DETAILED DESIGN REPORT
ON
THE PILOT INFRASTRUCTURE IMPROVEMENT WORKS
FOR
THE IMPROVEMENT OF RICE CULTIVATION
TECHNOLOGY PROJECT
IN
FIJI

JUNE 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

Recently, the demand of rice-supply in Fiji has been increased up to 40,000 tons per year. As of 1987, thirty percents of this demand, therefore, have been imported from other countries.

From this background, in April 1985, the Government of Fiji inquired a Japanese technical assistance, under the cooperation of JICA, for the Improvement of Rice Cultivation Technology Project covering the aspects of development, extension and training in rice cultivation technology.

At present, the programme started from the stage of studies and experiments is under way to the stage of activities including demonstration and extension of developed rice cultivation technology.

As a result of field studies in April 1987, the Matsuyama Mission decided the establishement of a Pilot Farm and extension facilities for farmers and the extension staff in the northern island (Vanua Levu) for the purpose of demonstration and extension training of rice cultivation technology.

According to the decision on March 20, 1989, JICA dispached the Detailed Design Survey Team on Pilot Infrastructure Works headed by Mr. K. Nagayoshi, Ministry of Agriculture, Forestry and Fisheries to the Project-site for related works.

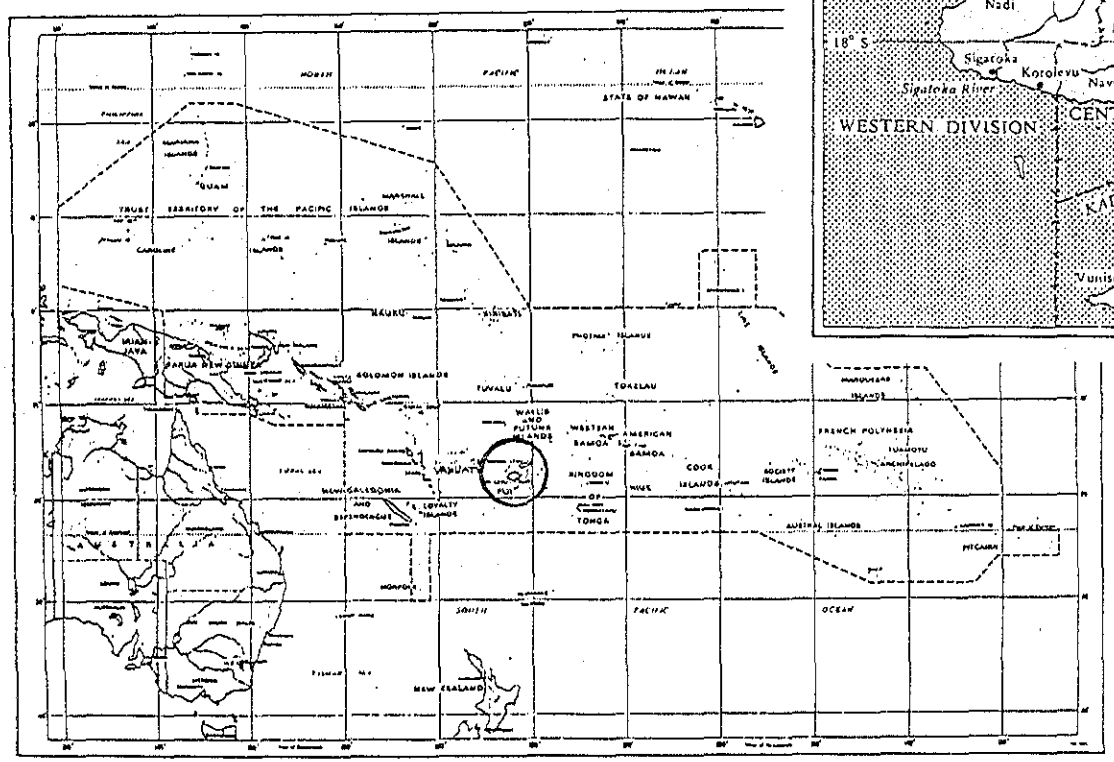
This report was prepared in accordance with the Implementation of Pilot Infrastructure Works.

