DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

DETAIL DESIGN REPORT

ON

INTEGRATED AGRICULTURAL DEVELOPMENT

DEMONSTRATION PROJECT

IN

MAHAWELI AREA

APRIL 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Socialist Republic of Sri Lanka and in accordance with the Record of Discussion signed on 11 February, 1985, the Government of Japan is providing technical cooperation for the Integrated Agricultural/Development Demonstration Project. The Detail Design Survey Team was dispatched to define appropriate content and scope of project components including the common facilities and buildings, project facilities, plant facilities and the experimental/demonstration farm, and to prepare a detail design for the same.

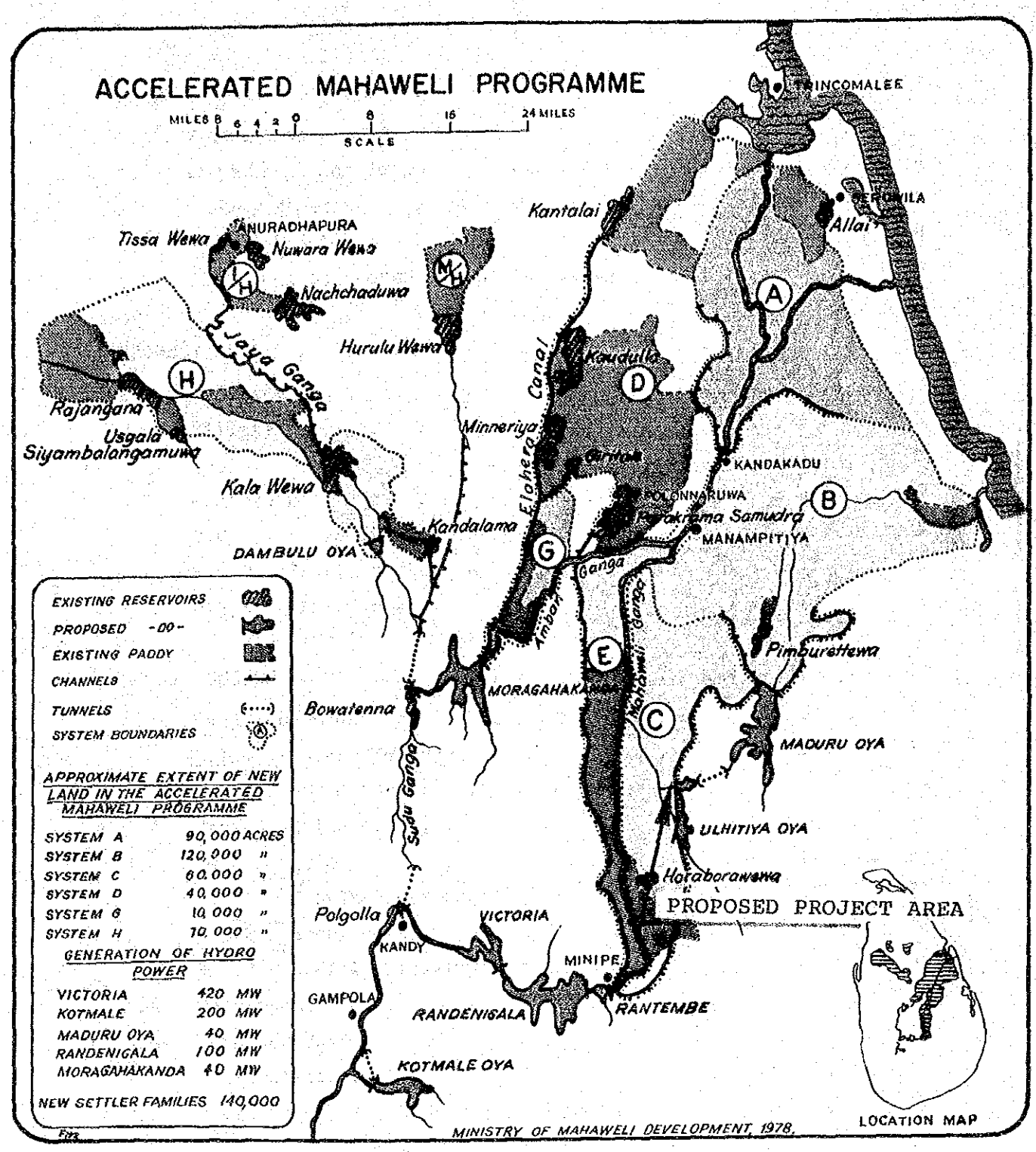
Giving due consideration to the recommendations of Sri Lankan Government officials concerned and of the Implementation Study Mission's findings, and based on subsequent field survey, the Team prepared a design approach and detail design advice which were submitted in the form of a Field Report. Upon return to the home office, the Team carried out further study to supplement and finalize the detail design and the results are incorporated in this Detail Design Report.

I wish to express my sincere appreciation to all concerned personnel in the Mahaweli Authority of Sri Lanka, the Mahaweli Economic Agency, the Mahaweli Engineering & Construction Agency, the Japanese Embassy in Sri Lanka, and other related agencies for their kind assistance and cooperation rendered on behalf of the Survey Team.

April 1985

Takashi TAGUCHI
Director
Agricultural Development
Cooperation Department
Japan International Cooperation
Agency

LOCATION MAP



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CHAPTER I

INTRODUCTION

1. INTRODUCTION

1.1 Background

The Government of Sri Lanka places high priority on agricultural development for attainment of self sufficient food supply, elimination of unemployment and promotion of economic development. Due to government promotion of various projects and schemes, attainment of self-sufficient food supply is envisioned by 1987. The quality of rice, the staple crop, however, is comparatively poor. The Government therefore regards improvement of rice quality and the promotion of crop diversification through introduction of field crops as the next step in the realization of development goals including raised farm incomes, increased agricultural exports and improved national nutrition.

As part of this strategy, the Government proposed the establishment of an experimental/demonstration farm and research center within System-C of the existing Mahaweli Ganga Development Project. The main objective is to conduct experiments on improved rice varieties as well as other crops and to demonstrate cultivation methods, post-harvest operations and water management to area farmers.

Accordingly, the Government of Sri Lanka requested the Government of Japan for technical cooperation to implement the above plan, termed the Integrated Agricultural Development Demonstration Project (hereinafter referred to as the Project). In response to this request, JICA dispatched a Contact Mission in November 1983 followed subsequently by the Preliminary Survey Mission. Upon compilation of the latter's findings, a Master Plan Survey Mission was sent to Sri Lanka in September 1984. The said Mission reviewed previous findings, and studied and defined appropriate content and scope of technical cooperation for the Project. In February 1985, the Implementation Study Mission was dispatched and discussions were held with officials of the Sri Lankan Government. Technical cooperation for the Project commenced for a 5-year implementation period upon signing of the records of discussion (R/D).

The Detail Design Survey Team was subsequently dispatched from 5 February to 11 March 1985 as the first phase of technical cooperation. This report presents the findings and conclusions of the Mission.

1.2 Objectives and Scope

Under the Project, an experimental/demonstration farm and research center will be set up in Unit 1 of Block 302, System-C in the existing Mahaweli Ganga Development Project area. Unit 1 is considered to be the most suitable of all designated development areas for paddy cultivation and thus the most appropriate for experiments on and extension of improved rice production technology.

The Project's long term objective is to increase the income of farmers in the area by introducing modern technology for integrated agricultural management based on cultivation of high quality rice varieties as well as of field crops.

Project components are:

a) to demonstrate a series of agricultural techniques from cultivation to post-harvest processing for production of high-quality rice;

b) to demonstrate the appropriate farming system including other crops to the local farmers in the Project area,

c) to demonstrate better On-farm water management techniques for (a) and (b) above; and,

d) to give technical advice to the Government Seed Farm in Unit 1 of Block 302.

Within the above framework, the Detail Design Survey Mission's objectives were to design the facilities required, including the experimental/demonstration farm and seed processing plant and to provide design advice. A list of study items and scope of work is tabulated on the following two pages.

Study Items	Study Scope	Financial Source
A. Building for Common Facilities[1/]		
1. Tractor shed	Design	Sri Lanka
2. Workshop	-do-	-do-
3. Buildings for seed processing and parboiling plants	-do-	Japan
4. Office expansion	Design advice	Sri Lanka
B. Utilities		
1. Water supply[2/]		
- plant facilities	Design	Sri Lanka
- offices & quarters	Design advice	-do-
2. Power supply[2/]	-do-	-do-
3. Telephone facility	-do-	-do-
C. Project Buildings[3/]		
1. Residences for experts		
- existing house	Design advice	Sri Lanka
- new houses	-do-	-do-
2. On-farm shed	Design	-do-
3. Mill building	-do-	Japan
D. Plant Facilities		
1. Layout for seed processing and parboiling plants	Design	Japan
2. Layout for milling units	-do-	-do-
3. Machinery and equipment		
- seed processing	Selection	-do-
- parboiling	-do-	-do-
- rice milling	-do-	-do-

1/ Common facilities refer to those facilities which will be used for both seed processing and demonstration purposes.

2/ Partial cost of equipment will be borne by the JICA.

3/ Project buildings refer to those which are used solely for experiment and demonstration.

(continue)

Study Items	Study Scope	Financial Source
E. Experimental Farm		
1. Inspection path	Design	Japan
2. On-farm ditches	-do-	-do-
3. Improvement of farm inlets	-do-	-do-
4. Fencing work for farm	-do-	-do-
5. Field drains	-do-	-do-
6. Drainage structures	-do-	-do-
7. Farm bund for water management test lot	-do-	-do-

1.3 Survey Members

The Detail Design Survey Team (hereinafter referred to as the Team) was composed of the following members.

Speciality	Name	Company
Team Leader, Post-harvest	Mr. Haruhiko Sakamoto	AFFPS Dept., JICA
Irrigation Engineer	Mr. Takafumi Suzuki	Chuo Kaihatsu Corp.
Architectural Design	Mr. Tetsuhisa Hirose	" " "
Plant Design	Mr. Masami Suda	" " "

The above members visited the field from 5 to 20 February 1985, nine days of which coincided with the Implementation Study Mission's field work period.

1.4 Work Schedule

The study period in Sri Lanka was from 5 February to 11 March 1985, and the major activities for this period are presented in Appendix I, TABLE-2.

1.5 Personnel Contacted During the Study

Officials from the various departments of the Sri Lankan Government and personnel from other organizations, etc., who assisted in the field are listed below. A diagram of organization within the Mahaweli Economic Agency (MEA) is presented in FIG. 1-1.

Ministry of Mahaweli Development

Col. Ivan Samarawickrama	Secretary

Mahaweli Authority of Sri Lanka (MASL)

Mr. K.H.S. Gunatillaka	Director General
Mr. L. Godamunne	Secretary-General
Mr. P.T. Senaratne	Deputy Secretary-General
Dr. Abhaya Attanayake	Director, Planning and Monitoring Unit

Mahaweli Economic Agency, MASL

Mr. D.J. Bandaragoda	Executive Director
Mr. Cecil Amerasinge	General Manager
Lt. Col. P.V. Pathirana	Resident Project Manager, "C"
Mr. P.H.K. Dayaratna	Project Co-ordinator, "C"
Mr. W.W. Udupihilla	Chief Equipment Engineer
Mr. W.M.R Iddawala	Senior Mechanical Engineer
Mr. G.W. Liyanage	Senior Agronomist
Mr. L. Divasiri	Agronomist
Mr. H.A. Wickramaratne	Chief Irrigation Engineer
Mr. M.D.M.H.B. Divaratne	Deputy Resident Project Manager, "C"
Mr. S.A. Samarasinghe	- do -
Mr. J. Boralessa	Farm Manager, Seed Production Farm, "C"
Mr. Jayasuriya	Block Manager, 302, "C"
Mr. B. Chandrasena	Irrigation Engineer, Block 302, "C"
Mr. M.S.K. Lekamwasam	Mechanical Engineer, "C"

Mahaweli Engineering Construction Agency

Mr. T.P. Ranasighe	Director "C"
Mr. Amaralira	Assistant Director, Machinery
Mr. L.H.S. de Silva	Chief Engineer
Mr. M. Gunawardewa	Civil Engineer, Zone 2 & 3, "C"

Mr. T.H.N.R. Gomes	Supervisor, "C"
Mr. E.A. Praneeth Amaratuna	Architect, "C"

Ministry of Finance and Planning

Mrs. Chandra Amarasekera	Deputy Director, External Resources
Mr. Senarat Weerapana	Assistant Director, External Resources

Ministry of Agriculture

Mr. Henry Gamage	Assistant Director, Agriculture Dept.
Mr. H.M. Pilakaratna	Researcher, Agriculture Mechanization Research Center

Paddy Marketing Board (PMB)

Mr. B.L.I. Amarasinghe	Manager, Malaketiya Rice Processing Center
Mr. T.B. Adhikarinayake	Researcher, Paddy Processing Research and Development Center

Ceylon Electricity Board (CEB)

Mr. N. Colombage	Electrical Engineer, Commercial Branch

Water Resources Board

Mr. S.B. Basnayake	Chief Geologist
Mrs. Kumudimi Dharmawardhana	Chemist

Embassy of Japan

H.E. H. Odaka, Ambassador
Mr. M. Itami, 1st Secretary
Mr. M. Kobayashi, 2nd Secretary

JICA Colombo Office

Mr. Y. Ikeda, Director
Mr. M. Sasago, Assistant Director

Consultant, "C"

Mr. G. Yatabe, Manager
Mr. Y. Sano, Construction Engineer
Mr. K. Sakata, Agronomist
Mr. M. Mori, Water Management Expert

CHAPTER 2

PROJECT AREA

2. PROJECT AREA

2.1 Location

Sri Lanka is a tropical island country located east of the southern tip of the Indian subcontinent between northern latitudes of 5.55° and 9.50°, and eastern longitudes of 79.42° and 81.52°. An imposing mountain range, the Piduralatagala mountains, extends across the central southern area at elevations of up to 2,524m. Level area to the south, west and east of the same forms a fairly narrow strip along the coast where rainfed paddy is cultivated. The northern half of the island is composed of a broad expanse of comparatively level land, a large portion of which is covered by jungle.

The Project area is located in the east-central sector of Sri Lanka in System-C of the Mahaweli Ganga Development Project to the northeast of the above mountain range on the right bank of the Mahaweli River. System-C is divided into zones 1 through 6. Zone 1 consists of existing farmland while Zone 2 consists of farmland developed under the Mahaweli Ganga Development Project and presently managed by settlers from other areas of Sri Lanka. Construction is underway in zones 3 and 4 but has not yet commenced in zones 5 and 6.

The Project area is located in Zone 3 which has recently been settled by farmers from other areas. Paddy cultivation was begun in 1984 and covers the majority of the 673ha area of the said zone. Unit 1 of Zone 3 comprises 217ha of paddy and 60ha of field crop area. The pilot demonstration farm site will cover 23ha of Unit 1 in the gently undulating southern portion with a maximum elevation of 95m and a minimum of 87m. The Government of Sri Lanka also plans to establish a seed farm in the area, preparations for which commenced in 1984-85 during the Maha season.

2.2 Climate

Rainfall distribution in Sri Lanka can be divided into two periods; the southwest monsoon from May to September, and the northeast monsoon from November to March. The southwest monsoon is intercepted by the mountain range extending through the central southern portion and consequently the southwest face of the said mountains and the southwestern

plain are subject to heavy rains while the northern half of the island and the area east of the mountains receive less than 500mm of rainfall during this period.

During the northeast monsoon on the other hand, rainfall occurs throughout the entire country with particular concentration in the mountainous region. The area in the south which receives more than 1,900mm of rainfall is referred to as the Wet Zone, while the central area which receives between 1,300-1,900mm is called the Intermediate Zone, and the northern area receiving less than the above is the Dry Zone. Although the Wet Zone comprises only one quarter of total land area, it contains 60-70% of the population, and includes virtually all tea, rubber and coconut cultivation area as well as the majority of rainfed paddy. In contrast, agriculture in the Intermediate and Dry zones mainly consists of shifting agriculture (Chena) and rice cultivation irrigated by water from tanks.

The Project area falls within the Intermediate Zone with 75% of rainfall concentrated between October and February (Maha season) and an annual rainfall of about 2,000mm. Average monthly temperature ranges from 25-30° with an annual average of 27.6°C. During the period from April to September, maximum average monthly temperatures rise above 35°C while minimum average monthly temperatures fall as low as 20.7°C from January to March, indicating a continental type climatic trend. The maximum temperature in the last 9 years was 42°C on 21 April, 1983 and the minimum was 14.2°C on 29 January, 1984. Average monthly relative humidity is 55-85% while the annual average is about 70%.

2.3 Soils

Soils in the Project area are derived from the Reddish Brown Earth (RBE) which is widely distributed in the Dry Zone. Soils at the upper portion of slopes are well drained while those in the lower portion and valley bottoms are poorly drained low humic clay soil. RBE soils thus comprise 1/3 to 1/2 of soils in the area.

The Unit 1 farm is covered by a comparatively thin layer of topsoil as it is located at a relatively higher elevation. The bedrock of the area is composed of weathered gneiss.

2.4 Socioeconomy

2.4.1 Agriculture

Agriculture, particularly cultivation of tea, rubber, cocconuts and rice, is the primary industry in Sri Lanka accounting for 70% of all exports. Rice quality and production quantity however, are not yet sufficient for export while other agricultural products are extremely sensitive to fluctuations in the world market.

Tea, rubber and cocconuts, the chief export items, are produced on large plantations; however, neither production volume nor plantation area has increased for several years. Rice production, on the other hand, has steadily increased over the last few years due to the Government's development efforts.

2.4.2 Settlers

Resettlement of farmers from other areas of Sri Lanka to the newly developed area of System-C began with Zone 2 in 1980. Settlement of Zone 3 in which the Project is located was completed in 1983 and that of Zone 4 is presently on-going. As of the Maha season 1984, 3,884 households had been established in Zone 2, 2,088 households in Zone 3, and 2,400 households in Zone 4. In 1985, resettlement of an additional 5,000 people is planned, mainly in Zone 4.

Settlers in Zone 3 are predominatly from Victoria Dam, Randenigala Dam, Kotmale Dam, Maduruoya Dam and the Mahaweli River Trans-basin Canal route areas, who have recieved land in System-C as compensation. In Unit 2, Block 302, settlers are from the Kotmale Dam area (highland and swamp) while settlers in Unit 3 are from the plain and dry zone area of Anpala Province.

2.4.3 Transportation

The national railroad, the Ceylon Railway, presently extends a total distance of 1,453km with 170 stations. Of the above, 103km consists of a two-track line while the rest is single track. The trunk line has been converted to diesel fuel.

