

If, prior to or during the course of the Works, any discrepancies are found in the drawings and/or the Technical Specifications etc. attached to this Contract, the Contractor shall follow the ruling given by the Inspection Committee at no additional cost to the JICA.

Article 13 Construction Method and Temporary Works

The construction method including implementation schedule and plan of the temporary works such as installation of temporary facilities, offices, ware houses, construction road, electric wiring, etc. shall be submitted by the Contractor and approved by the Inspection Committee at least ten (10) days in advance of the commencement of the Works.

Should the cost of the above temporary works be estimated in the unit cost of each work items of Bill of Quantities in this Contract, the Contractor is not entitled to claim any amount of charges for the temporary works.

Article 14 Modification of Plan

If the Inspection Committee finds it necessary to make modification of construction design and/or materials and so forth during the course of construction, the JICA has the right to order the modification of the Works to the Contractor, and such order shall be made in writing from the Inspection Committee to the Contractor.

The JICA agrees to adjust upwards or downwards the necessary expense for such modification to the Contractor, which will be estimated by unit price in the Bill of Quantities of this Contract in case of modification of quantities or construction works. In the case of additional works which are not quoted by unit price in the Bill of quantities of this Contract, the Inspection Committee will make estimation thereof and the JICA will pay to the Contractor for such additional works accordingly. But if the Contractor does not agree to such estimation, the Contractor is then entitled to negotiate with the JICA. Also the extension of the completion time due to the modification shall be given by the JICA who shall have the sole right to decide the number of days of such extension.

Article 15 Acceptance of the Works

When the entire Works have been completed, the Contractor shall submit the invoice in written form indicating the Work actually completed to the Inspection Committee. If there are compliance with drawings or Technical Specifications, the JICA shall accept the Works as the final acceptance of satisfactory completion Works within ten (10) days after the receipt of the written form and it shall be deemed that the final acceptance has been made on such date of the receipt of the written form.

On the other hand, should non-compliance with drawings or Technical Specifications or defects be found in the Works executed by the Contractor, the Inspection Committee will have the right not to accept the Works and to order the rectification of the Works. If the required period for the rectification of the Works is beyond the completion date, the Contractor shall not be relieved from its responsibility to pay the penalty as stipulated under Clause 5.3, and after the completion of rectification of the Works, then the final acceptance will be made in the same manner as described in the first paragraph of this Article.

During the course of construction, whether in the completion time or of extended time specified in the last paragraph of Article 4, the JICA has the right to accept a part of the Works already completed in the written form which shall be considered as a part of final acceptance. However, both parties shall negotiate with each other for the maintenance and usage of the accepted part of the Works, and the Contractor is not entitled to request the extension of the completion time due to any interruption caused by the use of such accepted Works by the JICA, or any delay in repairing such accepted Works.

Article 16 Construction Engineer

The Contractor shall appoint a construction engineer at his own expense for the supervision of the Works performance, who shall be authorized to act on behalf of the Contractor, and the instructions given to him shall be deemed as given to the Contractor. The construction engineer shall stay at the work site all the time and shall not leave without obtaining the prior approval of the Inspection Committee. If the Contractor replaces the construction engineer, the Contractor shall obtain the prior approval from the Inspection Committee in writing.

Article 17 Replacement of Labour, Engineer and Foreman

The Inspection Committee may request the Contractor to remove any of the Contractor's labours, foremen or engineers if it appears to the Inspection Committee that such labour, foreman or engineer is incompetent for his job or is not suitable or is not capable of handling his workmen or staff, and the Contractor shall promptly replace any such labour, foreman or engineer. No extra cost or claim for extension of time will be allowed because of such replacement.

Article 18 Sub-Contractor

The Contractor shall not sub-contract or assign any portion of the Works under this Contract without obtaining the prior approval of the JICA who has the sole right to decide which portion of the Works may be sub-contracted or assigned to the Sub-Contractor. However, the Contractor shall be fully responsible for the Works done by the Sub-Contractor.

Article 18 Notice

All notices required by this Contract shall be effective only at the time of receipt thereof, and only when received by the parties concerned at following address:-

The JICA Thailand Office
1674/1, new Petchburi Road, Bangkok 10310, Thailand

The Contractor _____

All Notices required by the terms of this Contract shall be made in writing in English Language, and delivered by registered mail or hand delivery.

Article 20 Dispute

In the event of any dispute arising from the interpretation and performance of the terms of this Contract, both parties agree to make the best attempt with sincerity and in good

faith to negotiate and amicably settle such dispute, failing which the parties agree to refer such dispute to arbitration under Thai Commercial Arbitration Rules and Regulation, Bangkok, by 2 arbitrators, each of which is to be appointed by each party. If either party fails to appoint its arbitrator within seven (7) days or should the arbitrators fail, within fifteen (15) days after their appointment, to agree upon the decision of the dispute or not decision is reached on the appointment of an umpire, then the dispute shall be brought before the Court of Thailand for decision under the laws and procedures of the Kingdom of Thailand.

This Contract is executed in duplicate of the same tenor, one of the original copy to be kept by JICA and the other original copy to be kept by the Contractor. Both the JICA and the Contractor have set their signatures and affixed the seals thereto in the presence of the witnesses.

JICA

Mr.

Resident Representative,
Japan International Cooperation Agency, Thailand Office.

Contractor

Witness

Witness