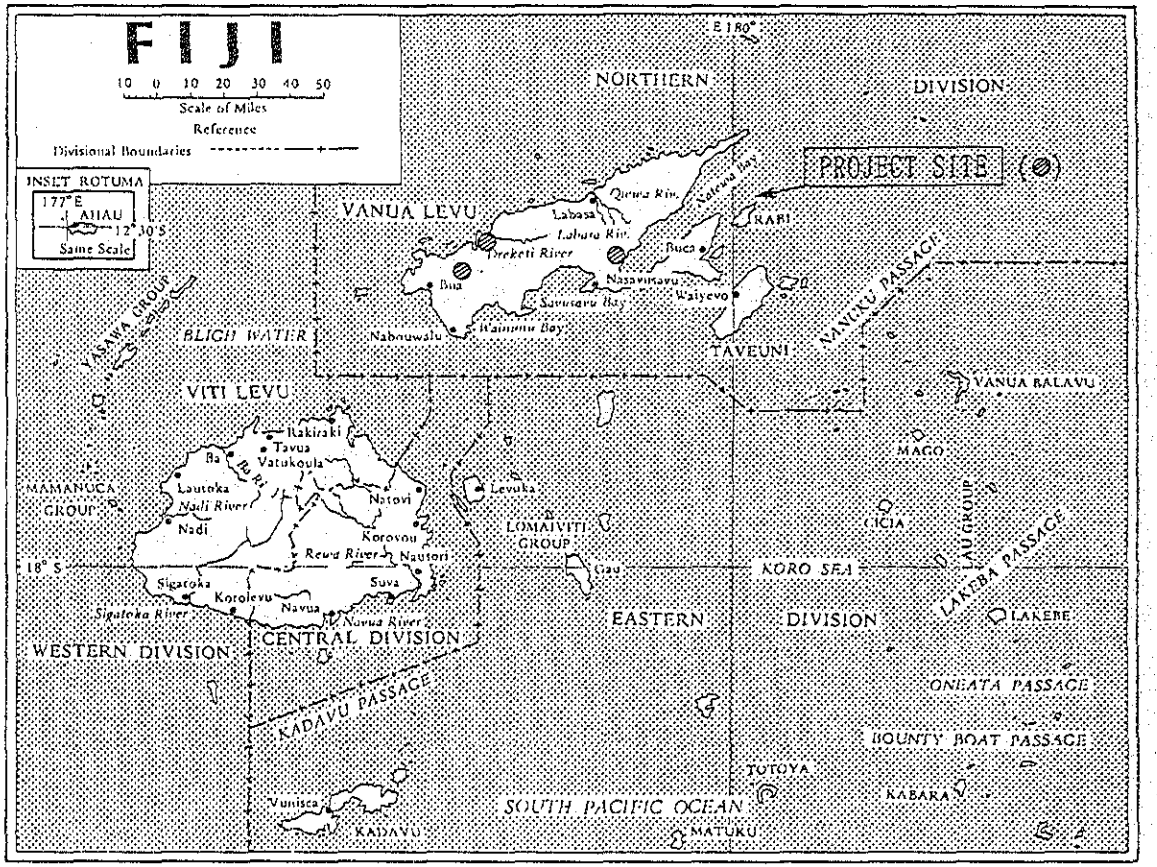
I would like to express my sincere thanks to the officials concerned for all their valuable assistance and cooperation.

June, 1989

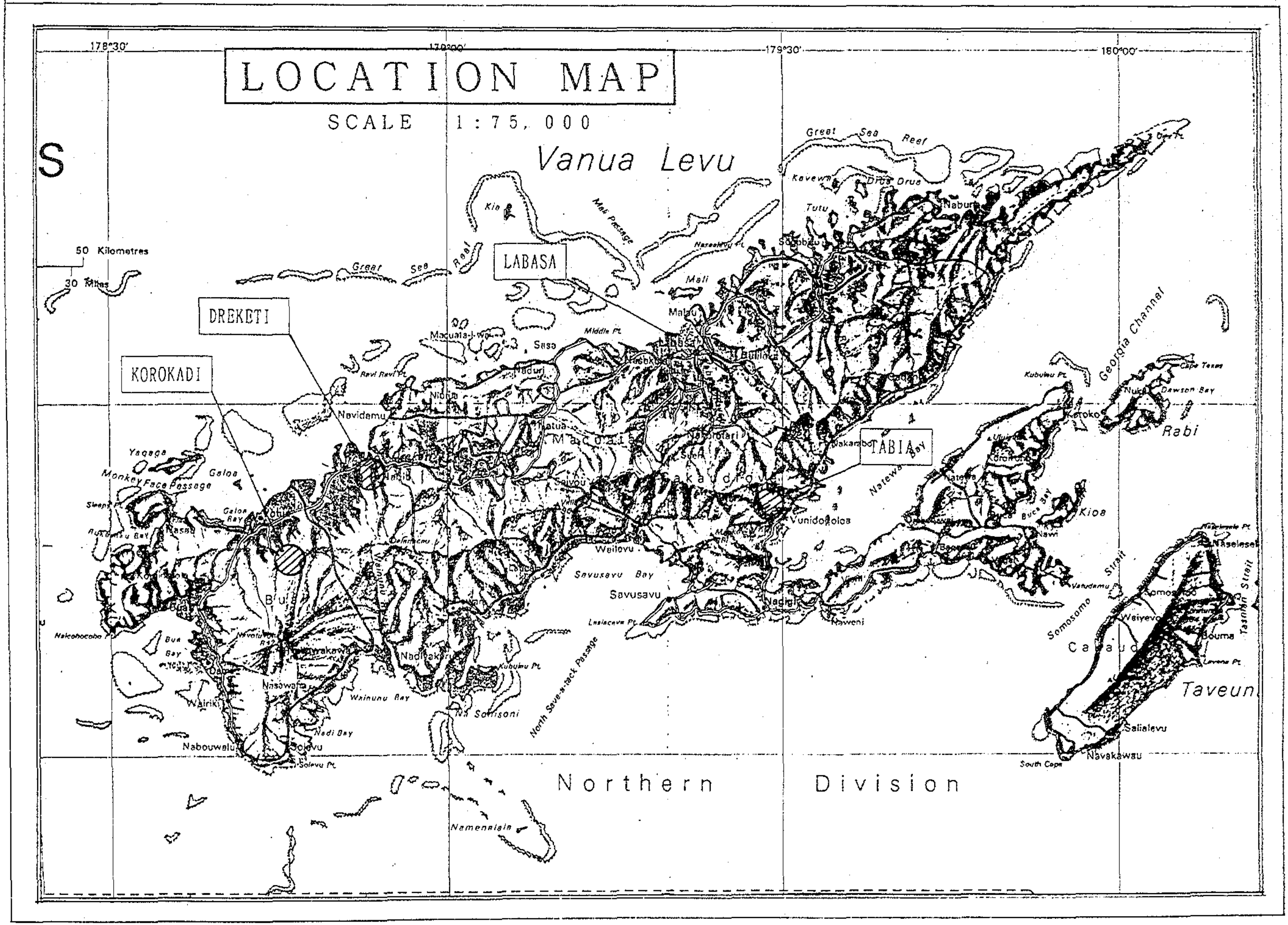
K. Miyamoto
Director
Agricultural Development
Cooperation Department
JICA