The railroad network joins the major cities, Colombo in particular and including Jaffna in the north, Galle in the south, Matale and

Trincomalee in the east and Kandy; however, there are few lines connecting the southeast area. The road network is comparatively well-developed, composed of A, B, C, D, and E class roads. "A" class roads are national trunk roads, while "B" class roads serve to reinforce the same.

There is no plan for construction of a railway line to serve System-C at present. Access from Colombo is by road via Kandy, covering a total distance of 207km (7 hours by car) and 92km (3.5 hours) from Kandy. Roads within System-C are being constructed as overall development progresses and consequently access to the Project site at present is poor. However, the System-C trunk road which is presently under construction and financed by Asian Development Bank is planned for completion by the end of 1985. This road, which will be paved, runs from Mahiyangana through the west side of the Project area for 3km to Polonnaruwa in the north. In addition, construction of a road along the Mahaweli River between Kandy and Mahiyangana is presently underway. Completion of the above road plans will greatly improve transportion within the Project area.

CHAPTER 3

DETAIL DESIGN

3. DETAIL DESIGN

3.1 Basic Approach

Detail design works consist of design advice and actual design. The items studied under each category are as described below.

3.1.1 Survey for Design Advice

(1) Overall Center Design

The residences, storehouse and drying yards for the research center are presently under construction by the Sri Lankan Government; however, coordination of the functional operation of each facility within the center is required. Accordingly, the Team surveyed the Project site and existing facilities to obtain data for formulation of an overall research center design including roads, landscaping, fencing, etc., and designation of sites for new project and plant facilities. The Team also took various measurements in order to check the location and elevation of each existing facility (FIG. 3-1).

(2) Buildings and Residences

1) Office

A six-room building with garage covering a total of about 300m^2 will be used as the central project office. The Garage covers 100m^2 of the total area while a barbed wire fence supported on concrete poles surrounds the office and a metal gate provides access.

Although there is a water supply system equipped with underground and overhead tank and an internal distribution line, the building presently lacks electric supply. Consequently, water must be hauled from Ulhitiya Lake.

2)Residences for Japanese Experts

In total, 3 houses on the site and one house in Girandurukotte are required for 5 Japanese experts. Sites for two houses equivalent to Grade IV for experts with families and one twin house equivalent to two Grade III

residences for single experts were selected at Ratkinda lakeside by the Team in consultation with MEA.

Several MEA standard Grade IV residences and a house formerly occupied by an English consultant, Mr. Bond, in Girandurukotte were proposed as a possible residence for the remaining Japanese expert and family. The living room surrounded by screen in Mr. Bond's house was highly evaluated and it was recommended that this house be selected for the design of residences for Japanese experts. In addition, the installation of several other facilities including a bath, rain water tank, and screen windows was recommended by the Team in design advice.

(3) Facilities

1) Electricity

A 33kV power line runs through the site and an old 250kVA substation is located nearby. However, all electrical equipment was previously removed and only the poles, wires and foundation remain. The Team surveyed and studied the present condition, and proposed sites for the substation and alignment of the distribution line both in the field as well as in the home office.

2) Water Supply

Existing water supply is derived from two ground water sources; one at the Toda temporary shed site and the other at a shallow well about 400m north of the Project area. These sources are presently unused. Residents at the Project site depend on water from the canal and water transported by tank lorry from Ulhitiya Lake.

A water quality study of shallow wells, Ulhitiya Lake and Ratkinda Lake was undertaken to determine a suitable water source for the plant boiler. In addition, a water depth study was carried out at Ratkinda Lake, which is most suitably located for water source.

3) Telephone and Radio

There are no phones installed at the Project site. VHF radios, on the other hand, have been installed by MEA at the office. In addition, a radio system belonging to MECA with the nearest station at Ulhitiya Circuit Bungalow, connects the MECA Head Office at Colombo.

3.1.2 Design Survey

(1) Post-Harvest Plant

As there are only small-scale traditional type facilities in the Project site vicinity, other modernized facilities were surveyed by the Team, including the Maraketiya rice processing plant, the Anuradhapura rice processing research center and the Bulnewa rice processing plant, all of which are managed by PMB, as well as the Pelwehera seed farm. The Maraketiya processing plant is equipped with Japanese Yanma farm machinery, the Bulnewa processing plant was designed and constructed by the U.S., and the Pelwehera seed farm uses machinery manufactured in Germany. The Anuradhapura research center tests each piece of machinery, demonstrates various processes and improves the same.

At present, PMB restricts the initial moisture content of paddy to less than 15%. The CFTRI parboiling method is used in which soaking and steaming take place in the same tank by the batch method. Use of hot water for soaking and steaming at more than 100°C reduces the operation time required. A drier is used to dry parboiled rice while the husk boiler provides heat for both the drier and parboiling.

In conjunction with survey of the above post-harvest plant, present harvest and threshing operations were also studied. Paddy is threshed by tredding the same under a tractor and consequently the percentage of foreign material content is extremely high.

(2) Buildings

In addition to study of the existing post-harvest plant, the Team also surveyed the farm machinery training center, the MECA

workshop, etc. Field survey was conducted for proposed building sites including bearing capacity of the soil and actual measurements. Survey findings indicate sufficient bearing capacity and also confirm structural safety with use of traditional foundation treatment methods.

(3) Experimental/Demonstration Farm

The experimental farm comprises 9ha of the farm area while the demonstration farm covers the remaining 14ha (DWG F1 - F3). Land consolidation works were completed in 1984, including construction of field canals. The experimental farm area has been designated as D1-7 and the demonstration farm area as D1-8 in reference to their respective water supply systems. Water is supplied from Ratkinda Lake to Tank No.1 from which it is conveyed to the site by the D1 distributary canal. Water supply to the experimental/demonstration farm is then diverted from D1 canal by a sharp crested weir and conveyed along field canals D1-7, D1-7-1 and D1-8. Design capacity of irrigation facilities is 2ℓ/sec/ha and features of the same are as outlined below.

Field Canal	Irrigated Area (ha)	Canal Length (m)
D1-7	4	370
D1-7-1	5	170
D1-8	14	730

Design capacity of field drains is 15ℓ/sec/ha and features of the same are as follows:

Canal	Drainage Area (ha)	Canal Length (m)
DC-D1-7-1	2.3 (excluding	320
DC-D1-7-2	4.1 off-farm areas)	155
DC-D1-8-1	3.8	400
DC-D1-8-2	1.8	200

Farm roads run along the outer edges of the farm site in the east, south and west with a width of 4-6m. Total length of existing roads is more than 1,500m, and an additional 360m of road exists in the experimental farm.

The first crop has already been planted throughout most of the demonstration farm and harvest of the same is envisioned in

April 1985. Small stones found in the field at the beginning were removed during the first tilling and have represented no hindrance since that time. Although topsoil is thin in some spots, distribution is generally comparable to the average depth in the Mahaweli area and improvement works are considered unnecessary.

Several facilities will be constructed or improved based on field survey and measurements including inspection paths, farm ditches, fences, field drains and farm inlets.

(4) Data Collection

All data required for formulation of the detail design were obtained from MEA, MECA, PMB, etc., and included meterological data, topographical maps, market prices, calculations, types of plant machinery, and results of various interviews. A list of data obtained is attached as TABLE 3-1.

(5) Supplementary Survey

A survey was conducted of the entire center site, the experimental/demonstration farm and the Ratkinda lakeside.

3.2 Design Advice

Based on the results of field survey, and after discussions with Sri Lankan officials, design advice and a preliminary design approach were compiled in the Field Report on Detail Design (hereinafter referred to as the Field Report) and submitted to MASL, MEA, MECA, the JICA Colombo office, and the Japanese Embassy in Sri Lanka prior to the Team's departure.

All design advice was included within the Field Report and the same was submitted to facilitate the early implementation of construction works. Although MEA had already begun tender bidding for the Japanese experts' residences, bidding was temporarily halted with the arrival of the Team. Based on the detailed advice contained within the Field Report, bidding was subsequently re-commenced. As for electric supply, telephones, and radio system, the related departments have already begun taking steps towards implementation. Works which will commence in the immediate future including water supply, office expansion and site preparation will require progress checks to expediate completion.

(1) Overall Center Layout

The overall center layout was planned as presented in Appendix I, FIG. 2-1 based on the results of field survey.

The design is divided into 3 zones; namely, i) offices for management research ii) plant facilities, workshop and tractor shed, and iii) residential zone. The existing road system will be fully utilized and expanded with the office zone as the focal point of the overall design forming the axis. The various zones will be connected by roads with due consideration given to the seperate function of each zone. In future, planting of trees along the roadsides is planned to reserve the environment of the residential zone.

(2) Office Expansion

Design advice for office expansion is as presented in Appendix I, FIG. 2-2, including the renovation of the existing garage, for use as the laboratory, site, laboratory, display shed and office for the Japanese experts. Recommended office expansion as advised in the Field Report consists of the following items:

- renovation of existing garage for use as a conference room
- remodeling of existing large room as office space for Japanese experts and counterparts
- remodeling of existing office for the Japanese Team Leader
- construction of laboratory, storeroom and additional toilet
- construction of display shed

(3) Residences for Japanese Experts

Upon discussion with MEA, it was planned that buildings proposed under the Project will be constructed in the Ratkinda lakeside area near the north end of the Ratkinda Dam due to the favorable natural environment of the same. Buildings to be constructed include three Grade IV houses two for Japanese experts and one for the Sri Lanka farm manager) and one modified Grade III house. In addition, one house formerly belonging to a Mr. Bond in Girandurukotte was recommended for renovation and use as a residence for Japanese experts.

Design advice also includes provisions for parking and landscaping. It was recommended in the Field Report that housing areas be planned to preserve and enhance the Ratkinda environment, and that only underbrush and small trees be removed from construction sites. Suitable rock materials are available for use in landscaping.

The proposed design for residences of Japanese experts is as presented in Appendix I, FIG. 2-3 and the specifications are the same as those for MEA Grade III and Grade IV houses. Utilities planned are as listed in the table below.

Utilities	Hall	Living Room	Bed Rm I	Bed Rm II	Bath-room	Other
Insect screen			All rooms			
Wood framed screen windows	x					
Fan (ceiling)	x	x	x	x		
Bathtub					x	
Water heater					x	
Electric outlet (wall mounted)	2	3	3	3	1	

Note: Corridor column: ø200; wood with varnish finish
External walls: brick; pointed joints; white paint finish
Roof: half-round tiles

(4) Electricity

Based on discussions with concerned officials in MEA, power demand for the entire research center was estimated as summarized below.

Location	Demand (kW)
Offices, etc.	52
Rice processing plant	120
Residences	43
Water pump	5
Lighting	3
Total	approx. 230

To supply the above electric demand, a substation (33kV/400V) capacity of about 350kVA is required, including an allowance of about 20%. However, in accordance with standard specifications of the Ceylon Electricity Board (CEB), construction of a 400kVA substation is planned.

The Team formulated a preliminary layout for the proposed 400V electrical distribution line within the center (Appendix I, FIG. 2-6) and incorporated the same within design advice in the Field Report. However, upon review of electrical design advice in the home office, a more economical layout was formulated and the former plan was revised accordingly, as presented in Appendix II.

MEA had already requested CEB to provide electric facilities before the arrival of the Team, and a detailed request for implementation of the above revised layout is strongly recommended. Although CEB is the implementing agency for construction work, the following portions of the substation and distribution line between the plant and substation will be provided under Japanese technical cooperation as reimbursible items.

Equipment	Amount
Transformer (33kV/440V/400kVA and equipment)	1 unit
Distribution line	1 unit

(5) Water Supply

Based on discussions with concerned officials of MEA, daily water requirement for the entire research center was determined as follows:

Location	Daily Water Requirement (m^3)
Offices, etc.	5.5
Rice processing plant	20.0
Domestic water supply	36.5
Total	62.0

Water requirement for the overall water supply plan of the research center can be delineated into the following items:

Maximum daily water supply	81m^3
Water tank capacity (8 hours)	21m^3
Water pump capacity (8 hours operation)	3ℓ/sec

The Team judged ground water sources to be insufficient in both quality and quantity for the center's water supply. Provision of a safe water supply using ground water would require installation of numerous wells. Accordingly, use of water from the Ratkinda Reservoir (LML 119.5m) was proposed. The said reservoir has sufficient head to supply water to the maximum elevation in the research center area (EL. 100m).

The above plan was included as design advice within the Field Report (Appendix I, FIG. 2-6) and early commencement of construction on the basis of the same was recommended. The purification tank presently under construction by MECA in System-B was given as a reference for a sample design. The water pump and delivery pipe are planned to be included within Japanese technical cooperation. Present market prices for these items are as given below.

Water pump (ø50mm)
3,500GPM x 120ft x 3.7kW, 3 phase
Suction and discharge pipe (GI pipe, 75mm dia. x 170m)
Delivery pipe (PVC pipe, 100mm dia. x 1,500m)

(6) Telephone and Radio

Specifications of radios installed in the existing center are as follows:

VHF	Channel No.1	167.78MHz
VHF	Channel No.2	168.17MHz
Transmission Distance		within 40km

There are presently 29 VHF radio sets within System-C, all of which are owned by MEA. In addition, there are several radio sets owned by MECA which connect the area to the MECA Colombo office. The specifications for the same are on the following page:

HF	Channel No.1	6,920KHz
HF	Channel No.2	3,595KHz

Eight of the above MECA sets are found in System-C, and there are also some 78MHz band systems being introduced.

As recorded in the Field Report, the Team proposed the installation of telephones with linkage system in three locations; the center office, Japanese expert quarters in the Project site, and the Japanse expert residence in Girandurukotte. In response to this proposal, the System-C Project Coordinator has already begun necessary procedures.

(7) Other

In addition to the above items, the Team also provided design drawings for the layout of the following:

- workshop
- tractor shed
- on-farm shed

Construction of the same will be financed and implemented by MEA (Refer to Appendix III).

3.3 Detail Design

Based on design survey findings, detail designs for the post-harvest plant, buildings, etc., were drawn-up in the home office and drawings for the same make up part of this report.

3.3.1 Post-Harvest Plant

The post-harvest plant for the Project is mainly divided into the following 3 facilities:

- seed processing plant
- parboiling plant
- rice milling plant

Each of these facilities is interrelated and for the purpose of demonstration all three will be installed in the same building. Layout of facilities was designed to provide sufficient space for demonstration and

observation, and to ensure versatility under various conditions. Layout for the above plant facilities and a flow chart for the same are given as FIG. 3-2 and 3-3, respectively. The capacity of each item was determined as described hereunder.

(1) Seed Processing Plant

Seeds will be processed and packaged at the plant to distribute certified seed produced on the 194ha government seed farm in Unit 1 to farmers in the newly developed 22,000ha irrigated area in System-C.

Five seed varieties are produced at the seed farm as tabulated below.

Growing Period	Seed Variety
120 - 135	Bg 11-11
	Bg 400-1
105	Bg 94-1
	Bg 34-8
90	Bg 276-5

Seed production and the paddy cropping system at the seed farm and of farmers in System-C are presented in Appendix I, FIG. 3-1. Seed which has a 120-135 day growing period requires a minimum of 45 days after harvesting for distribution to farmers. The number of operating days per season for the seed processing plant was therefore designated at 45 days and capacity of the same will correspond to peak seed harvest.

The cropping system presented in the above mentioned figure corresponds to the last harvest of the Yara season and the final sowing of the Maha season for each seed variety. As shown, the harvest periods of each variety overlap. Accordingly, equipment in the seed processing plant should be thoroughly cleaned after processing of each seed type to avoid mixing the same. Said cleaning will require a total of 4-5 hours. Adjustment of the harvest period for each of the 5 seed varieties at the seed farm is also necessary and cooperation of seed farm personnel is desirable.

Certified seed is to be distributed to the farmers once every 4 croppings and the certified seed supply ratio is planned to

increase from the present 10% to 25% of total seed demand. Capacity for facilities presented below conforms to figures used in "Project Proposal for a Certified Seed Paddy Production Farm in Zone 3 -Unit 1, Block 302, System-C".

System-C paddy area	22,000ha
Seed requirement/unit area	104kg/ha
Annual paddy cropping intensity	175%
Seed supply ratio	25%
Annual number of days for seed processing	90

Based on the above data, the annual seed requirement is 22,000 x 104 x 1.75 x 0.25 ÷ 1,000 = approximately 1,000t, and required seed processing capacity per day is 1,000 ÷ 90 ≒ 12t. Assuming operation of a double shift during the peak period, a 12 hour operating period is feasible even in consideration of a 4 hour cleaning period and a comparatively economic processing capacity of 1t/hr is obtained.

In layout of seed processing facilities due attention was given to the fact that facilities not only process and select seeds but also circulate surplus paddy to the parboiling plant and milling facilities located in the same building. Seed processing facilities are planned for optimum flexibility to respond to the demands of each task as follows.

1) Installation of a drier is planned to allow input of both wet and dried seed paddy.

2) A temporary paddy storage tank will be installed to facilitate flow of paddy to each facility, whether to the seed grading facility, parboiling plant or rice mill.

3) Paddy, whether wet or dried, will be returned to the tank after precleaning or grading to be transferred to the parboiling plant and rice mill.

4) All machines and equipment for the seed processing plant will be types which are/or easy to clean and the plant will be equipped with a compressor and vacuum cleaner for cleaning purposes.

With the above provisions, the seed processing plant will be capable of the following operations.

1) Dried Paddy

a) Precleaning, grading and, packaging for subsequent distribution.

b) Circulation of surplus paddy after pre-cleaning or grading to the parboiling plant and/or milling plant.

2) Wet Paddy

a) Precleaning, drying, grading, and packaging of seeds for subsequent distribution.

b) Circulation of wet paddy to the parboiling plant after precleaning.

c) Circulation of paddy to the parboiling plant and/or rice mill after precleaning and drying, or after precleaning, drying and grading.

Paddy in Sri Lanka is presently threshed by tredding harvested paddy with a tractor or draft animal. This method however, results in a high percentage of impurities and damaged paddy hindering grading. Accordingly, it was determined in discussions with MEA that all paddy used in the processing plant will be threshed by mechanical threshers at the government seed farm.

Details of equipment are given under Section (4) 'Layout and Specifications for the Post-Harvest Plant'.

(2) Parboiling Plant

In principle, paddy used in the parboiling plant will be surplus paddy produced at the government seed farm. Plant capacity was accordingly calculated on the basis of the same. Available parboiling days were estimated at 200 days/year excluding the 90 days required for seed processing. Plant facilities however, will allow parboiling operations to proceed at the same time as processing operations. Plant capacity was calculated according to the following items, values for which were obtained from the above mentioned Project proposal and discussions with MEA.

Paddy yield of seed farm	100 bushels/acre (5,140kg/ha)
Paddy area of seed farm	194ha
Annual paddy yield	1,994t (5,140x194x2)
Annual seed requirement	1,000t
Annual paddy surplus	994t
Available parboiling days/year	200
Daily parboiling requirement	5t/day

To process the above daily requirement, design capacity of the parboiling plant was determined at 5t/day. Three parboiling methods were considered in selection of parboiling equipment; namely the Goviya, CFTRI and continuous steaming methods.

The Goviya method is an improved version of the traditional Sri Lankan parboiling method. The said method has somewhat reduced labor requirement; however, a substantial amount of labor is still needed for input and extraction. Moreover, the temperatures of water and steam are difficult to control resulting in inconsistent quality. The continuous steaming method has never been used in Sri Lanka and consequently maintenance would be unreliable. Furthermore, the cost of the same is high.

In comparison with the above, the CFTRI method has been introduced in all PMB facilities and, as the same operates by the batch method, trouble occuring in one area does not necessitate shutdown of the entire facility. Accordingly, the CFTRI method was adopted for use in the present Project.

For demonstration purposes, both graded paddy and cleaned wet paddy will be processed. Moreover, various dry methods will be tested, including the use of cooling devices, artificial drying combined with tempering method, and sundrying, to determine the optimum parboiling system for use in System-C. To facilitate demonstrations, layout of parboiling facilities is designed to be as flexible as possible and details of the same are presented in FIG. 3-2.

The boiler, which uses rice husks produced in milling for fuel, will be used as the heat source for parboiling in consideration of operating costs. Although husk boilers are available from several Japanese companies, the cost of the same is high and maintenance problems are envisioned. Husk boilers used in Sri Lanka, on the other hand, are smoke tube boilers equipped with simple brick furnaces, maintenance for which is relatively simple. This type of boiler was accordingly adopted for use in the present Project.

(3) Rice Milling Plant

In principle, the rice milling plant will process parboiled paddy. Required capacity is therefore 5t/day. However, as design capacity is about 1t/hr of paddy, the facility may also be used for milling of surplus paddy when load is less than full capacity. To ensure production of high quality rice, the mill requires a rubber roll huller. This will prevent the intrusion of broken rice. In addition, installation of a stoner in front of and behind the huller will prevent the introduction of stones in milled rice and reduce wear on the roller.

Layout is as presented in FIG. 3-2 while specifications for the same are presented hereunder.

(4) Layout and Specifications for the Post-Harvest Plant

Overall layout of post-harvest plant facilities is presented in FIG. 3-2. As these facilities are for demonstration, the following points are considered important for optimum demonstration effectiveness.

1) Disposal areas for plant waste should be kept clean and care should be taken to prevent accumulation of ash, hulled husks, empty husks, etc.

2) Seeds and parboiled rice should be transported to the storehouse etc., and the inside of all facilities should be cleaned.

A flow chart is presented in FIG. 3-3 and specifications for each part are outlined below.

(1) Basic Conditions

1) Receiving

Only one seed variety can be received for processing per day. Average receiving rate is designated at 15t/day with 22% water content (maximum rate is approximately 21t/day and minimum is 3t/day). Five seed varieties will be handled (BG 11-11, BG 400-1, BG 94-1, BG 34-8, BG 276-5). Average water content of paddy recieved shall be approximately 22% and the rate of impurities will be a maximum of 10%.

2) Seed Size

Length:	5.1 - 9.4mm
Width:	2.0 - 2.9mm
Thickness:	1.9 - 2.3mm
Bulk density:	0.58

3) Weather conditions

Average temperature: 27.7°C

Total rainfall: 1,963mm (max. 509mm in December, min. 5mm in June)

4) Other Conditions

Electricity:	400V, 50Hz for 3 phase with 4 lines and 230V, 50Hz for single phase
Water:	60ppm CaO_3
Building:	Max. height of eaves: 9m
	Max. height of ridge: 13m

(2) Concept of the Plant

1) Flow of Paddy

The flow of paddy from one section to another is shown in the attached chart (FIG. 3-3).

2) Capacity and Components

The capacity of each facility and the components of the same are listed as follows:

Receiving

Capacity: 5 t/hr

Components: receiving hopper; seed pre-cleaner; seed bucket elevator; 500kg platform scale; dust collection system

Seed Drying

Capacity: 12t/day

Components: seed drier; belt conveyor; seed bucket elevator; steam heat exchanger for seed drier; dust collection system

Temporary Seed Storage Tank

Capacity: total storage capacity 18t

Components: tanks with upper cover and lower hopper; manual shutter; loading belt conveyor or gravity chute; unloading belt conveyor; seed bucket elevator; dust collection system

Seed Grading

Capacity: 1t/hr

Components: aspirator; length separator; width separator; seed bucket elevator; dust collection system

Seed Packing

Capacity: 1t/hr

Components: weighing control tank; semiautomatic scale; bag sewing machine; seed bucket elevator; dust collection system

Parboiling

Capacity: 5t/day

Components: Paddy tank; soaking cum steaming tanks; husk boiler; conveyor for parboiled rice with high water content; cooler for hot parboiled rice; parboiled rice drier with tempering tanks and steam heat exchanger; bucket elevator; belt-conveyors; loading apparatus for sun dried parboiled rice;

rice husk conveyors; rice husk tank; dust collection system

Rice Milling

Capacity: 1t/hr

Components: paddy tanks for milling pre-cleaner; paddy stoner; rubber roller rice huller; paddy separator; brown rice stoner; 2-stage rice polisher; bran remover; broken rice separator; weighing control tank; rice husk conveyors; automatic rice packing machine; bucket elevators; bran collection system; dust collection system

Portable Diesel Generator

Capacity: 50kVA, 400V, 50Hz, 3-phase - 1 unit

Cleaning Equipment

Capacity: sufficient power for cleaning of post harvest plant

Components: air-compressor; vacuum cleaner

3.3.2 Architecture

(1) Architectural Design

1) Plant Building

Based on study of its various functions, the plant was divided into 4 blocks. For ease of operation and in consideration of the mutual relationship between each block, the same were incorporated into one building thus simplifying the plant structure. The 4 blocks are as presented below.

Block 1	Block 2	Block 3	Block 4
Office Receiving & Distribution Area	Seed processing Seed drier Milling Storage	Parboiling	Husk Boiler

Structural materials and the area required for each block are delineated as follows.

Structure	Material
Floors, columns, beams	reinforced concrete
Walls	brick masonry
Roof	angle truss

Block	Area (m^2)
1. Office	24
Receiving & distribution area	92
2. Seed processing, seed drier, milling & storage	324
3. Parboiler	72
4. Husk boiler	72

Areas for seed processing, seed storage, etc., will be protected from birds by wire mesh. In addition, a pit (5m x 5m; D: 2m) for waste water from the parboiler will be excavated behind the plant building towards Tank No.7 as part of levelling works.

2) Tractor Shed

The proposed tractor is planned to provide easy access to tractors and other equipment. A storeroom and toilet are located on one side of the shed while an office is planned on the other side. Recommended materials and area required are as presented below.

Structure	Material
Columns, beams	reinforced concrete
Walls	brick masonry
Roof	angle truss
Floor	concrete reinforced with welded wire mesh

Facility	Area (m^2)
Office, storeroom & toilet	72
Tractor shed	360

3) Workshop

The proposed design for the workshop, which consists of the farm machinery repair and maintenance shop, was planned so as to facilitate smooth and integrated operation of each work item in consideration of the interrelationship between the same. For suitable ventilation use of wire mesh is recommended for partition of each work area. An office is planned on one side of the workshop while a storeroom and toilet are planned on the other side. Recommended materials and area required are as given below.

Structure	Material
Columns, beams	reinforced concrete
Walls	brick masonry and wire mesh partitions
Roof	angle truss
Floor	concrete reinforced with welded wire mesh

Facility	Area (m^2)
Office, storeroom & toilet	36
Work space	180

4) Farm Shed

The recommended farm shed site is in the southeastern end of the pilot farm with a comparatively higher elevation. A storeroom for farm tools is planned on both sides of the shed while the central space is designed as a rest area. Use of local materials and construction methods is recommended while the areas for the storeroom and rest area are both estimated at $25m^2$ each.

(2) Materials

1) In principle, local building methods and local materials will be used in construction. The same will conform to MECA specifications as compiled in Technical Specifications Volume III published by Sri Lanka.

2) Finishing Materials

Exterior and interior finishing materials to be used in the Project are outlined on the following page.

Plant Building

a) Exterior Finishing

Roof: corrugated asbestos slate sheet
Walls: face brick, two coats of colored wash in lime
Fittings: steel door (hanging door); wood flush doors with waterproof veneer; wooden framed glass windows; wooden framed welded wire mesh windows

b) Interior Finishing

Floor: rendered concrete
Skirting: rendered concrete; paint finish
Walls: colored cement lime sand plaster finish smooth
Ceiling: painted plaster
Fixtures: wood veneer flush door
Concrete columns, beams: paint finish
Steel trusses: Oil paint finish over rust resistant coating
Bird fence: oil paint finish on welded wire mesh

Tractor Shed

a) Exterior Finishing

Roof: corrugated asbestos slate sheet
Walls: face brick; two coats of colored wash in lime
Fixtures: wooden hanging doors; welded wire mesh partitions; wooden flush doors; steel frame welded wire mesh hanging doors; wood frame welded wire mesh windows and wooden shutters

b) Interior finishing

Floor: rendered concrete
Skirting: rendered concrete; paint finish
Walls: colored cement lime sand plaster finish smooth
Fixtures: wooden flush doors; welded wire mesh partitions with oil paint finish
Concrete columns, beams: paint finish
Steel trusses: oil paint finish over rust resistant coating
Bird fence: welded wire mesh with oil paint finish

(3) Structural Design

1) Basic Approach

Structural specifications will conform to general construction methods in Sri Lanka. Main buildings will be concrete rigid frame structures and walls will be constructed of locally manufactured brick. Structures were designed to ensure structural safety and economic and technical feasibility.

2) Structural Design

Calculations

All calculations for structural design were based on local standards or, where such standards were non-existant, on those of the Architectural Institute of Japan (AIJ).

Design Outline

a) Live Load

Live load for each structure is as presented in the table below.

Unit: Kg/m^2

Location	Floor & Beams	Structural Foundation
Office	300	180
RC Roof	100	100
Steel Frame Roof	30	30

b) Wind Pressure

Figures for calculation of wind pressure were adopted from "Design of Buildings for High Winds" Vol. 31 published in Sri Lanka as follows.

Wind pressure, $W = cq\ A$, $\quad q = 47\sqrt{h}$

where, w: wind pressure
c: coefficient of wind force
q: wind velocity (kg/m^2)
A: area (m^2)
h: height from ground level

c) Design Concrete Strength

Design concrete strength for main structures is

FC = 180kg/m^2 (tested after 28 days)

and that for other structures is also FC = 180.

d) Foundation

The foundation bed was designated at a depth of 0.55m below ground level using a direct foundation. Design bearing capacity of soil is 20t/m^2.

e) Materials

Reinforcing bar	Type II (b) ribbed twisted SD 24
Steel framing	SS 41
Bolts	SS 41
Concrete	cement, ordinary Portland cement, BS 12

(4) Architectural Facilities Design

1) Standards and Specifications

Design standards and specifications will conform to local standards or, for those items where no local standard exists, with the following:

- British Standards (BS)
- Japan Industrial Standards (JIS)
- Japanese Electrotechnical Committee Standards (JEC)
- Japanese Electrical Manufacturers' Association Standards (JEMA)

2) Facility Design Approach

Local conditions, including supply and demand, as well as special features of each building such as space and function, were considered in facility design. Facilities and equipment were selected for ease of operation and simplicity in order to ensure sufficient maintenance and durability.

3) Air Conditioner and Ventilation Facilities

Air conditioning and ventilation facilities were selected according to suitability to climate and local conditions.

Window and packaged air conditioners were selected as the seperate units can operate independently to air condition individual rooms when necessary. Moreover, spare parts for the same are readily obtainable and maintenance is uncomplicated.

Natural ventilation is facilitated through architectural design.

4) Water Supply, Drainage and Plumbing

Water will be supplied to the Project site from the Ratkinda Dam as shown in Appendix I, FIG. 2-6. Water will be pumped from the reservoir to a tank (capacity: $27m^3$) and supplied by the gravity method as needed. PVC pipe will be used.

Drainage is divided into sewage and waste water drainage systems, both of which will be equipped with PCV pipe. Plumbing fixtures for washrooms, etc., will be porceline with chromium-plated accessories.

5) Electrical Facilities

In principle, electrical facilities will conform to the following standards with due consideration given to conditions in Sri Lanka.

- British Standards
- Japan Industrial Standards
- Japan Electrotechnical Committee Standards
- Japanese Electrical Manufacturer's Association Standards

Electrical facilities were designed on the basis of the overall plan while at the same time considering integration within each individual building. Emphasis was placed on ensuring safe and pleasant working and living environments in consideration of construction cost and economic feasibility of maintenance.

Electricity will be supplied to each machine via a control panel and a distribution line, the latter being 3-

phase, 4 wire, 400V/230V, 50Hz. To maintain a safe, well-lit working environment while at the same time conserving energy costs, lighting will mainly be provided by flourescent lights. Details of lighting facilities are as follows:

- Office: 400 Lx
- Work Areas: 300 Lx
- Electric System: 1-phase, 2 wire, 230V, 50Hz
- Outlets: in each of the 3 offices; in the plant

3.3.3 Experimental/Demonstration Farm

(1) Outline of Farm Facilities Design

The farm site described in section 2.1 was selected on the basis of the Master Plan Study directly downstream of Ratkinda Dam at the southeastern end of the government seed farm. This site is only about 500m south of the research center with uniformly shaped subdivided farm lots.

Facilities required to convert the site into an experimental/demonstration farm have already been clearly defined by the Master Plan Study. On the basis of the R/D of the same, further discussions with Sri Lankan officials and detailed site survey, the Team drew up the detail design for the necessary facilities as presented hereunder and in DWG F1-F7.

1) Inspection Paths

Inspection path routes were determined as shown in DWG F1-3 on the basis of survey findings. The 9ha experimental farm site is presently divided into 80 paddy fields and routes were selected to allow observation of each field. In the case of the demonstration farm, 72 out of a total of 89 fields (14ha total) will be observable from inspection paths. The remaining 17 fields will be accessible via bunds. The inspection paths will connect with the main farm road where there are existing culverts for crossing the existing field canal.

The standard inspection path has a designed width of 4m and a height of 40cm, allowing the passage of small vehicles

(DWG F5). Corners are designed with a 1m corner cut and total path length is 2,680m.

2) On-farm Ditches

On-farm ditches will provide irrigation water directly to all paddy. The command area covered by each ditch ranges from about 0.5ha to 1.6ha and design capacity is 3.2ℓ/sec. Ditch cross sections were designed in consideration of such factors as tilling rotation.

Proposed alignment of ditches is along existing bunds and proposed inspection paths. In this way, earthen ditches may be simply formed by construction of another bund, 0.3m in height, adjacent to the existing one. Design bottom width of ditches is 0.3m and total length is 3,710m (Refer to DWG F4).

3) Improvement of Farm Inlets

In addition to construction of on-farm irrigation canals, improvement of existing farm inlets is required. Improvement works include the installation of one ø150mm RC pipe (ℓ=2.0m) and diversion box in a total of 23 sites (DWG F4).

4) Field Drains

A sharp crested weir has been installed at both the experimental and demonstration farm sites to measure the amount of water intake at the same. In order to study water balance over a wide area and determine the total discharge for the 23ha site, construction of on-farm field drains to collect discharge is planned. Cross section of the field drain was designated with a 0.3m bottom width and a height of 0.5m on the basis of a unit discharge volume of 1ℓ/sec/ha as applied in the existing Mahaweli development project. Total length is 1,200m.

Capacity of existing field drains was studied and the slope and drainage capacity were judged to be sufficient. However, as the same are earthen structures, periodic maintenance and repair will be required.

5) Drainage Culverts

With construction of inspection paths and field drains, installation of crossing structures will also be required. Culverts consisting of two ø45cm, RC pipes, each 2.45m in length, are designed for installation at a total of 8 sites (DWG F5). Construction of an additional sharp crested weir is planned at the terminus of the field drains to measure return water and discharge (DWG F6).

6) Farm Fence

The need for fencing to prevent the intrusion of animals into the farm area was stressed by the government seed farm manager and the Master Plan Study Mission. Accordingly, installation of a barbed wire fence around the entire farm area is planned. Wooden gates are planned at points where the said fence crosses roads and total fence length is 2,750m (DWG F1).

7) Corrugated Sheet Bunds

To measure the amount of horizontal percolation etc. from paddy, bunds will be constructed of corrugated sheets. One corrugated PVC sheet reinforced with wire mesh will be cut into 3 pieces. These will be fixed side by side in the ground with each sheet partially overlapping the next to prevent seepage. Total length of corrugated sheet bunds is 600m and, in consideration of allowance, a total of 400 sheets are required (DWG F7).

8) Other

Although the Master Plan Study Mission reported a high small stone content in the paddy fields, the majority of stones were removed at the beginning of the first cropping season (December, 1984) and consequently this work item has been deleted from the Detail Design.

A portion of bunds in the experimental/demonstration farm, particularly in the experimental farm, have deteriorated. Repair of the same by farm staff upon commencement of cropping is judged to be required.

Five fields in the center of the demonstration farm were found to have a higher elevation than those in the upstream portion of the on-farm ditch. The water distribution system plan was accordingly revised to facilitate supply to the said field.

3.4 Construction Cost

(1) Construction Works

Construction works which will be funded by Japanese grant aid under the Project are as outlined below.

OUTLINE OF THE WORK

Work Item	Quantity	Description
1. Plant Building[1/]	(584m^2)	Floor: reinforced concrete
Clearing area	92m^2	Columns: " "
Office	24m^2	Beams: " "
Seed grading, milling, etc.	324m^2	Walls: brick masonry
Parboiling plant	72m^2	Roof: angle truss
Husk boiler	72m^2	
2. Experimental/Demonstration Farm Facilities	(23ha)	
Inspection roads	2,680m	W: 4m, unpaved
On-farm ditches	3,710m	bottom width: 0.3m, H: 0.3m earthen ditch
Improvement of inlets	23 sets	0.15m dia. RC pipe & diversion box
Field drains	1,200m	bottom width: 0.3m, H: 0.3m; earthen ditch
Drainage under crossings	8 sets	0.45m dia. RC pipe; L: 4.9m
Sharp crested weir	1 set	W: 1.8m
Fence	2,750m	H: 1.5m barbed wire
Bund construction	600m	corrugated PVC sheet reinforced with wire mesh

(2) Criteria of Cost Estimation

MECA calculated construction costs of Mahaweli River development for 1980, 1981 and 1984. Based on increases in labor, steel and concrete costs for the same, the annual rate of increase in construction cost over the last 4 years is estimated at about 16%. Construction cost for the Project was estimated on the basis of several factors such as price escalation, contingency and unit rate for 1984.