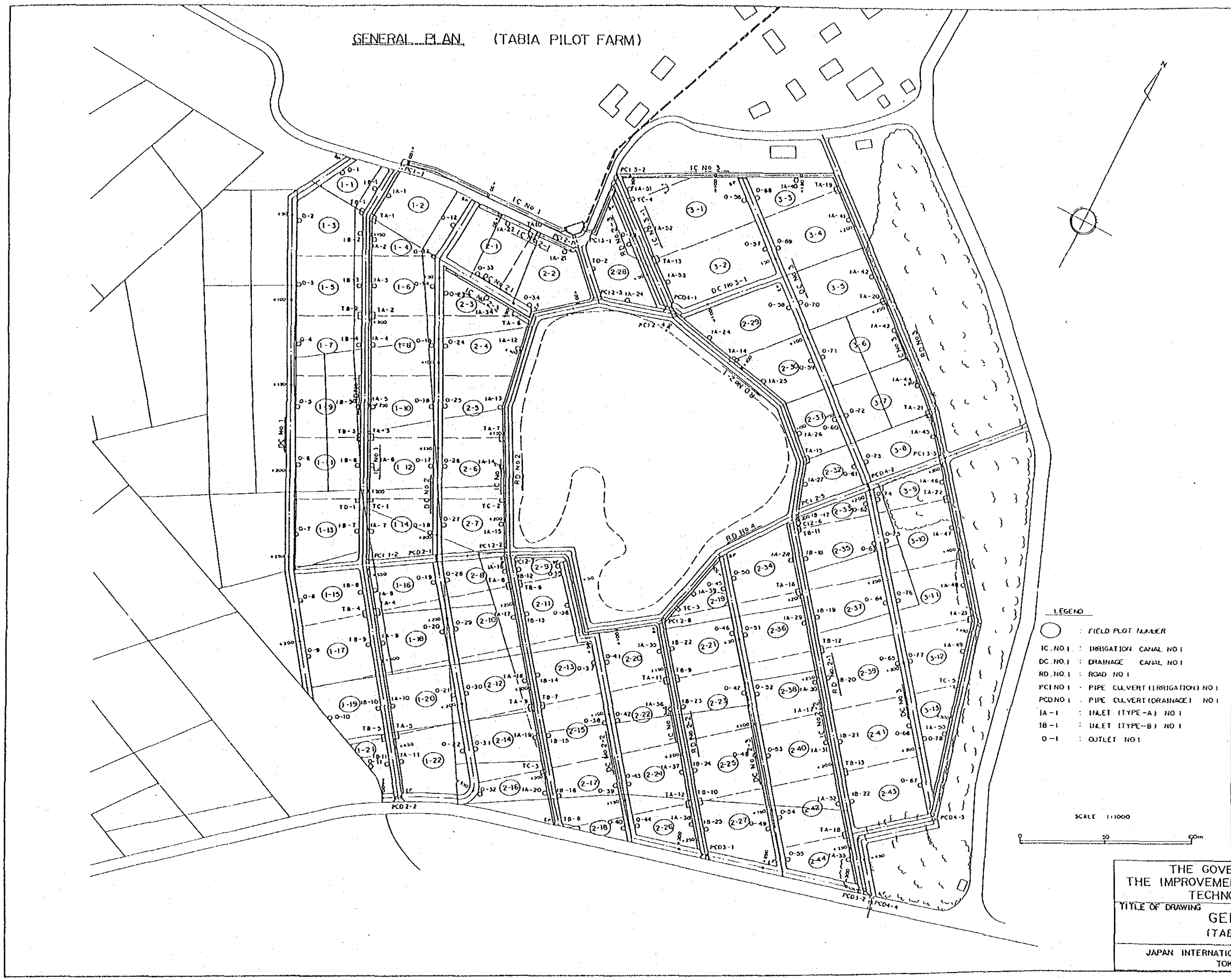
LOCATION MAP





出典：South Pacific Commission, South Pacific Economies 1978 : Statistical Summary


LOCATION MAP
SCALE 1:75,000
S
Vanua Levu
178°30'
179°00'
179°30'
180°00'
50 Kilometres
30 Miles
LABASA
DREKETI
KOROKADI
TABIA
Great Sea Reef
Mali Passage
Georgia Channel
Rabi
Kioa
Taveuni
Savusavu Bay
Savusavu
Natewa Bay
Monkey Face Passage
Yaqaga
Galoa
Nabouwalu
Navidamu
Naduri
Macuata-i-wai
Sasa
Middle Pt.
Mali
Malau
Nabuni
Tutu
Kavewa
Drua Drua
Cape Texas
Dawson Bay
Nuku
Kubulau Pt.
Vunidogoloa