3.5 Work Schedule

Rainfall recorded at Mahiyangana (since 1974) and Girandurukotte (since 1981) in the Project vicinity was collected and monthly rainfall derived from the same is presented in TABLE 3-2. As daily rainfall data were available for the 3 year period from 1982-84, number of working days during the said period was also studied. The average number of working days for the 3 year period is presented in TABLE 3-3. As TABLE 3-2 clearly indicates, rainfall in 1980 was exceptionally scarce while that in 1984 was exceptionally heavy compared to other years. Accordingly, the number of working days shown in TABLE 3-3 is considered on the safe side as the same includes data for 1984. Completion of all earthworks, concrete works, roofing, etc., by mid-September is strongly recommended as in the average year, Maha season begins in October, the heavy rains of which greatly reduce work efficiency.

On the basis of the above data, the construction schedule is planned as in FIG. 3-4. The proposed construction period, including preparation, is approximately 6 months for buildings and about 4 months for civil works at the experimental/demonstration farm. The period required for installation work at the plant is estimated at about 2 months commencing after completion of building construction, and include running tests of the plant and training of local staff in operation and maintenance.

3.6 Construction Contractor

(1) Features of Construction Work

Construction work for the Project can be broadly divided into civil works for the experimental/demonstration farm (23ha) and construction of the plant building (584m^2) which houses post-harvest facilities. The features of the two categories are as described below.

1) On-Farm Facilities

Local contractors are generally sufficiently experienced and familiar with all types of civil work required for on-farm facilities, and if due care is taken in levelling ditches and drains, no difficulties are envisioned.

Care should also be taken to protect existing facilities including ditches, roads and culverts from damage during construction. All main construction and concrete works should be completed before October to avoid the heavy rains.

2) Plant Facilities

As the plant is designed with a high roof (about 9m) constructed of metal trusses, a competent local contractor with experience in such work and a high standard of workmanship is desirable. All works including foundation, concrete placing and roofing, are planned to be completed by mid-September. The motor driven shutter will be supplied from Japan.

(2) Selection of Contractor

As indicated by the above work descriptions, the contents of civil works for the experimental/demonstration farm and plant construction works are quite different. In addition, the two sites are separated by about 500m. However, in consideration of the relative remoteness of the site, material procurement, labor, scheduled deadline and supervision, implementation of civil works and plant construction works by a single contractor is judged to be most advantageous.

3.7 Draft Contract and Specifications

On the following pages a draft Contract and proposed specifications for the Project are provided. In discussion with the concerned parties, the same will be finalized for use under the Project.

CONTRACT

The Representative of Japan International Cooperation Agency, Colombo Office, the Democratic Socialist Republic of Sri Lanka which is located at .....
..... Mr. .....
or his successor (hereinafter referred to as the Employer) as the firstparty, and
.....
which is located at .....
(hereinafter referred to as Castractor) on the second party, hereby conclude a contract of the Construction work of the experimental field and plant building for the Integrated Agricultural Development Demonstration Project, Mahaweli Area on the following terms.

ARTICLE 1 (a) DESCRIPTION OF WORK

The Contractor shall carry out the construction work of the experimental field and plant buildings for the Integrated Agricultural Development Demonstration Project in Unit 1 area, Block 302, System "C", Mahaweli Ganga Project.

ARTICLE 1 (b)

The following documents shall be deemed to form, be read, and constructed as part of this Agreement viz:

- The attached Detailed Drawings
- The attached Specifications

ARTICLE 2 CONTRACT SUM OF CONSTRUCTION

The contract sum of construction shall be .....
.....(.....).

ARTICLE 3 TIME LIMIT OF SUBMISSION OF PRICED BILL OF QUANTITIES

The Contractor shall submit a copy of the Priced Bill of Quantities to the Employer within seven (7) days after signing by both parties of this Agreement. The Contractor reserves the right to remeasure the work and check the Bill of Quantities, both for quantity and description.

ARTICLE 4 TIME LIMIT ON CONSTRUCTION AND ITS PROLONGATION

The Contractor shall commence the work within ten (10) days after signing by both parties of this Agreement, and complete the work by ....., 1985.

ARTICLE 5 DELAYS

In a case where it is clear that the Contractor is failing to fulfill his obligations within the period referred to in the preceding Article, the Contractor shall inform the Employer of this by a letter as soon as possible, and if the Employer agrees that the delay is due to such causes as natural calamity or others for which the Contractor is not liable, a reasonable extension of time will be approved. In this case, the sum referred to in Article 16 will not be collected.

ARTICLE 6 PROCESS OF CARRYING OUT OF WORK

The Contractor shall carry out the work in accordance with the Drawings and Specifications referred to in Aritiele 1 (b). In cases where it is necessary for the Contractor to carry out such work as is not mentioned therein for the purpose of promoting the present construction or for reasons of established practices, the Contractor shall carry out the said work under the direction of the Employer or his authorized representative. In cases where the Contractor finds any doubt in the plans of construction, the Contractor shall ask the Employer for the necessary directions before commencing the work on that part for which there exists some doubt.

The Employer shall provide such information and details within seven (7) days of the written request from the Contractor.

ARTICLE 7

The Contractor shall follow the direction of the Employer or his designated supervisor. As to materials for the construction, the Contractor shall use only those inspected and approved by the Employer or the supervisor appointed by the Employer. In cases where any defective work has been done as a result of such use of materials which have not been inspected by the supervisor, or of disobedience to the direction of the supervisor, the Contractor shall be liable to charge the materials or

repair the work at his own responsibility. The construction shall be carried out in accordance with the proper technique, and durability shall be the principal aim as regards to the construction.

ARTICLE 8 WORKMEN

As to the workmen to be hired by the Contractor for the work, the Contractor shall assume the responsibility as entrepreneur or employer, as provided for by Laws and Regulations in Sri Lanka.

ARTICLE 9 TRANSFER OF RIGHT AND OBLIGATION

The Contractor shall not assign or sublet to a third party the whole or part of the construction except in cases where the Contractor has obtained written approval from the Employer.

ARTICLE 10 DAMAGES

In cases where any damage is caused to the Employer or a third party, materials or construction, through carelessness on the part of the Contractor during the course of work or transportation of materials, the Contractor shall be liable to repair or compensate such damages at his own expense by the date appointed by the Employer or the third party.

ARTICLE 11

In cases where the Contractor fails to repair or compensate such damages referred to in the preceding Article by the fixed date, the Employer may pay for such repair on behalf of the Contractor, and collect compensation from the Contractor by deducting the amount from the sum of construction to be paid to the Contractor by the Employer under the provisions of Article 21, and in cases where the damages exceed the sum of construction, the Employer may collect the deficit from the Contractor.

ARTICLE 12 (a) CHANGE OF CONSTRUCTION DRAWINGS AND SUBMISSION OF NECESSARY DOCUMENTS

In cases where the Employer feels it necessary to discontinue the work owing to unavoidable circumstances, or to alter the plan of construction, the Employer may request the Contractor to calculate, on the basis of the unit prices as detailed in the priced Bill of Quantities referred to in

Article 3, so as to increase or decrease the sum of construction resulting from the suspension or alteration of the work, and the Contractor shall comply with the request. When the Employer orders such a suspension or alteration, *depending on the statement of the above mentioned calculation*, the Contractor shall submit a written consent by the date appointed by the Employer.

ARTICLE 12 (b)

Where work cannot be properly measured and valued on the basis of the unit price in the Bill of Quantities referred to in Article 3, the Contractor will be allowed to calculate on the basis of the daywork rates which shall be approved by the Employer before their application.

ARTICLE 13 (a) PRICE ADJUSTMENT

In the case of the costs of materials rising sharply as a result of the fluctuation in the market prices due to an unexpected change in the economic conditions, a reasonable adjustment of the contract sum or the unit prices in the Bill of Quantities will be made through negotiations between the Employer and the Contractor.

ARTICLE 13 (b)

In case where a loss such as may render it unreasonable for the contract sum referred to in Article 2, is inflicted upon the Contractor by virtue of the Employer's failure to provide the information and details referred to in Article 6 or to obtain the necessary approvals under the local byelaws, then a reasonable adjustment of the above mentioned sum will be made on the basis of the detailed claim submitted by the Contractor.

ARTICLE 14 RIGHT TO RESCIND CONTRACT AND PENALTY

In cases where the Contractor fails to fulfil his obligations under this contract, the Employer may rescind the whole or part of the Contract. In such a case, the Employer may collect from the Contractor a sum as a penalty of ten percent (10%) of the amount which is equivalent to the rescinded. In cases where the damages caused to the Employer, on the account of the non-fulfilment of Contract by the Contractor, exceed the sum referred to in the preceding paragraph, the Employer may further demand the Contractor to pay the excess.

ARTICLE 15

In cases other than provided for in Article 14 where the Contractor fails to fulfil his obligations, or in cases where the fulfilment of obligations by the Contractor is regarded to be difficult, the Employer may ask a third party to fulfil, at the cost of the Contractor, the whole or part of the obligations of the Contractor. Even if liability of the Contractor exceeds the contract sum referred to in Article 2 in consequence of this, the Contractor shall not raise any objection to it.

ARTICLE 16

In cases other than provided for in Article 14 where the Contractor fails to complete the construction at his own responsibility within the period referred to in Article 4, the Contractor shall be liable, within a period fixed by the Employer, to pay the Employer per week of delay a sum equivalent to 0.1 percent (0.1%) of the contract sum referred to in Article 2.

ARTICLE 17 DAMAGE CAUSED BY NATURAL CALAMITY, ETC.

In cases where serious damages occur to the completed part of the work, or the materials, tools, etc., already carried into the field of construction, the Contractor shall promptly inform the Employer of the circumstances. If such damages are caused by a natural calamity, an earthquake, a flood, a civil war, a war, an epidemic, or a general/trade strike, riot or other unavoidable reasons, for the occurrence of which no responsibility can be attributed to either the Employer or the Contractor, and it is admitted that the Contractor has played the role of good administrator to avoid the occurrence of such damages, the Employer shall be liable for the amount of the damages which shall be fixed through negotiations between the Employer and the Contractor.

ARTICLE 18 (a) INSPECTION

The work at any stage shall be subject to inspection to be conducted by the Employer or an inspector appointed by the Employer in the presence of the Contractor, and necessary labor and articles required for such an inspection shall be provided by the Contractor.

ARTICLE 18 (b)

In cases where the work fails to pass the inspection referred to in the preceding paragraph, the Contractor shall carry out necessary repair at his own cost under the direction of the Employer.

ARTICLE 19 DATE OF COMPLETION OF CONSTRUCTION AND OBLIGATION THEREAFTER

The date of completion of construction shall be regarded as that on which the final work, including removal of temporary facilities and cleaning, has passed the inspection referred to in Article 18, and on that date the object of the construction shall be delivered to the Employer by the Contractor. For a period of one year thereafter, any defect in the construction, the cause of which is judged in the opinion of the Employer to be attributable to faulty or inadequate techniques or materials employed by the Contractor, shall be immediately repaired or improved by the Contractor at the cost of the Contractor.

ARTICLE 20 PAYMENT

Payment for the part of the work already completed shall be allowed for twice excluding advance payment during the course of construction at the request of the Contractor provided that it has passed the inspection referred to in Article 18, based on the unit prices in the Bill of Quantities.

However, the amount of the payment shall be limited to ninety percent (90%) of the work already completed. The final payment will be made within one (1) month after the Employer receives the bill which will be issued by the Contractor on or after the date of completion of construction referred to in Article 19.

ARTICLE 21 (a) SETTLEMENT OF DISPUTE

If there arises any dispute with regard to this Agreement or the Detailed Drawings or Specifications referred to in Article 1 (b), it shall be settled by a mutual consultation between the Employer and the Contractor.

ARTICLE 21 (b)

Should it not be possible to reach a mutual Agreement between the Employer and the Contractor on such dispute, then it shall be referred to an Arbitrator or Arbitrators acceptable to both the Employer and the Contractor and the decision of this Arbitrator or Arbitrators shall be binding on both the Employer and the Contractor.

CONCLUSION OF THE AGREEMENT

Two copies of the Agreement shall be prepared with the signatures of both parties affixed to each of the copies, one copy to be held by each party.

Date .....

Employer
Signed .....

Contractor
Signed .....

WITNESS
Signed .....

TERMS AND CONDITIONS OF THE CONTRACT

1. **Objectives**

The Japan International Cooperation Agency (JICA) intends to construct an 'Experimental and Demonstration Farm and Plant Building for Paddy Processing Plant in Unit 1, Block 302, System "C"' in the Democratic Socialist Republic of Sri Lanka.

2. **Work Schedule**

The Contractor shall submit to the Employer for his approval the detailed work schedule for performing the construction works specified in Article 1 (b) of the Contract and attached "Description of the Works" within ten (10) days after signing by both parties of the Agreement.

3. **Operation of Work**

To supervise the construction works, the Contractor is required to retain a full-time engineer fully responsible for the works at the construction office. If the engineer does not stay at the office without appropiate reason, the Employer reserves the right to stop the works or part of the works instantly and the Contractor is required to be responsible for any damage from this neglect.

4, **Progress Report**

Progress reports shall be submitted to the Employer by the Contractor every month. If there is any delay of work from the agreed schedule, the Contractor shall submit the modified work schedule to the Employer to justify for such a delay so as to achieve the originally set target.

5. **Acceptance of Completed Work**

Upon receipt of the written request from the Contractor, the Employer will check the work actually benformed in the field. If everything is satisfactorily completed, the Employer will accept that part of work within seven (7) days after the receipt of the

request. If there are any inconsistencies and shortcomings in the work presented by the Contractor, the Employer will reserve the right not to accept the work. During the improvement of the work, it will be regarded that the work has not been accepted. After completion of the improvement work, the Contractor shall request the Employer to inspect the same. If the improvement work is satisfactorily completed, the Employer will accept the work within seven (7) days after the receipt of the request.

However, the acceptance does not necessarily mean the discontinuation of the responsibility of the Contractor for possible damages to that part of the work. The complete acceptance takes place only when all the works have been completed and accepted.

6. **Increase or Decrease of Unit Price**

In the event of remarkable fluctuation in the costs of labor, materials, equipment, etc., the adjustment of unit prices may be made based on the escalation factors through negotiations between the Employer and the Contractor. However, no adjustment will be made in case of the delay of construction works due to the fault of the Contractor.

7. **General Text**

The construction works shall proceed in accordance with the Drawings and Specifications in every respect. If the same is found lacking in detail the Contractor may refer to the quidelines prepared by the Mahaweli Engineering & Construction Agency. However, before proceeding the Contractor is held responsible to confirm his planned approach with the Employer's site supervisor.

In case, however, the Employer adds to or revises the original Drawings and/or Specifications in order to attain further engineering perfection, the Contractor is required to proceed with the construction in accordance with the added or revised drawings and/or specifications in every way without any objections.

8. Alignment, Leveling and Site-Plan Setting

The Employer is to inform the Contractor of the bench mark which gives the base elevation to be used for the construction. The succeeding steps shall be the duty of the Contractor. The Contractor shall set and determine the alignment and elevations in accordance with the Drawings in the construction area and obtain inspection by the Employer prior to the commencement of the construction. The Contractor is required to preserve all the pegs that indicate the alignment and elevations in a good condition throughout the construction period. In cases where the Employer requests, the Contractor shall conduct checking survey and submit the results to the Employer as soon as possible.

SPECIFICATIONS

1. GENERAL

1.1 In principle, construction methods and materials shall conform to MECA specifications as compiled in 'Technical Specificatons, Volume III' published by Sri Lanka. However, as the same are prepared as a general guideline, the following specifications shall supersede said publications when a conflict arises between the two.

2. SURVEY & LAYOUT WORK

2.1 Data and information developed by the Contractor as Survey Work shall be reviewed with the Engineer as and when requested.

2.2 The Contractor shall protect existing or established reference points or markers as necessary.

2.3 No Work under the Contract shall be permitted to proceed until respective Survey and Layout Work has been provided and verified as correct.

2.4 Survey Work shall be under direct control and continuous supervision of a Civil Engineer or Licensed Surveyor, retained and paid by the Contractor as part of Work under this Contract.

3. CLEARING AND GRUBBING

3.1 Clearing and grubbing shall consist of clearing ground surfaces within designated areas of all trees, stumps, fallen timber, logs, snags, brush, undergrowth, hedges, heavy growth of grass or weeds, debris, rubbish of any nature, natural obstructions or such materials which, in opinion of the Engineer, are unsuitable for the proposed project site including the grubbing of stumps, roots, and the disposal from the project area of all spoil materials resulting from clearing and grubbing by burning or otherwise.

3.2 All spoil materials removed by clearing and grubbing shall be disposed by burning or by removal to approved disposal areas.

Piles for burning shall be placed either in cleared areas near the center or in adjacent open spaces where no damage to trees, other vegetation, or other property will occur. The Contractor shall be responsible for controlling fires in compliance with any and all local laws and regulations relative to building fires at site. Ashes resulting from burning shall be removed and disposed as directed by the Engineer.

3.3 Ground surface shall be graded after removal of all spoil materials to the appropriate elevation as directed by the Engineer.

4. EARTHWORK

4.1 Excavation

4.1.1 The excavation covers all kinds of soil including clay, sand, pebble, gravel and cobble stone, and does not include soft or hard rock excavation. If a rock layer is encountered, additional cost for that excavation will be paid by mutual Agreement between the Employer and the Contractor.

4.1.2 The excavation for the construction of boxes, pipelines and other structures shall be done in an adequate and proper manner in consideration of the construction method of the structures.

4.2 Backfilling

The excavated materials shall be used for backfilling after removing unsuitable materials. The backfilled materials, shall be well tamped, moistened and compacted in each horizontal layer not exceeding 20cm in thickness.

4.3 Embankment

4.3.1 The Contractor shall place and compact the materials for embankment true to the lines, grades and dimensions shown on the Drawings or as directed by the Engineer.

4.3.2 Embankment materials shall be reasonable well-graded and suitable ones acceptable to the Engineer. The embanked materials shall be well tamped, moistened and compacted in each horizontal layer not exceeding 20cm in thickness.

4.3.3 The compaction of road materials shall be executed by a bulldozer of not smaller than 15t class or other heavy equipment approved by the Engineer for 5 times in each layer. However, the compaction of the final layer shall be performed by a tireroller or equivalent approved by the Engineer.

4.3.4 The Contractor shall clear up roots, stumps and any other unnecessary materials along the alignment of the road before embankment operation.

4.3.5 Embankment materials shall be obtained from a proper and suitable borrow pit or pits outside the site at the responsibility of the Contractor. If the Contractor wants to use the materials inside the site for embankment, prior approval of the Engineer shall be received.

4.4 Grading & Compacting

The Contractor shall perform the grading work in an adequate and proper manner for the road without filling, where its alignment, section or profile is not suitably fitted to the requirements of the Drawings or as directed by the Engineer, and shall perform the compacting work by a motor grader or other equipment approved by the Engineer for 5 times in each section.

4.5 Gravel and Cobblestone

4.5.1 Gravel and cobblestone shall be placed as shown on the Drawings or as directed by the Engineer.

4.5.2 The materials for gravel and cobblestone shall be either natural or crushed, round or semi-round pieces of rock with suitable diameter.

4.5.3 Gravel and cobblestone shall be neatly placed, trimmed and compacted true to the line, elevations and dimensions after compaction of the base surface.

4.6 Removal of Surplus Soil

Surplus soil shall be removed to a suitable place inside the site as a rule. However, if it is impossible to find a suitable place inside the site, the Contractor shall find a suitable place outside the site upon obtaining the approval of the Engineer.

5. CONCRETE WORKS

5.1 Plain Concrete

5.1.1 The plain concrete of $1m^3$ shall have the following compositions by volume:

Cement - 1 (Min. 225kg)
Sand - 3 (Approx. $0.54m^3$)
Gravel - 6 (Approx. $0.81m^3$)

5.1.2 Cement and gravel shall be well washed and graded, hard and free from dust, mud and organic matter.

5.1.4 Sand shall have a fineness modulus of not less than 2.5. Size of gravel shall be smaller than 40mm in diameter.

5.2 Reinforced Concrete

5.2.1 The reinforced concrete of $1m^3$ shall have the following composition by volume:

Cement - 1 (Min. 350kg)
Sand - 2 (Approx. 0.50m^3)
Gravel - 4 (Approx. 0.75m^3)

5.2.2 Cement shall be brand new, good quality and absolutely dry.

5.2.3 Sand and gravel shall be well washed and graded, hard and free from dust, mud and organic matter.

5.2.4 Sand shall have a fineness modulus of not less than 2.5. Size of gravel shall be smaller than 25mm in diameter.

5.3 Mixing

5.3.1 Cement, sand and gravel shall be mixed with a mechanical mixer as a rule. When a mechanical mixer is used, each batch shall be continuously revolved for not less than 90 seconds after all materials including water are added in the mixer.

5.3.2 New materials shall not be added before all the concrete in the mixer has been removed.

5.3.3 The quantity of water to be added shall be such as to obtain proper workability and consistency.

5.3.4 Water to be used in concrete mixing shall be fitfor drinking.

5.4 Placing

5.4.1 No concrete shall be placed until all form work, treatment of surface, reinforcement and other embedded parts have been inspected and approved by the Engineer.

5.4.2 All surfaces upon or against which concrete is to be placed shall be thoroughly cleaned and well moistened before concrete is placed except for where there is danger of freezing.

5.4.3 Laitance on the surface of the concrete at any and all horizontal joints shall be throughly removed by suitable

means to the satisfaction of the Engineer, before placing succeeding concrete.

5.4.4 Before concrete is placed, the surfaces of concrete so prepared and approved in accordance with the provisions shall be covered with mortar with a composition of cement 1 to sand 2.

5.4.5 Placing of concrete, once started, shall be carried out continuously in order to prevent the development of cold joints.

5.4.6 In placing concrete in columns and walls, suitable tools acceptable to the Engineer shall be used in order to avoid segregation of the materials.

5.4.7 Concrete, soon after being placed, shall be sufficiently compacted by tamping and vibrating with suitable tools.

5.5 Curing

5.5.1 After concrete has been placed, it shall be protected and cured strictly in accordance with the method approved by the Engineer.

5.5.2 The Contractor shall cover the surface of concrete with mats, burlaps or wet sand and maintain watering operation for at least 7 days.

5.6 Formwork

5.6.1 Wooden forms shall comply with the positions, shapes and dimensions of the structure shown on the Drawings, and shall be rigid and strong enough to support the weight of concrete without deformation or deflection.

5.6.2 Froms shall be tight enough to prevent the seepage of water and mortar, and designed to permit ready removal.

5.6.3 The form surfaces coming into contact with concrete shall be thoroughly cleaned and oiled before placing concrete. Oil to

be applied shall be mineral oil or an other kind which will not stain the concrete surface.

5.6.4 Chamfers shall always be employed at corners of forms so as to produce beveled edges on all permanently exposed concrete surfaces.

5.6.5 Forms may be reused upon approval of the Engineer provided that they are in good and proper condition and thoroughly clean.

5.6.6 Forms shall not be removed until the concrete obtains enough strength against imposed loads and other incidental loads occuring during construction.

6. REINFORCEMENT

6.1 Mild steel bars shall be processed strictly in accordance with the shapes and dimensions shown on the Drawings or as directed by the Engineer, without effecting any damage to the quality of materials.

6.2 Diameters of bends and hooks are as follows:

Bend: 5 times bar's diameter or more
Hook: 4 times bar's diameter or more

6.3 Steel bars shall be well cleaned, arranged in the right places and put together very rigidly so that no movement takes place during concrete placing.

6.4 Intersecting points and splices of steel bars shall be fixed with suitable clips or wire of 0.7mm or more in diameter.

6.5 Steel bars shall be accurately placed in the position shown on the Drawings, and spaced with mortar blocks, metal spacers or other spacers suitable for supporting loads imposed in order to maintain the positions, alignment and coverage throughout the form erection, reinforcement work and concrete placing operation.

6.6 Overlap lengths for splices shall have, as a rule, 45 times and 35 times bar's diameters for tension and compression sides, respectively. Both ends of the bar shall have proper hooks.

6.7 Splices at places where bigh stress is to be applied shall be avoided.

6.8 Standard coverage shall be 40mm, unless otherwise directed by the Engineer.

7. MORTAR PLASTERING WORKS

7.1 Mortar for plastering shall have the following composition by volume:

Cement - 1
Sand - 3

7.2 Quality of sand shall be the same as that used for concrete. However, it shall be used after sieving with 1.2mm sieve.

7.3 Before plastering, the surface of concrete or brick to be plastered with mortar shall be thoroughly cleaned and moistened.

7.4 The first coating of minimum. 3cm thick shall be made carefully by using a trowel. No remarkable void shall be left.

7.5 After scratching the surface of the first coat, the second or finishing coating of minimum. 1cm thick shall be made carefully especially of the chamfer and corner so that no spot remains. After plastering, final finish treatment shall be effected with brush or a trowel.

7.6 Spraying of water on the surface of mortar shall be continued for at least 4 days after completion of plastering.

7.7 Floor plastering shall be performed as soon as possible after concrete is placed.

8. STONE MASONRY WORKS

8.1 Ashlar stone to be used in the works shall be obtained from an approved quarry, and shall be free from holes or defects, and shall not be thin or slender. The size shall not be smaller than 25cm.

8.2 Before any masonry work is started, a sample wall section shall be laid for the approval of the Engineer.

8.3 Mortar paste shall be placed between ashlar blocks with suitable thickness in accordance with the Sri Lankan standard or as directed by the Engineer.

9. CONCRETE PIPE WORKS

9.1 Precast concrete pipes shall be placed at road crossing locations true to the lines, grades and dimensions shown on the Drawings or as directed by the Engineer.

9.2 Excavated soil shall be set aside in order not to hinder traffic and topsoil shall be preserved seperately from subsoil so as to be used as topsoil over backfill earth.

9.3 The trench dimensions shall be suitable or adequate for normal operation of precast concrete pipe placing.

9.4 The bottom of the trench shall be leveled except for the pipe joints portions. In the case of rocky or stoney ground, at least 10cm excess-excavation is required and shall be backfilled with sand or sandy soil.

9.5 In backfilling, due care shall be taken to avoid direct touching of pipes with stones, and backfill materials shall be thoroughly tamped at every 20cm layer.

9.6 Before lowering the pipe into the trench, inside and ends of the pipe shall be made free from sand, mud, pebbles and other obstacles, and thoroughly cleaned.

9.7 The pipes shall be carefully laid with no cracks, breaks or any other damages.

9.8 Pipe joints shall be wrapped with mortar 20cm in width and 10cm in thickness.

9.9 Surplus soil after backfilling shall be removed to a suitable site as per normal procedures of Sri Lanka.

10. BRICK MASONRY WORKS

10.1 Brick to be used shall be of good quality having no irregularity in shape, cracks or flaws.

10.2 Bricks shall be cleaned first and laid rightly and evenly along the batter board.

10.3 No vertical joints placed in a straight line shall be allowed.

10.4 Mortar paste shall be placed between bricks with suitable thickness in accordance with the Sri Lankan standard or as directed by the Engineer.

11. PAINTING WORKS

11.1 Paint shall for all steel structures such as steel pipes, door and windows and also be applied for surfaces of wall and lumber.

11.2 Steel surfaces shall be thoroughly cleaned and painted with one coat of rust-preventing paint before it is delivered from the workshop or factory. However, portions where it is impossible to paint after assembling shall be coated twice with rust-preventing paint at the factory before delivery.

11.3 The portion to be buried in concrete will not be required to be painted.

11.4 Painting shall be done with a brush uniformly and properly so that such defects as nonuniformity and bubbles will not occur.

12. CARPENTRY WORKS

12.1 Lumber shall be clear surfaced on all four sided and shall be worked in the such patterns as are indicated or specified.

12.2 Nails and accessories shall be steel and galvanized and the size and type shall be as indicated in the Drawings or as directed by the Engineer.

13. TILE WORKS

13.1 Tile to be used shall be of good guality having no irregularity in shape, nor cracks or flaws.

13.2 Tile shall be cleaned first and laid rightly as shown in the Drawings or as directed by the Engineer.

13.3 Tile shall be fixed firmly in accordance with Sri Lankan standards or as directed by the Engineer.

DESCRIPTION OF THE WORKS

The works proposed to be undertaken under this Contract for the construction of the Experimental and Demonstration Farm, and Plant Building in Unit 1, Block 302, System "C", Mahaweli Area, shall include furnishing of all labor, materials, plant and equipment necessary for construction and supplying completely the items given below.

OUTLINE OF THE WORK

Work Item	Quantity	Description
1. Plant Building	584m^2	
Loading area	(92m^2)	Floor: reinforced concrete
Office	(24m^2)	Columns: " "
Seed grading, milling, etc.	(324m^2)	Beams: " "
Parboiling plant	(72m^2)	Walls: brick masonry
Husk boiler	(72m^2)	Roof: angle truss
2. Experimental and Demonstration Farm Facilities	23ha	
Inspection paths	2,680m	W: 4m, unpaved
On-farm ditches	3,710m	bottom width: 0.3m, H: 0.3m earthen ditch
Improvement of inlets	23	0.15m dia. RC pipe & diversion box
Field drains	1,200m	botton width: 0.3m, H: 0.3m; earthen ditch
Road crossing culverts	8	0.45m dia. RC pipe; L: 4.9m
Sharp crested weir	1	W: 1.8m
Fence	2,750m	H: 1.5m barb wire
Bund construction	600m	Corrugated PVC sheet reinforced with wire mesh

BILL OF QUANTITIES

ARICHITECTUAL WORK

No.	Description	Unit	Qty.	Unit Rate	Amount	Remarks
A.	**Plant Building Works**					
1	Land Levelling Work	m^3	300			
2	Common Excavation Work	m^3	243.4			
3	Compacted Gravel	m^3	68.3			
4	Concrete Work (1:3:6)	m^3	30.5			
5	Concrete Work (1:2:4)	m^3	286.2			
6	Form Work	m^3	286.2			
7	Reinforcement Work	t	54.3			
8	Steel Trass Work	t	44.3			
9	Welding	m	132.6			
10	Brick Masonry Work	M^3	118.5			
11	Door and Window Work	-	LS			
12	Metal Work	-	LS			
13	Corrugated Asbestos Sheet Roofing Work	m^2	865.4			
14	Waterproof Work	m^2	20.0			
15	Plastering Work	m^2	505.3			
16	Painting Work	m^2	2,563.1			
17	Gutter Work	-	LS			
18	Miscellaneous Work	-	LS			
19	Drainage Work, etc.	-	LS			
20	Electric Work	-	LS			
21	Plumbing Work	-	LS			

BILL OF QUANTITIES

CIVIL WORK

No.	Description	Unit	Qty.	Unit Rate	Amount	Remarks
A.	**Construction Work of Inspection Path (2,620m)**					
1	Stripping Work of Top Soil	m^3	1,200			
2	Common Excavation Work (haul: 1,200m)	m^3	4,932			
3	Placing & Compaction Work Including Watering (roller)	m^3	4,932			
B.	**Construction Work of On-Farm Ditch**					
1	Common Excavation Work (haul: 1,200m)	m^3	835			
2	Placing & Compaction Work Including Watering (manual)	m^3	835			
C.	**Improvement Work of Farm Inlet (23 sets)**					
1	Common Excavation Work	m^3	67.2			
2	Backfilling Work	m^3	57.5			
3	Compacted Gravel Work	m^3	3.5			
4	Concrete Work (1:3:6)	m^3	2.3			
5	Concrete Work (1:2:4)	m^3	4.7			
6	Form Work	m^3	7.0			
7	Reinforcement Work (ø6mm)	kg	122.6			
8	Furnishing Pipe (ø150mm)	m	112.7			

No.	Description	Unit	Qty.	Unit Rate	Amount	Remarks
D.	**Construction Work of Culvert for Irrigation (2 sets)**					
1	Common Excavation Work	m^3	11.7			
2	Backfilling Work	m^3	10.0			
3	Compacted Gravel Work	m^3	0.6			
4	Concrete Work (1:3:6)	m^3	0.4			
5	Concrete Work (1:2:4)	m^3	0.8			
6	Form Work	m^3	1.2			
7	Reinforcement Work (ø6mm)	kg	21.3			
8	Furnishing RC Pipe (ø150mm)	m	19.6			
E.	**Construction Work of Drainage Canal**					
1	Common Excavation Work	m^3	630.0			
2	Embankment Work (manual)	m^3	270.0			
F.	**Construction Work of Culvert for Drainage (8 sets)**					
1	Common Excavation Work	m^3	54.4			
2	Backfilling Work	m^3	48.0			
3	Compacted Gravel Work	m^3	1.3			
4	Concrete Work (1:3:6)	m^3	5.0			
5	Concrete Work (1:2:4)	m^3	22.2			
6	Form Work	m^3	27.3			

No.	Description	Unit	Qty.	Unit Rate	Amount	Remarks
7	Reinforcement Work (ø12mm)	kg	266.7			
8	Furnishing RC Pipe (ø450mm)	m	39.2			
G.	**Construction Work of Sharp-Crested Weir (1 set)**					
1	Common Excavation Work	m^3	19.0			
2	Backfilling Work	m^3	10.0			
3	Compacted Gravel Work	m^3	1.49			
4	Concrete Work (1:3:6)	m^3	1.8			
5	Concrete Work (1:2:4)	m^3	7.3			
6	Form Work	m^3	9.1			
7	Reinforcement Work (ø12mm)	kg	390.24			
8	Steel Work (L: 50x50x5x1,800)	kg	8			
9	Gitmodjomh Water Level Gage		no . 1			
H.	**Construction Work of Corrugated Sheet Bund**					
1	Common Excavation Work	m^3	420.0			
2	Backfilling Work	m^3	420.0			
3	Furnishing Reinforced PVC Sheet	no.	400			

No.	Description	Unit	Qty.	Unit Rate	Amount	Remarks
I.	**Construction Work for Fence (2,750m)**					
1	Common Excavation & Spoil to Waste or Fill Material	m^3	687.5			
2	Backfilling Work	m^3	613.3			
3	Compacted Gravel Work	m^3	28.9			
4	Concrete Work (1:3:6)	m^3	41.3			
5	Concrete Work (1:2:4)	m^3	33.0			
6	Form Work	m^3	74.3			
7	Reinforcement Work (ø9mm)	kg	7,205			
8	Furnishing of Barbed Wire	m	1,828.8			
9	Furnishing of Wooden Gate	set	6			

TABLES, FIGURES

AND DRAWINGS

TABLE 3-1 DATA LIST

1. MAPS
   1) WATER RESOURCES DEVELOPMENT PLAN (S=1:253,000)
   2) TOPOGRAPHIC MAP (S=1: 63,360)
   3) GENERAL LAYOUT OF SYSTEM C (S=1: 63,360)
   4) LAYOUT OF TOWN PLANNING OF GIRANDURUKOTTE
   5) LAYOUT PLAN OF UNIT 1 (S=1: 5,000)
2. RESOURCE DEVELOPMENT: 1978-1982
3. NATIONAL ACCOUNTS OF SRI LANKA: 1975-1982
4. IMPACT OF DEVELOPMENT ON FERTILITY IN SRI LANKA
5. PADDY THRESHING MACHINERY TEST REPORT (1980): F.M.R.C
6. POST-HARVEST LOSSES AND SMALL FARMER STORAGE PROBLEMS IN SRI LANKA
7. THE PADDY /RICE INDUSTRY IN SRI LANKA
8. MILLING QUALITY OF PADDY VARIETIES IN SRI LANKA
9. PARBOILING: PMB
10. GUIDE TO GRAIN DRYERS
11. EFFECT OF DIFFERENT DRYING METHODS ON QUALITY OF PARBOILED PADDY
12. DESIGN OF BUILDINGS FOR HIGH WINDS
13. SPECIFICATIONS FOR COMMON BURNT CLAY BUILDING BRICKS
14. SPECIFICATIONS FOR HOT ROLLED MILD STEEL ROUND BARS FOR CONCRETE REINFORCEMENT
15. SPECIFICATIONS FOR COLD WORKED DEFORMED STEEL BARS FOR THE REINFORCEMENT OF CONCRETE
16. SPECIFICATIONS FOR DIMENSIONS AND PROPERTIES FOR STEEL CHANNELS, ANGLES AND TEE BARS; METRIC SERIES
17. CODE OF PRACTICE FOR THE STRUCTURAL USE OF CONCRETE

TABLE 3-2

RAINFALL FOR A 10-YEAR PERIOD (1974-84)