Nakambo
Weilevu
Lesiaceva Pt.
Wainunu Bay
Nadi Bay
Solevu
Solevu Pt.
Nasowara
Wairiki
Bua Bay
Na Savisoni
North Save-a-tack Passage
Somosomo Strait
Tasman Strait
Naselesele
Waiyevo
Bouma
Salialevu
Navakawau
South Cape
Namenalala
Northern Division



NOTE

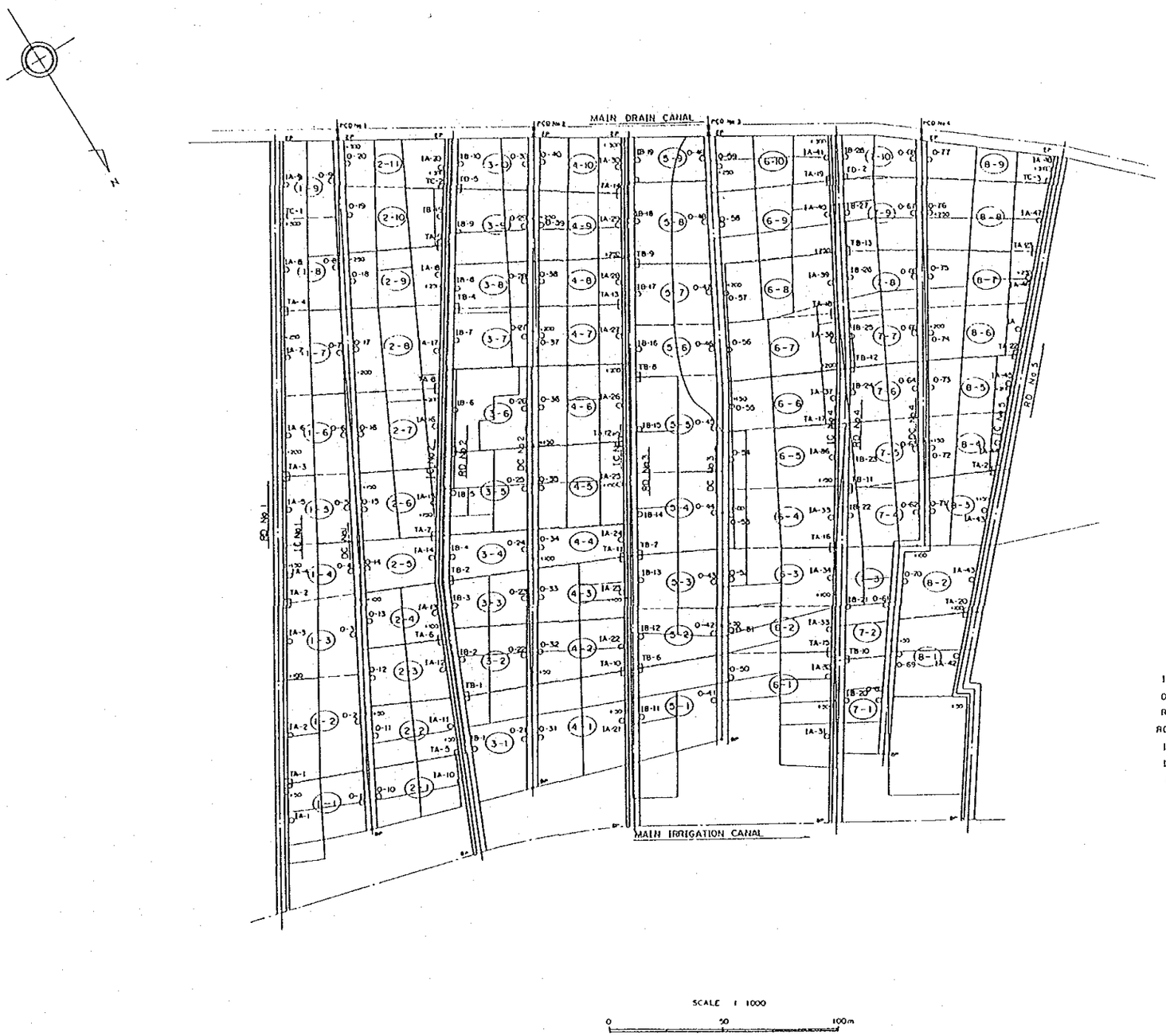
THE GOVERNMENT OF FIJI
THE IMPROVEMENT OF RICE CULTIVATION TECHNOLOGY PROJECT

TITLE OF DRAWING
GENERAL PLAN
(TABIA PILOT FARM)

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO JAPAN

DWG. No

GENERAL PLAN (KOROKADI PILOT FARM)