Unit: mm

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
1974	2.3	155.7	54.6	288.0	92.7	29.2	15.5	101.6	228.9	35.3	109.0	552.2	1665.0
1975	242.3	130.3	205.0	92.5	114.0	0	132.6	24.9	64.3	44.7	249.7	403.1	1703.6
1976	712.0	98.0	51.1	126.2	11.9	0	62.7	87.1	2.5	45.0	301.8	852.2	2350.5
1977	131.8	122.2	143.5	134.4	72.9	3.8	46.5	9.7	246.1	334.5	505.2	530.1	2280.7
1978	144.0	194.8	96.0	142.2	87.4	0	30.7	0	46.2	362.2	280.9	604.3	1988.7
1979	205.7	81.8	120.4	112.5	51.8	5.1	72.1	80.5	154.4	354.6	498.3	376.4	2113.6
1980	99.1	0.5	106.9	110.5	23.1	0	0	1.8	11.4	128.5	409.4	110.5	1001.7
1981	93.0	163.0	74.0	71.0	62.0	0	166.0	38.0	108.0	234.4	157.1	397.3	1563.8
1982	17.3	0	125.5	56.9	110.2	1.9	18.7	64.8	70.5	330.4	514.8	580.6	1891.6
1983	111.0	0	0	17.5	89.5	11.7	85.7	51.0	35.5	367.1	119.9	828.8	1717.7
1984	688.5	769.0	339.5	107.5	20.2	0	246.2	36.5	298.1	116.8	325.8	365.7	3313.8
Average	222.5	155.9	119.7	114.5	66.9	4.7	79.7	45.1	115.1	214.0	315.6	509.2	1962.8

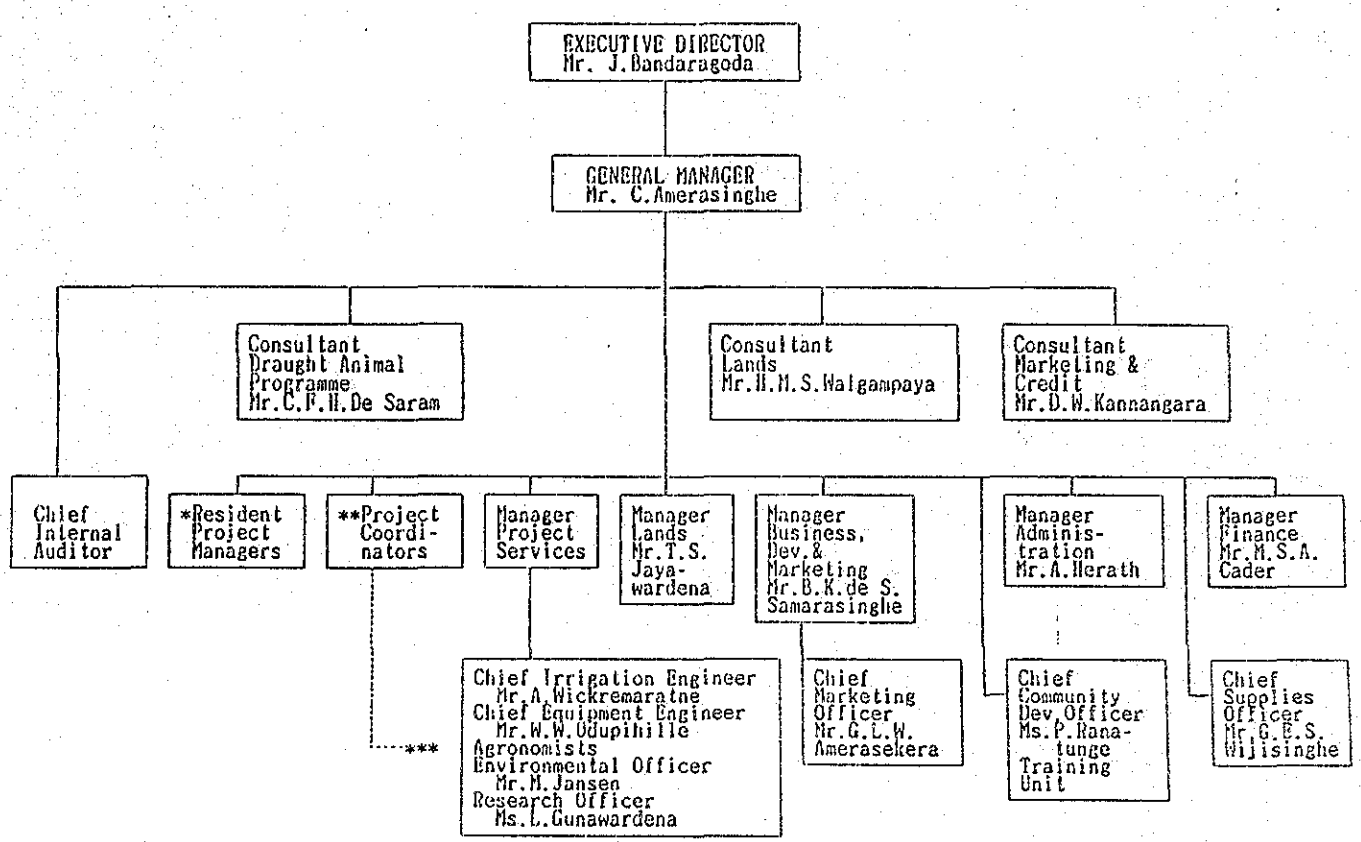
1974 ~1980 Mahiyangana Colonization Scheme
1981 ~1984 Girndurukotte

TABLE 3-3 OPERATIVE DAYS FOR CONSTRUCTION

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1982	31	28	25	27	20	30	30	27	23	11	9	9
1983	26	28	31	29	28	28	30	30	26	18	25	5
1984	4	8	22	27	30	30	23	29	20	26	15	25
Average	20	21	26	28	26	29	28	29	23	18	16	13
	WET SEASON		DRY SEASON							WET		

Daily rainfall (mm)	0	10	20	30	40 or more
Non Operative days	0	1	2	3	4

ORGANIZATION OF MEA



Resident Project Managers

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3. Mr.Jayantha Jayawardena - Tambuttegama
4. Mr.P.Jaywickerma - Kalawewa
5. Mr.R.B.Dissanayake - M-5
6. Mr.W.I.Gunawardena - RPM(G)

(M)

7. Lt.Col.P.V.Pathirana - RPM(C)

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2. Mr.C.A.Fernando(B)
3. Mr.L.P.Perera(M)
4. Mr.W.K.Jayasinghe(G)
5. Mr.P.M.K.Dayaratne(C)
6. Mr.W.Jayakulasuriya(General)

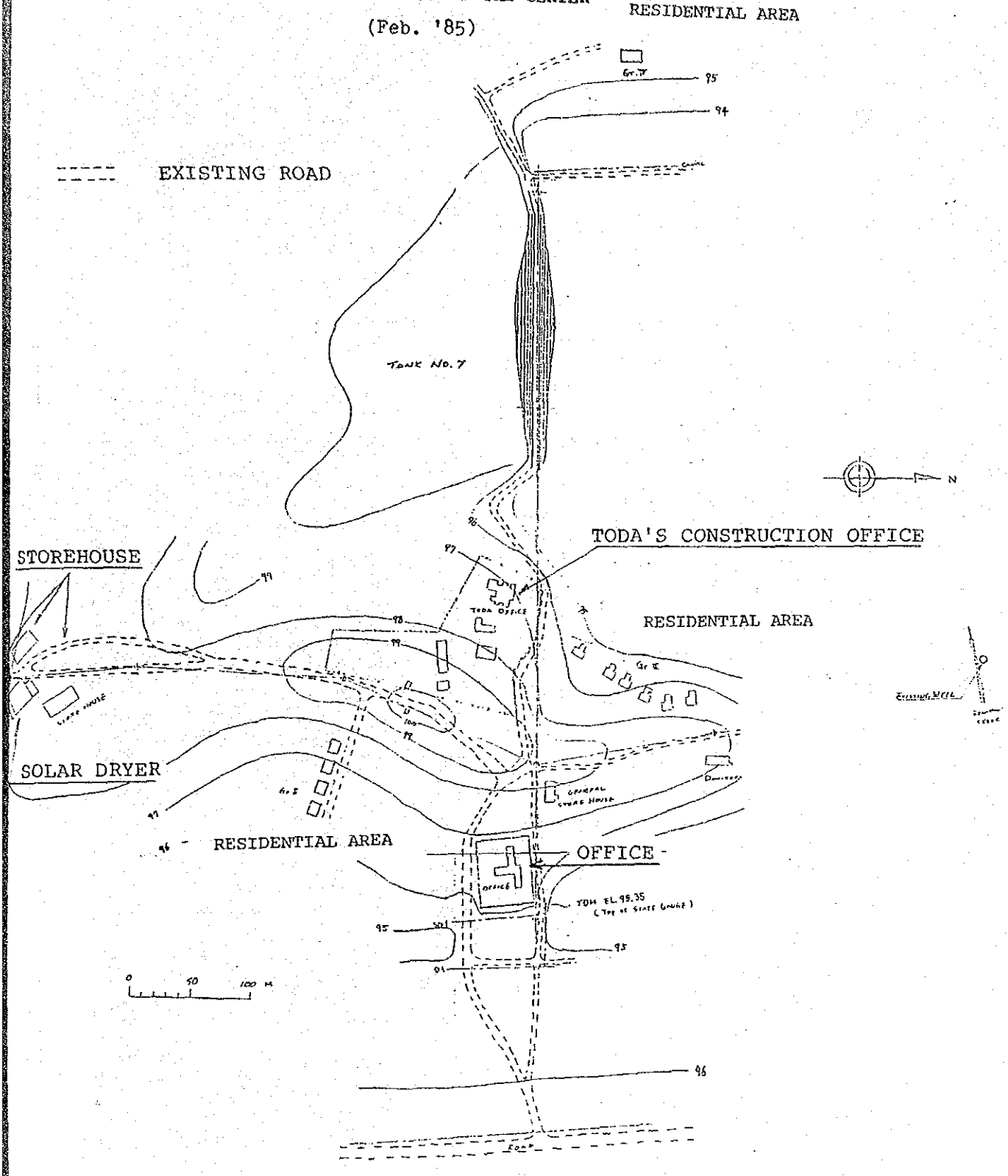
Agronomists

*** 1. Mr.D.Buddadasa
2. Mr.L.Dewasiri
3. Mr.G.Liyanage
4. Mr.M.Galpottage

FIG. 3-1

PRESENT CONDITION OF THE CENTER

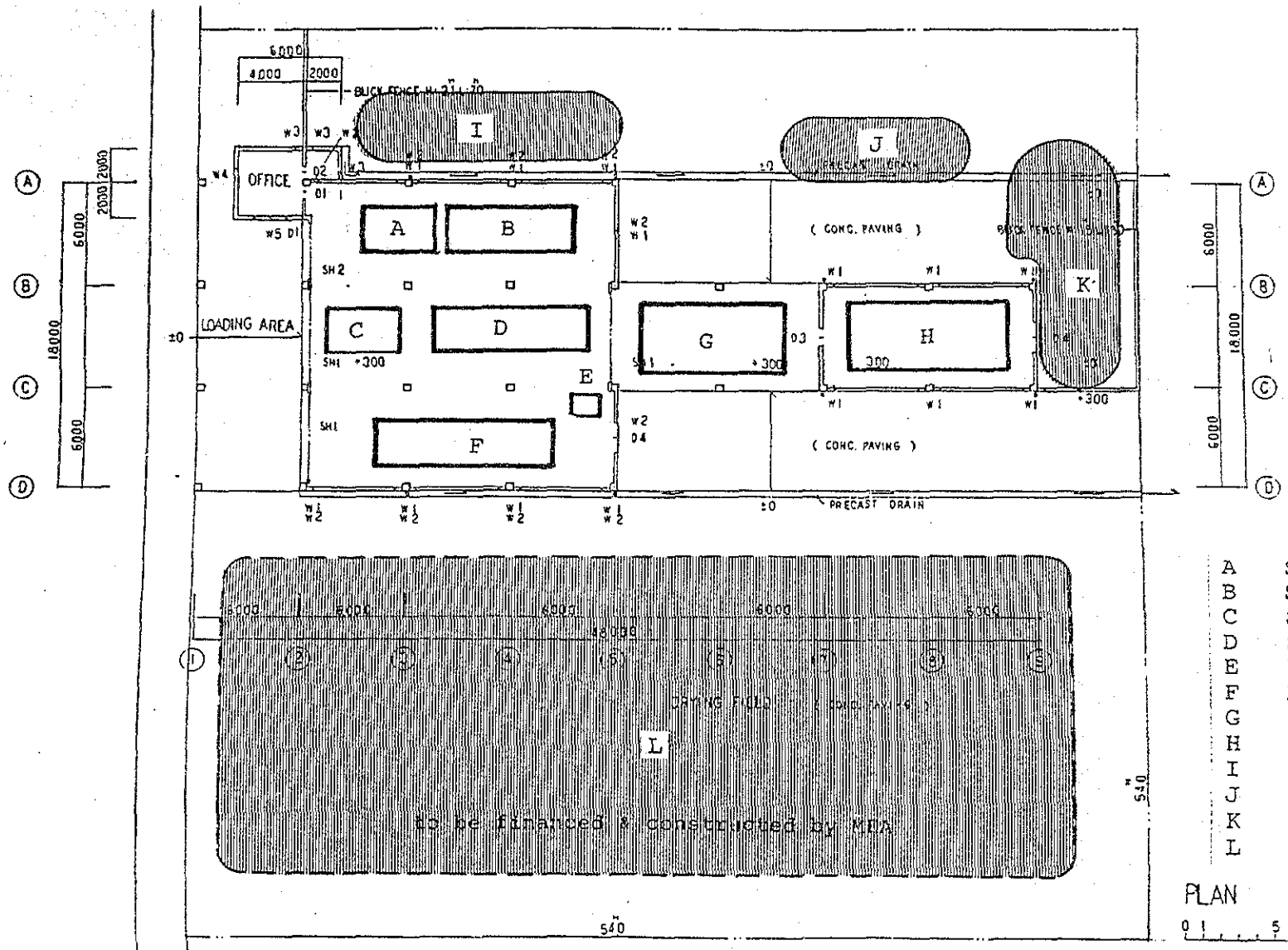
(Feb. '85)



PRESENT CONDITION OF THE CENTER

AS OF FEB, 1985

OVERALL LAYOUT OF THE PLANT



A SEED CLEANING
B SEED DRYER
C SEED CLEANING
D STORAGE TANK
E PARBOIL RECEIVING
F MILLING
G PARBOILING
H HUSK BOILER
I DUST STOCK AREA
J HUSK STOCK AREA
K ASH STOCK AREA
L SUN DRYING YARD

FIG. 3-2

FIG. 3-3 **FLOW CHART OF THE PLANT**

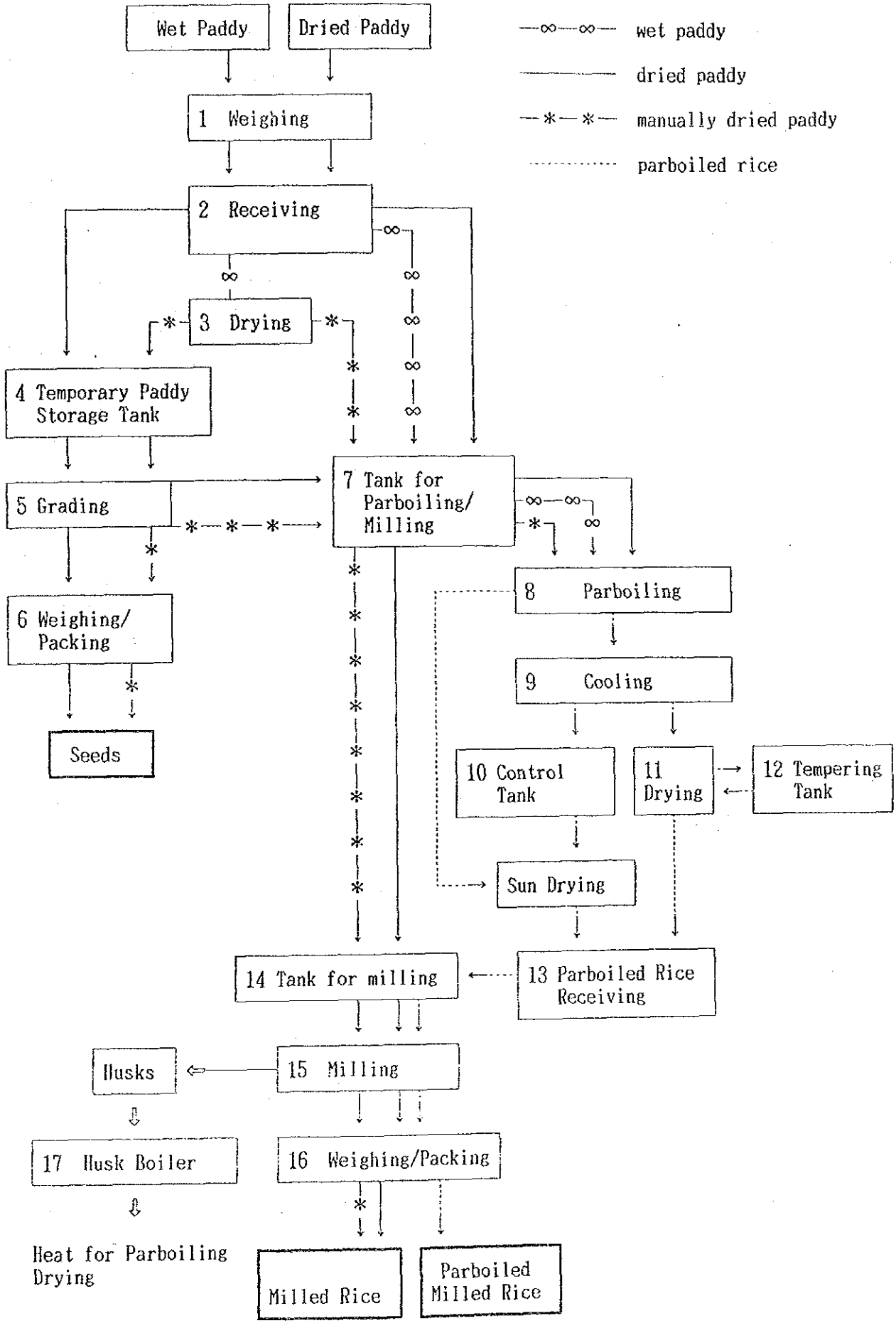
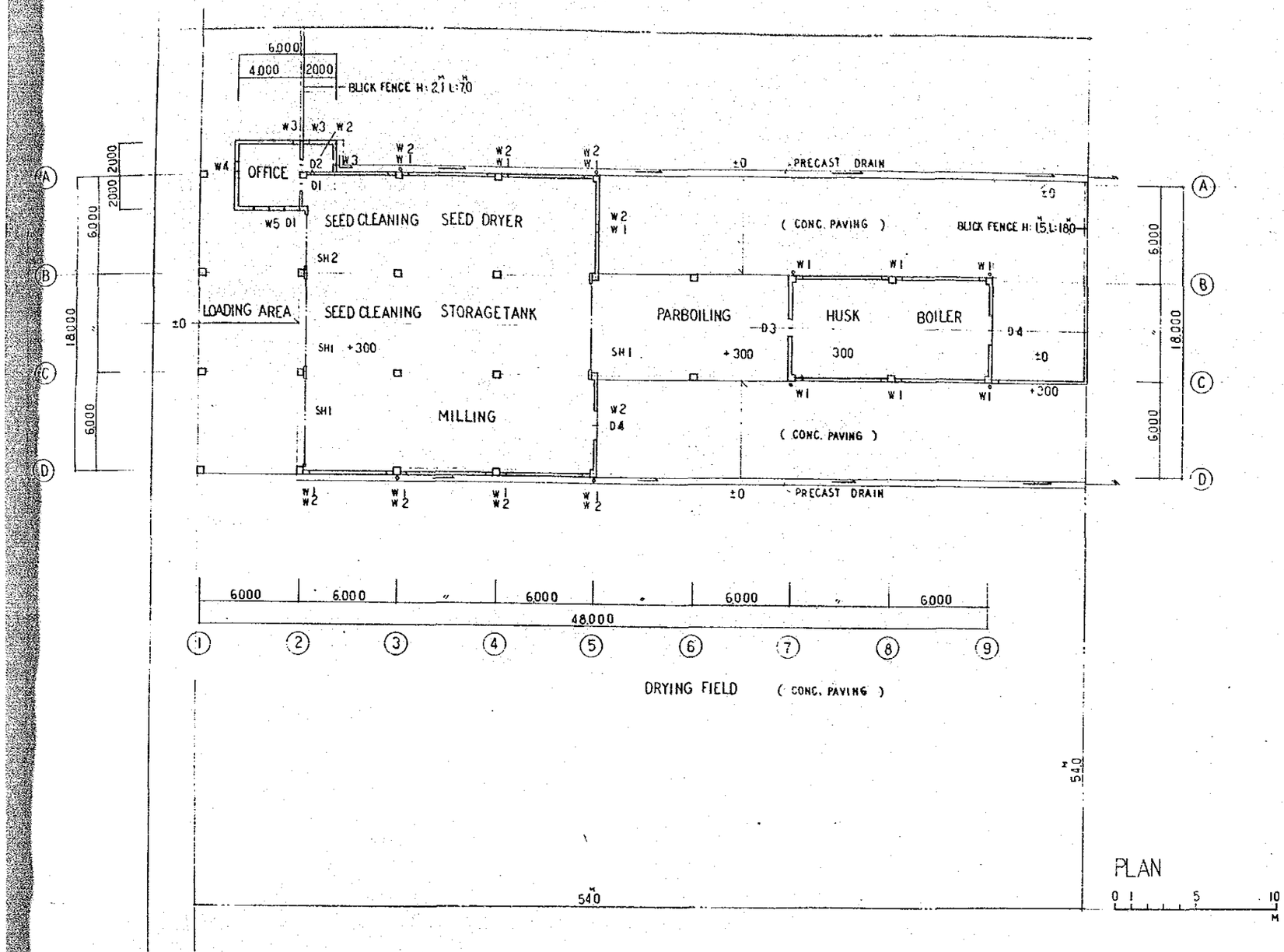