LEGEND

( )	FIELD PLOT NUMBER
IC No 1	IRRIGATION CANAL No 1
OC No 1	DRAINAGE CANAL No 1
RD No 1	ROAD No 1
RCD No 1	PIPE CULVERT (DRAINAGE) No 1
IA-1	INLET (A-TYPE) No 1
IB-1	INLET (B-TYPE) No 1
O-1	OUTLET No 1

SCALE 1 1000

0 50 100m

NOTE

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TOKYO JAPAN

DWG No

GENERAL PLAN

DREKETI PROJECT

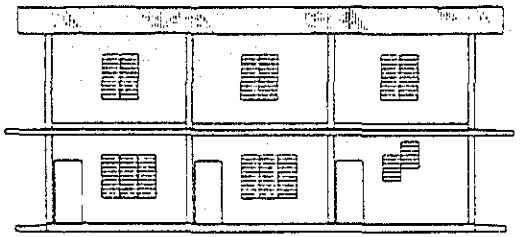
14,000

8,000

10,000

2,000

LABORATORY AND EQUIPMENT HOUSE

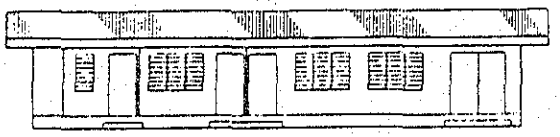


8,000

10,000

2,000

EXTENTION TRAINING CENTER

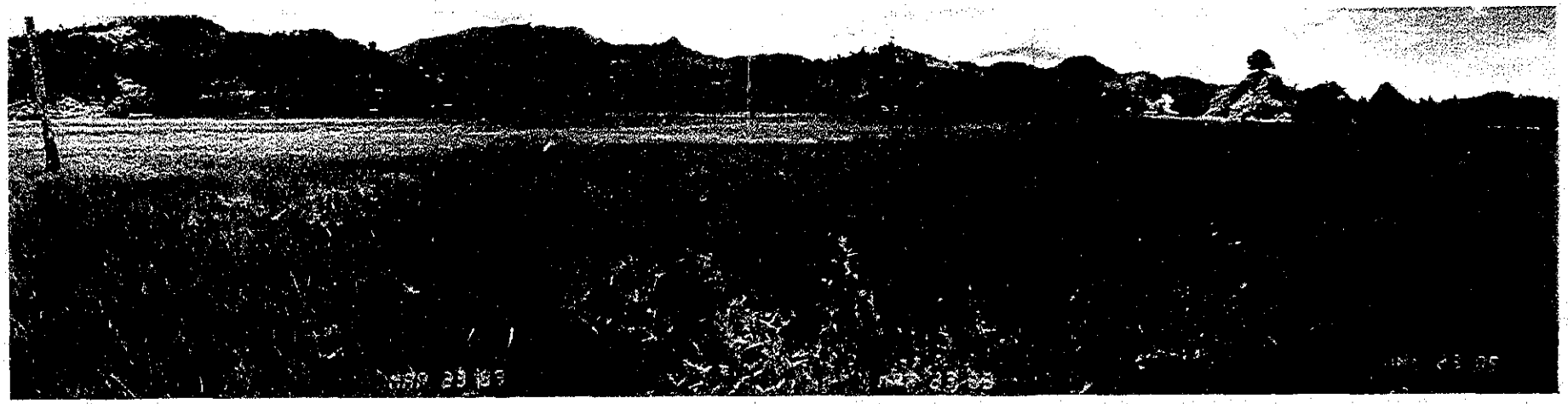


1,000

15,000

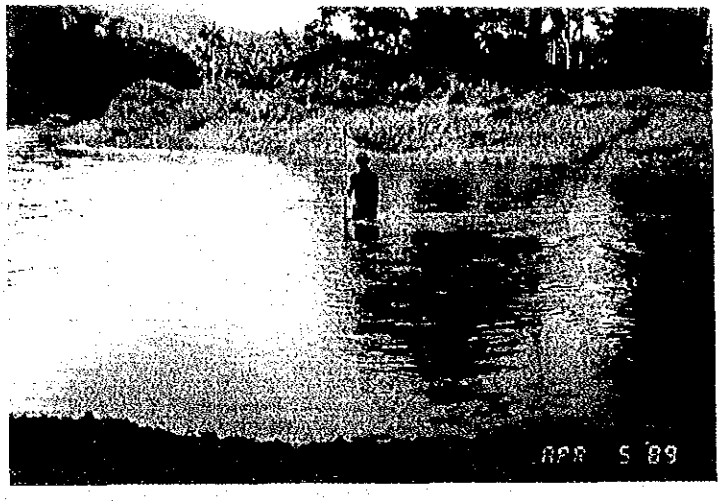
16,000

PROPOSED PILOT FARM AREA



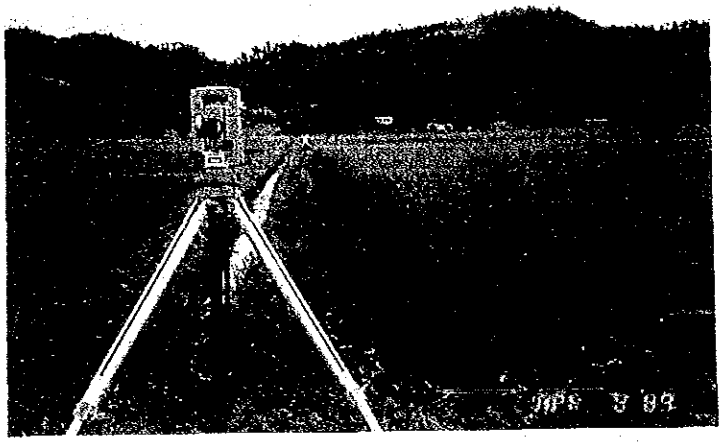
TABIA AREA VIEW (EXISTING FARM LAND : 50ha)