FIG. 3-4 CONSTRUCTION SCHEDULE

Work Item	Quantity	Schedule (month) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
Preparatory Work									
Plant Building									
Foundation Work									
Structure Work									
Masonry									
Roofing									
Door/Window									
Interior Finishing									
Exterior Finishing									
Miscellaneous									
Electrical Work									
Plumbing									
Drainage, etc.									
Revision									
Experimental/Demonstration Farm									
Inspection Path	2,680 m								
On-Farm Ditch	3,710 m								
Farm Inlet	23								
Farm Drain	1,200 m								
Drainage Culvert	8								
Sharp Crested Weir	1								
Corrugated Sheet Bund	600 m								
Fencing	2,750 m								



ALL DIMENSIONS ARE SHOWN IN MM

AREA TABLE

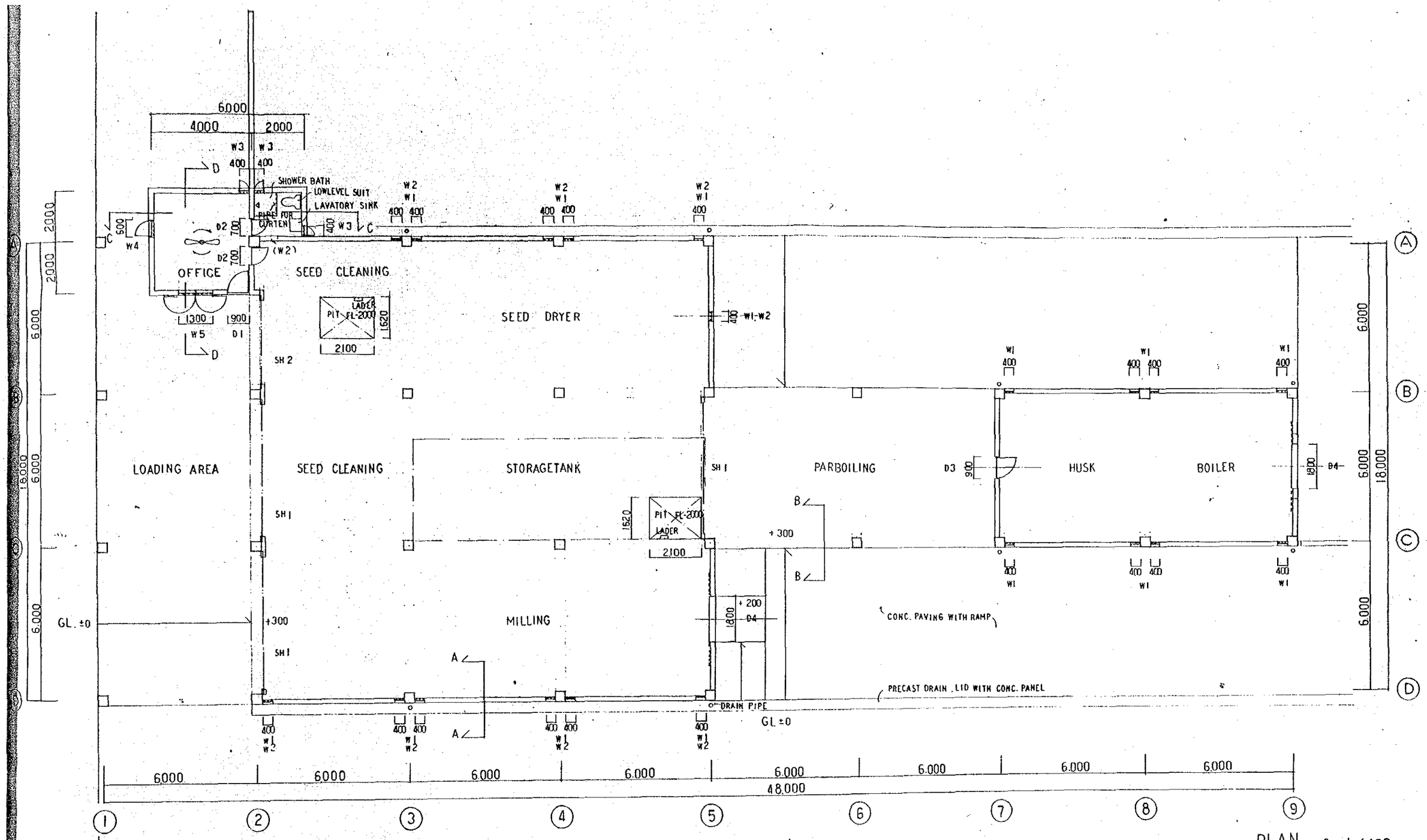
		M²
	OFFICE	24.0
	LOADING APEA	92.0
	SEEDCLEANING	
	SEED DRYER	324.0
	MILLING	
	PARBOILING	72.0
	HUSK BOILER	72.0

MAHAWELI AUTHORITY OF SRI LANKA
INTEGRATED AGRICULTURE DEVELOPMENT DEMONSTRATION PROJECT IN MAHAWELI AREA

PLANT BUILDING

LAYOUT PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN DWG No. B-1



SCHEDULE OF DOORS WINDOWS & SHUTTER

TYPE	SIZE WIDE	SIZE HIGHT	DESCRIPTION	NO
D 1	900	2100	FLASH PANEL: PLYWOOD	1
D 2	700	2100	FLASH PANEL: MARINE PLYWOOD	2
D 3	900	2100	FLAT STEELSHEET WITH WELDED BRRACING L-45×45	1
D 4	1800	2100	— DO — (SLIDING DOOR HANGOVER)	2
W 1	400	3600	GALVANIZED WELDMESH	20
W 2	600	3600	— DO —	13
W 3	400	1550	GLAZED (OPENABLE WOOD FRAME) & GALVANIZED WELDMESH	3
W 4	600	1550	— DO —	1
W 5	1300	1550	— DO —	1
SH 1	5600	4600	ELECTRIC MOTOR OPERATED ROLLING SHUTTER	3
SH 2	3600	4600	— DO —	1

NOTE

TOILET FLOOR TO BE 50mm BELOW MAIN FLOOR LEVEL
SHOWER BATH FLOOR TO BE 100mm BELOW TOILET FLOOR LEVEL

PAINTED / CONCRETE STRUCTURAL FRAMES
STEEL STRUCTURAL FRAMES (VERMILLION)

BRICKS / QUARITY & STRENGTH FOR SIRUCTURAL USE
EXTERNAL WALL (FACE BRICK) / TWO COATS OF COLORED WASH IN LIME
INTERNAL WALL / COLORED CEMENT LIME SAND PLASTERING FINISH SMOOTH

PLAN S : 1 / 100

0 1 5 10 M

MAHAWELI AUTHORITY OF SRI LANKA
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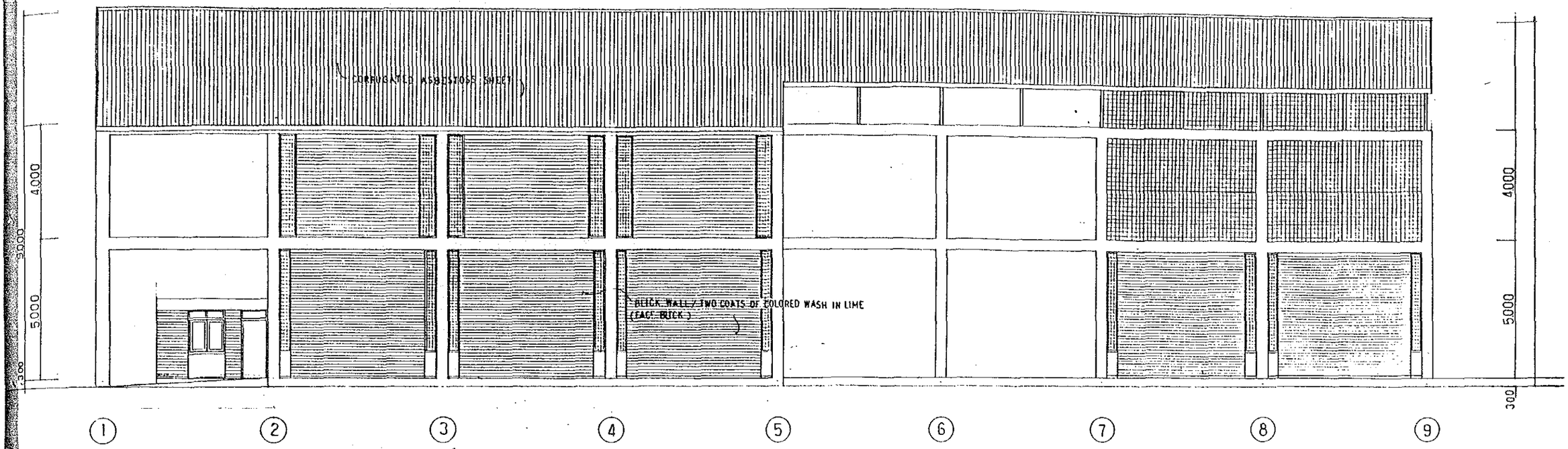
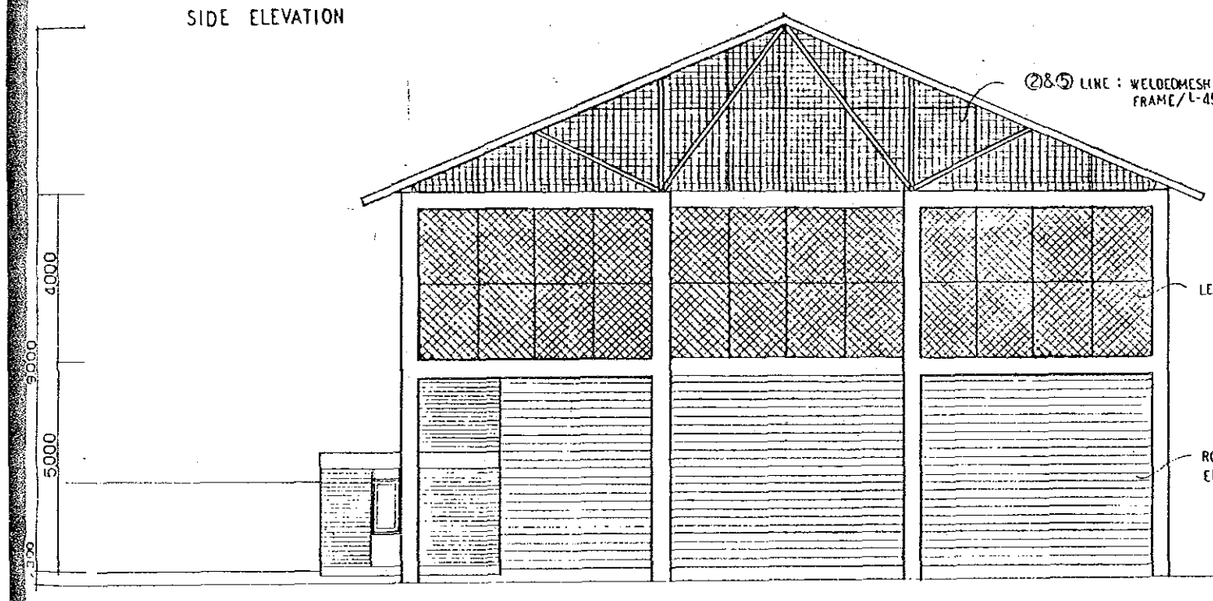
PLANT BUILDING

PLAN

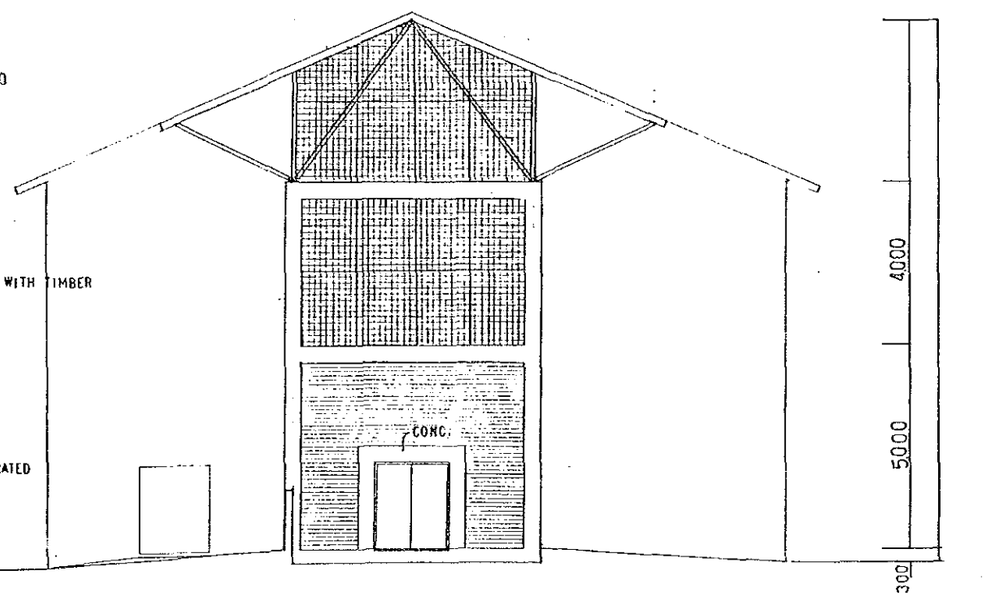
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN DWG No. B-2