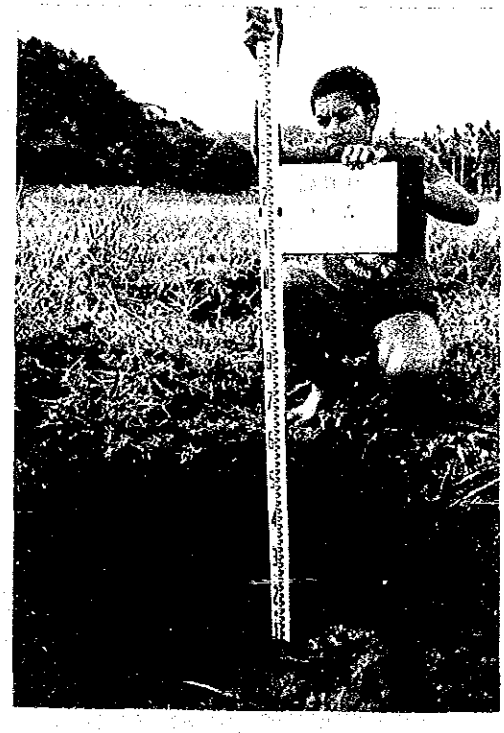
TABIA AREA VIEW FROM THE TOP OF THE ROCK HILL IN EAST SITE
(PROPOSED PILOT FARM AREA IS THIS HILL SIDE)



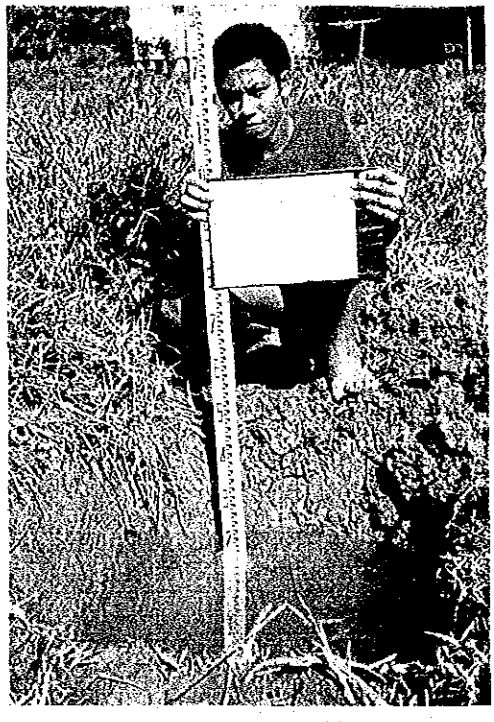
TABIA RIVER
(WATER RESOURCES OF PROJECT)

EXISTING DRAIN IN TABIA





SOIL PROFILE
(SOUTH POINT IN TABIA PILOT AREA)

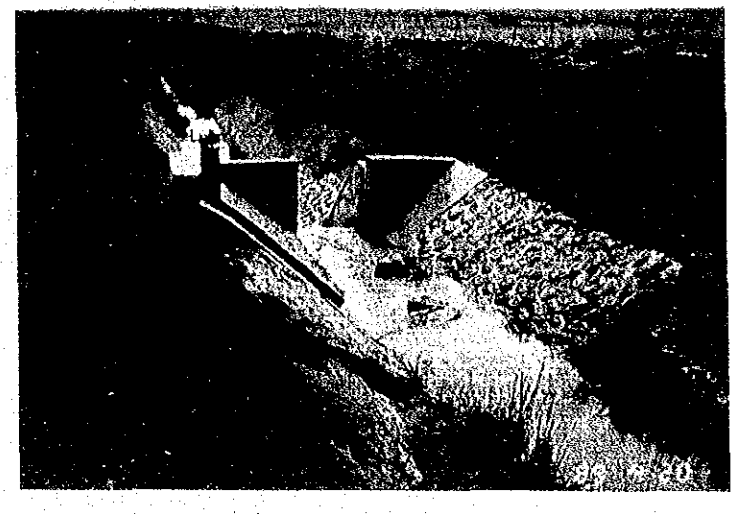


SOIL PROFILE
(NORTH POINT IN TABIA PILOT AREA)

PROPOSED PILOT FARM AREA

KOROKADI AREA VIEW (PROPOSED PILOT FARM IS LOCATED IN RIGHT HAND SITE)

VIEW OF SOUTHERN FARMING LOT IN PILOT FARM / THIS SIDE IS MAIN DRAIN

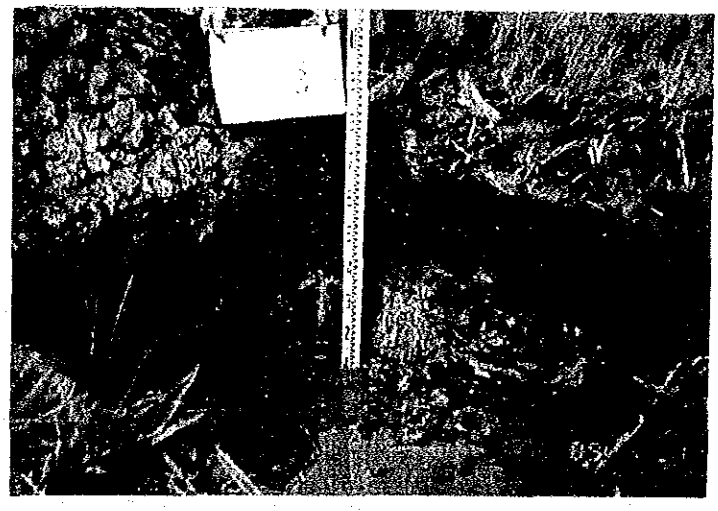


EXISTING MAIN
IRRIGATION CANAL

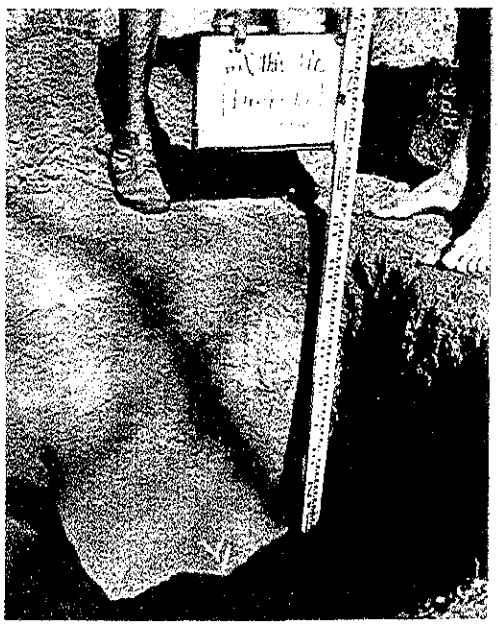
EXISTING MAIN
DRAINAGE CANAL

SOIL PROFILE
(SOUTHERN FARMING LOT IN PILOT AREA)

SOIL PROFILE
(NORTHERN FARMING LOT IN PILOT AREA)



DREKETI PILOT AREA / PROPOSED SITE OF PILOT FACILITIES



SOIL PROFILE
(AT PROPOSED FACILITIES SITE)

OFFICIAL MEETING : MARCH 28, 1989
CENTER:MR. J. Teaiwa, RIGHT:MR. K. NAGAYOSHI, MR. N. USUKI

ABBREBIATIONS

ORGANIZATION

MPI	Ministry of Primary Industries
D & I Div.	Drainage and Inrrigation Division
KRS	Koronivia Research Station
FCA	Fuji College of Agriculture
DB	Drainage Board
FAP	Food and Agriculture Organization
UNDP	United Nations Development Programme
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency

UNIT

ac	Acre= 1 ac=4,047m^2(1 ha=2.47 acres)
Q	Quantity (m^3/sec)
V	Velocity (m/sec)
ϕ	Diameter (mm)
Hz	Heltz
Kw	Kilo Watt
m	Meter
mm	Milli Meter
Hp	Horse power
F$	Fiji Dollar =F$1.00=¥93 (As of March 1989)

OTHERS

R/D	Record of Discussion
F/S	Feasibility Study
D/D	Detailed Design
GDP	Gross Domestic Product
DP9	Fuji's Ninth Development Plan

SUMMARY

SUMMARY

1. BACKGROUND OF STUDY

(1) The Inprovement of Rice Cultivation Technology Project in Fiji started in April 1985, and at present developement of rice cultivation technology, extension, and training are under way with the cooperation of JICA.

(2) In August 1986, the Model Farm 15ha was completed in the yard of KRS, as the Model Infrastructure Improvement Work. Further in December 1988, 16ha rice field equiped irrigation system was established in Navua area for the research and test of rice cultivation technology, and demonstration and extension of new technology, moreover 14ha rainfed rice field was also established in Nausori area as the pilot farm.

(3) The detail design study team was dispatched to carry out the field survey for establishment of the pilot farm, and extension and training facilities for farmers and extension officials in Vanua Levu. Execution of this project in Vanua Levu was recommended by the Matsuyama Mission as one of further cooperation activities in April 1987.

(4) The study team which consisted of Ministry of Agriculture,Forestry and Fisharies, JICA and Consultant carried out the field survey in 45 days from March 20 to May 3, 1989. Team and Ministry of Primary Industries discussed and decided to establish two pilot farms in Korokadi Valley and Tabia, and one extension and training facilities in Dreketi. The consolidation plan for the pilot farms in 3 areas were prepared through the detailed field survey, data collection and deskwork in Japan.

2. DETAILED DESIGN OF TABIA PILOT FARM

(1) Tabia area is located in 20km North-east of Savusavu in Vanua Levu, and of which about 50ha on the right bank of Tabia river alluvial area is being utilized for the rice field. Total 12ha, eastern part 7ha of existing rice field and adjoining 5ha of wasteland, were selected for the pilot area and decided to execute necessary works.