SIDE ELEVATION



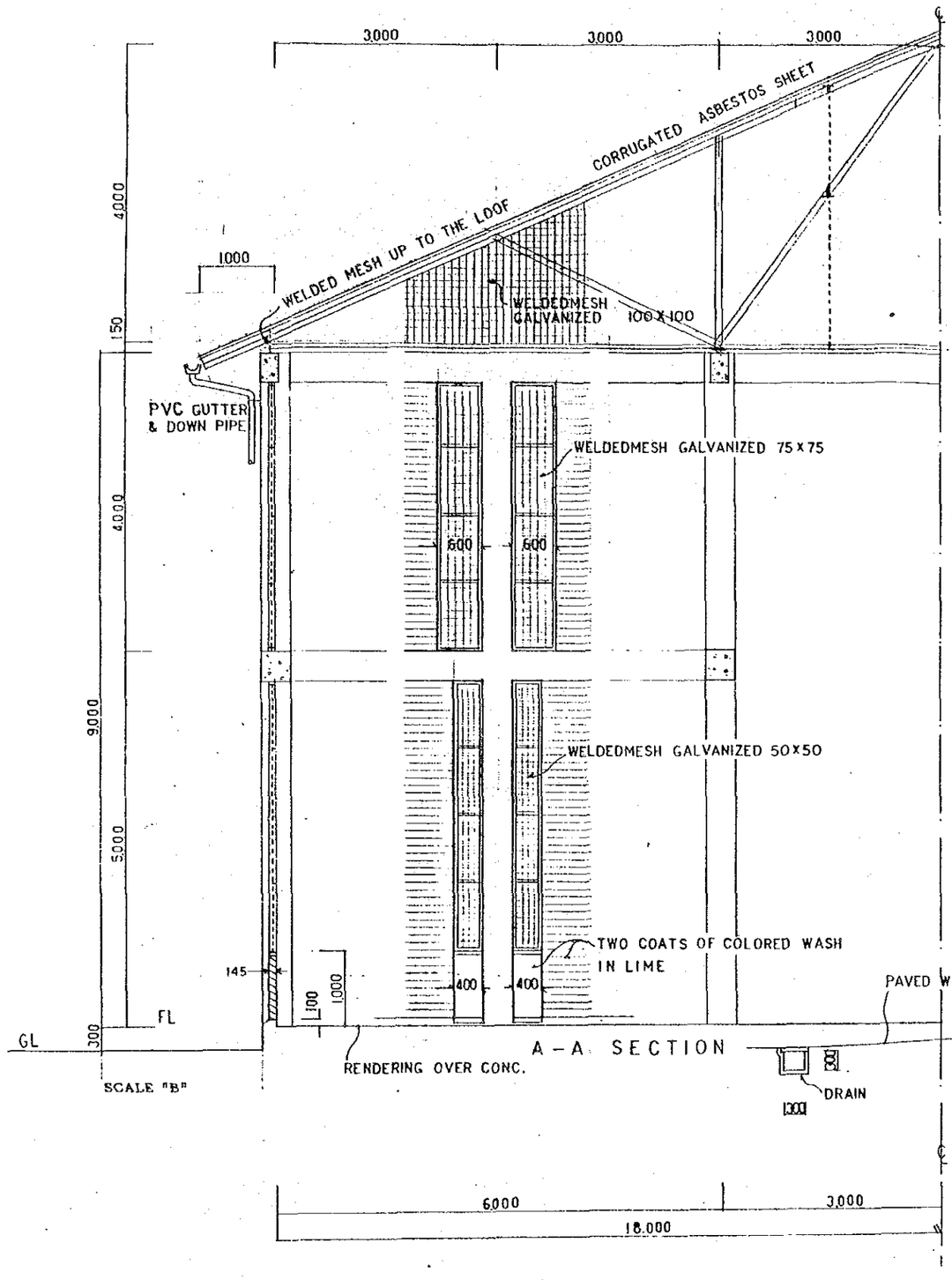
FRONT ELEVATON

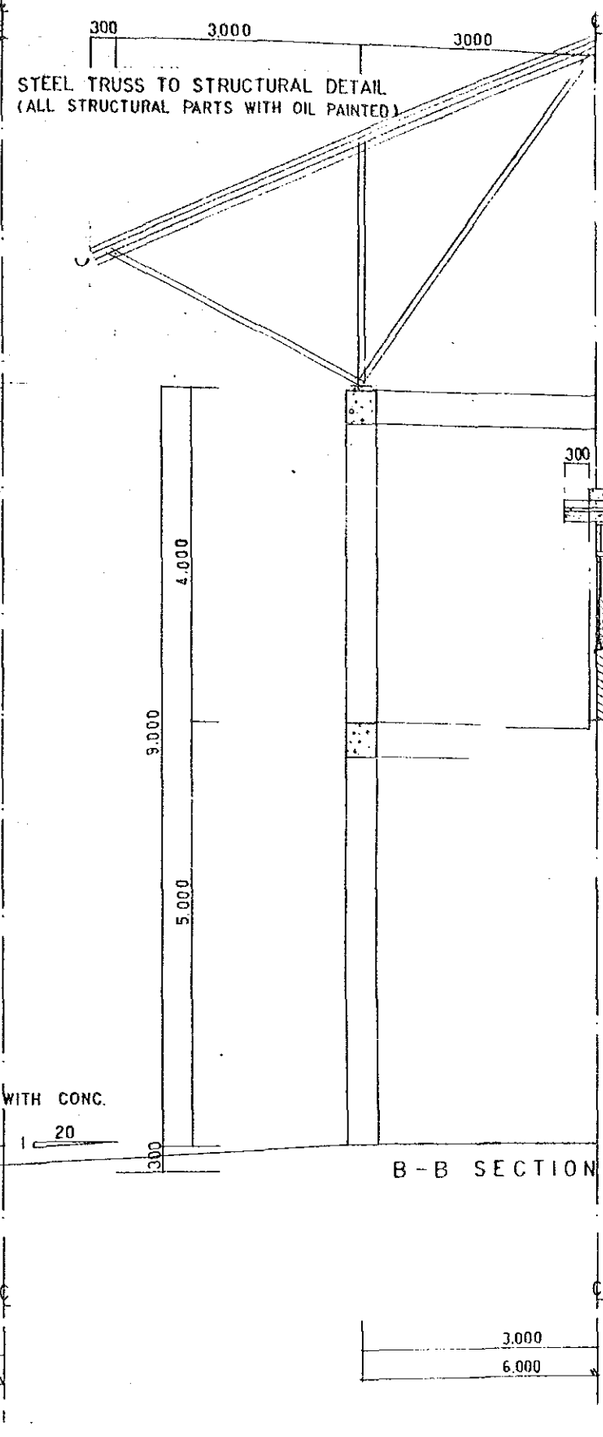


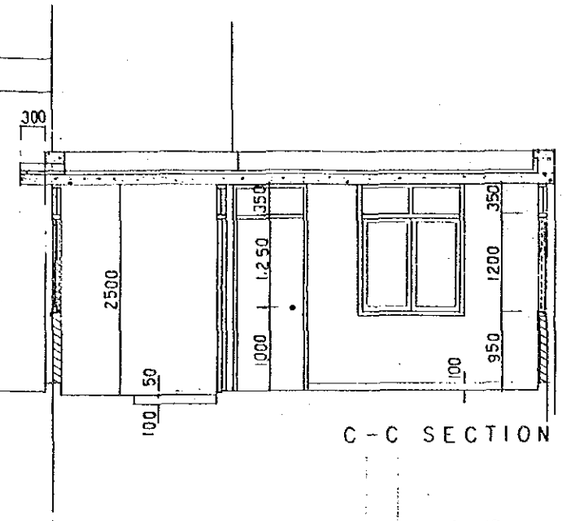
REAR ELEVATION

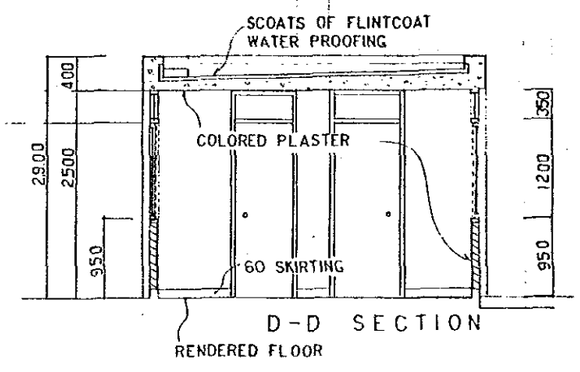
0 1 5 10 M
S:1/100

MAHAWELI AUTHORITY OF SRI LANKA
INTEGRATED AGRICULTURE DEVELOPMENT DEMONSTRATION PROJECT IN MAHAWELI AREA
PLANT BUILDING
ELEVATION
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN DWG No. B-3



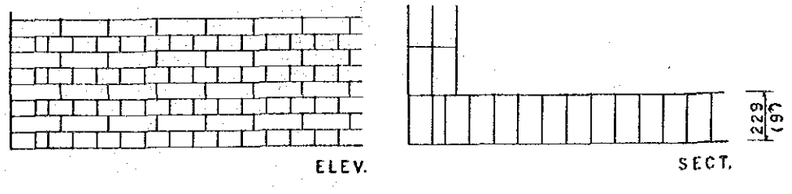






BRICKS WALL DETAIL
(ENGLISH BOND)

SCALE "A"



S:1/20 SCALE "A"

S:1/50 SCALE "B"

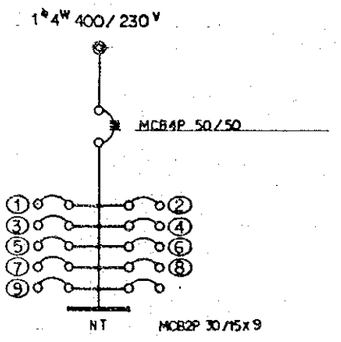
MAHAWELI AUTHORITY OF SRI LANKA
INTEGRATED AGRICULTURE DEVELOPMENT DEMONSTRATION PROJECT IN MAHAWELI AREA
PLANT BUILDING
STRUCTURE DETAILS
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN DWG No. B-4

LEGEND

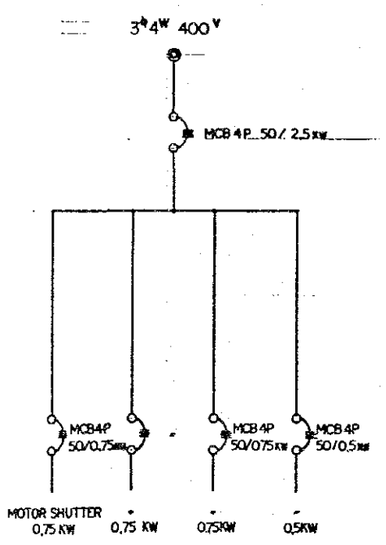
SYMBOL	ITEM	REMARKS
	POWER PANELBOARD	
	LIGHTING PANELBOARD	
	FLUORESCENT LAMP	
	WALL MOUNT RECEPTACLE	DUPLEX TYPE
	TUMBLER SWITCH	
	PULL BOX	
	CONDUIT WIRING UP or DOWN	
	CONDUIT WIRING	CONCEAED IN WALL or CEILING
		CONCEAED IN SLAB
		BARE

FLUORESCENT LIGHT FIGURE PLAN

A	FL 40^{W} x 1	B_1	FL 40^{W} x 1
		B_2	FL 40^{W} x 1 Water proof type



LOAD SCHEDULE PANEL



SHUTTER CONTROL PANEL

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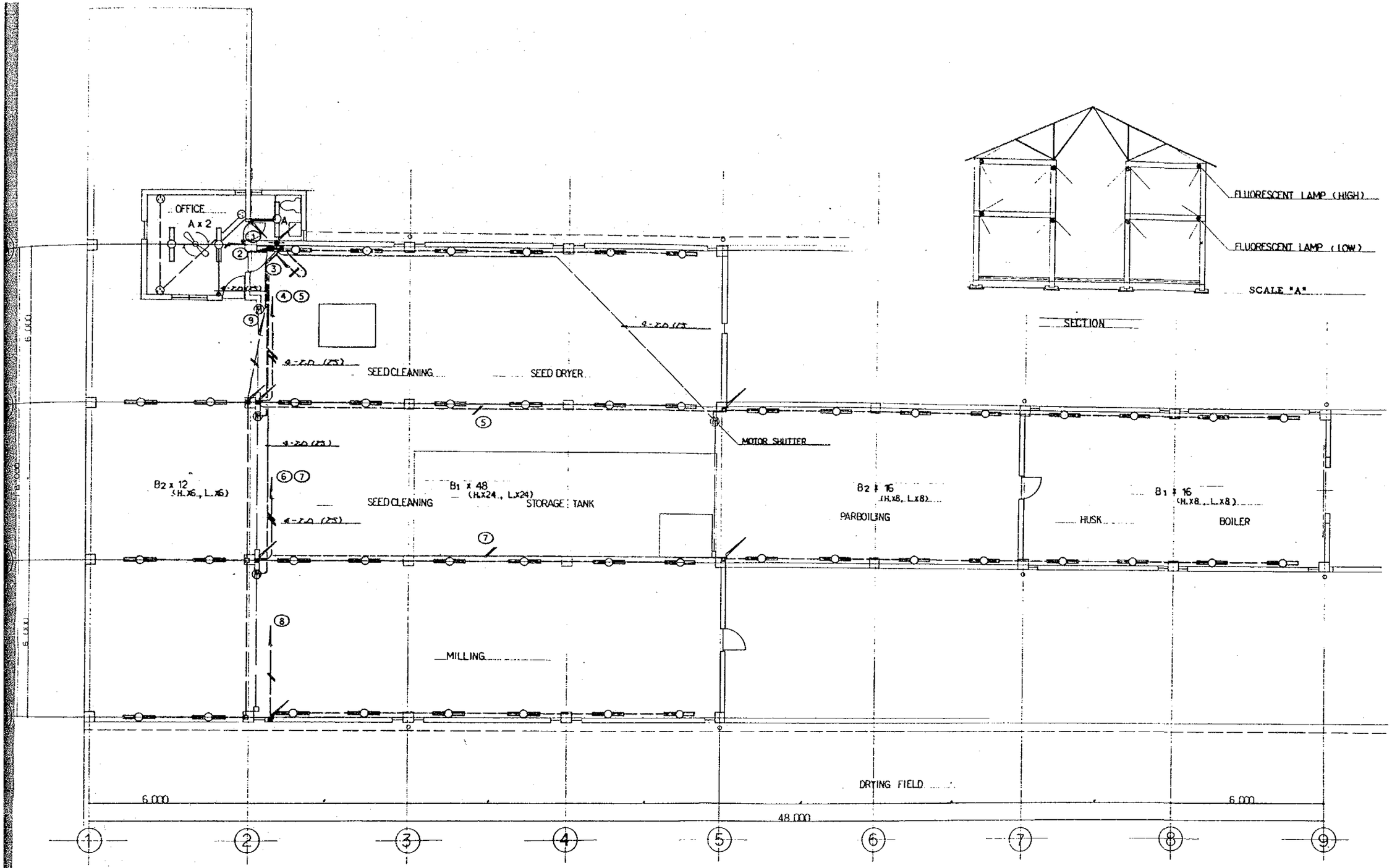
PLANT BUILDING
ELECTRIC DETAILS
JAPAN INTERNATIONAL COOPERATION-AGENCY
TOKYO, JAPAN DWG No. B-5



SCALE "A"

SECTION

SCALE "B"

ANY CIRCUIT WIDTOUT FURTURE DESIGNATION INDICATED AS FOLLOWS

———	2-1.6 (19)
—f—	2-2.0 (19)
———	2-1.6 (19)
—f—	2-2.0 (19)
———	2-1.6 (19)
—f—	2-2.0 (19)

0 1 5 10 20
SCALE "A"

0 1 5 10
SCALE "B"

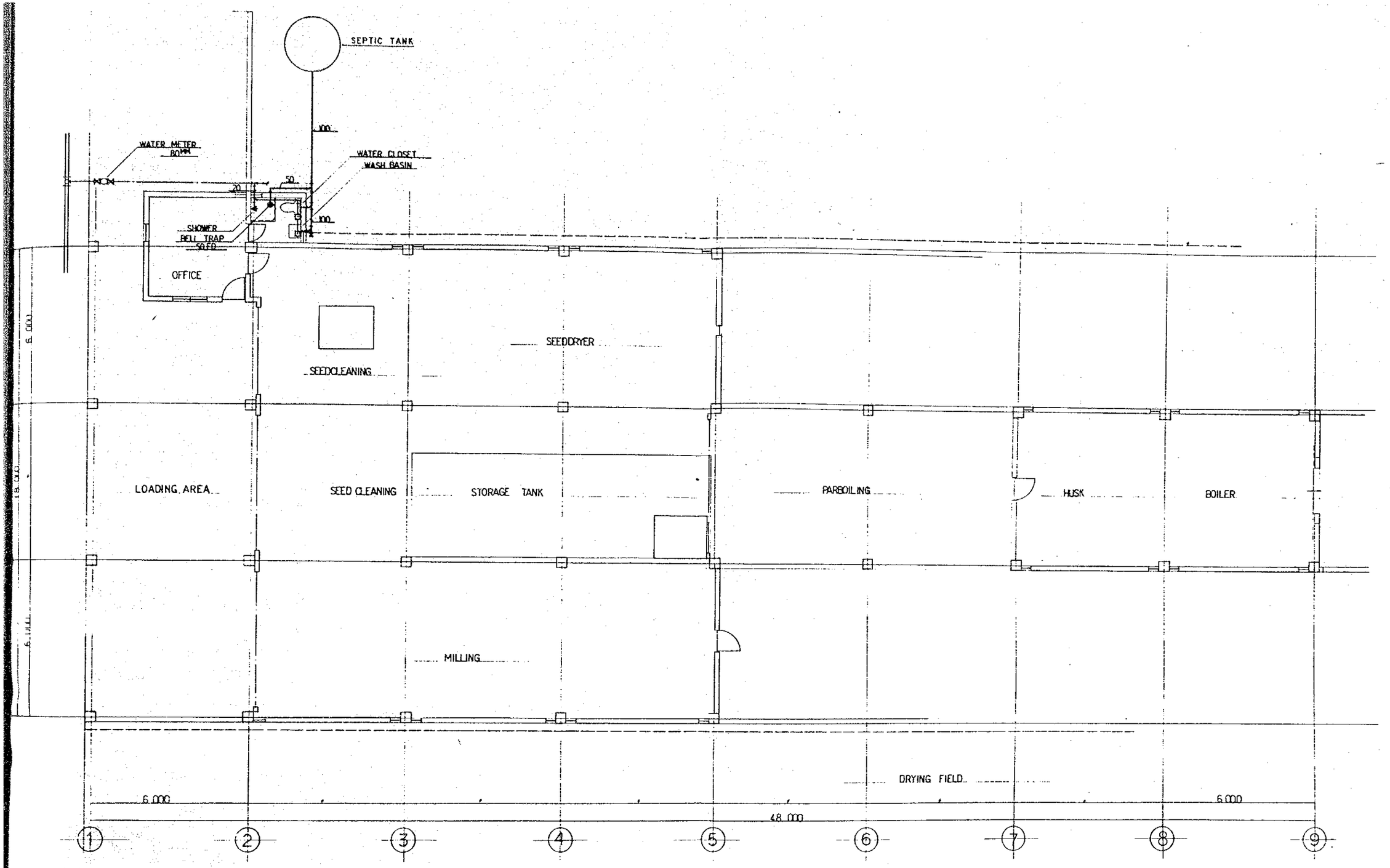
MAHAWELI AUTHORITY OF SRI LANKA
INTEGRATED AGRICULTURE DEVELOPMENT DEMONSTRATION PROJECT IN MAHAWELI AREA

PLANT BUILDING

LIGHTING PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO, JAPAN — DWG No. B-6



0 5 10 M

MAHAWELI AUTHORITY OF SRI LANKA

INTEGRATED AGRICULTURE DEVELOPMENT DEMONSTRATION PROJECT IN MAHAWELI AREA

PLANT BUILDING

DETAILS OF PLUMBING WORK

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO, JAPAN DWG No. B-7