(2) Existing each plot is too small like as 5a to 37a and levelling is no good, therefore uneven growth of paddy and poor drainage areas are spreaded in many places. Effective utilization of rice field is not enough, because of secondary or tertiary drains and farm roads in the area are very few and no good condition. In present situation, plowing is carried out by animals, therefor each plot is small, but bigger scale consolidation shall be needed for the introduction of mechanization in future.

(3) The area has a mild slope from north to south, then tertiary canals and drains are arranged along the slope. Scale of a unit plot is designed with about 15a. Farm roads are arranged about 100m interval and paved by the gravel 10cm thick.

(4) Irrigation water source is Tabia river and it is intaked by submergible pumps. Discharge sump, pipeline and farmpond are equiped as the delivery facilities. Two pump sets are arranged which drived by the engin generater.

(5) Discharge of irrigation water is 20mm/day or 2.3l/sec/ha based on the soil test in the field, and discharge of drainage water is 12l/sec/ha based on the Fijian Standerd.

3. DETAIL DESIGN OF KOROKADI PILOT FARM

(1) Korokadi area is located in Vua, North-west Part of Vanua Levu, there is 200ha existing rice field which has the weir, main canal and main drain.

However there is no necessary facilities such as secondary and tertiary irrigation canals, tertiary drainage canals, farm roads, enough levelling, etc., therefor effective water utilization and increasing of the yield can not be realized.

(2) For the improvement of this condition, establishment of the pilot farm for rice farming was decided and 9ha of 2 blocks in the southern part of the Korokadi project area was sellected for it. Existing unit plot is comparatively small and not good levelling, therefor each plot is rearranged to enough scale of 10a to 12a for the animal plowing.

(3) According to the detail design 5 lines of secondary irrigation canal and 4 lines of secondary drainage canal are arranged along the land slope from the main canal side to the main drain. Secondary, roads which has 10cm thickness gravel paving, shall be arranged adjoining each secondary irrigation canal.

(4) Cross section of secondary irrigation canals are designed at 20mm/day of consumption water according to the soil survey, and secondary drainage canals are designed at 12 l/sec/ha of Fijian standerd.

4. DETAIL DESIGN OF DREKETI EXTENSION AND TRAINING FACILITIES

(1) Several large scale rice production projects such as Korokadi, Dreketi, Vua and others are on going under ADP in Vanua Leve also. It is a big problem that knowledge of extension officials and farmers' farming level are so low, though the rice production projects are being proceeded at present.

(2) Training and leading of rice production technology at the Koronivia Research Station in Viti Levu (Southern Island) are getting the good results, therefore also in Vanua Levu (Northern Island) to establish the training and extension facilities

was planned for raising up of technical level of extension officials and farmers.

(3) Buildings of training center are planned to establish in the office area of the Dreketi Rice Project which is the center of rice production in Vanua Levu.

(4) Facilities are consisted of 120 sq.m of a training building for about 20 persons, 112sq.m of a laboratory for rice tests and warehouse. A training building is one floor wooden house and a laboratory is tow stories concrete block house.

5. CONSTRUCTION PLAN

In case of three projects of Tabia, Korokadi and Dreketi shall be started simultaneously, it needs about six months for construction period so that the earth work which is main construction item.

Since the main work in Tabia and Korokadi is field levelling, therefore levelling work shall be done in the first half of the cocnstruction period, and in the last half roads, irrigation canal, drains and others done.

Constrruction works of a training center and laboratories in Dreketi are needed 3-months and 5-months construction period respectively each other, after the land levelling work of the building construction site is finished by Fijian side.

In advance of the start of the construction works, to execute of tendering and to exchange the contract signing with a contractor are needed, and for this procedure aboout one (1) month is necessary.

In a point of location, Korokadi and Dreketi are adjoining each other, other hand only Tabia is 140km seperated from two, therefore 2 supervisors are required.

Construction schedule is shown in Table A.

Table A Construction Schedule

Work Item	First Month	Second Month	Third Month	Forth Month	Fifth Month	Sixth Month	Seventh Month	Remarks
(Contract Work)	------							
Tabia Project								
1) Preperation work		———						
2) Land cosolidation		———	———	———	———	———		
3) Pump, Pipe line				———	———	———	———	
4) Irri. facility				———	———	———	———	
5) Drain facility				———	———	———		
6) Road work			———	———	———			
7) Clearance work							———	
Korokadi Project								
1) Preperation work		———						
2) Land consolidation		———	———	———	———	———		
3) Irri. facility				———	———	———	———	
4) Drain facility				———	———	———	———	
5) Road work			———	———	———			
6) Clearance work							———	
Dreketi Project								
1) Preperation work		———						
2) Foundation work		———	———					
3) Housing work			———	———	———	———	———	
4) Clearance work							———	

6. CONSTRUCTION COST

The construction cost of Pilot Infrastructure Works in Tabia, Korokadi and Dreketi Projects is shown in Table 8.

Table 8 Construction Cost

Work Item	Construction Cost	
	(F$)	(¥'000)
(Tabia Project)		
• Land Consolidation Work	62,066	5,772
• Pump, Pipe line Work	27,950	2,599
• Irrigation Facility Work	59,152	5,501
• Drainage Facility Work	27,342	2,542
• Road Work	29,016	2,698
Sub total	205,527	19,114
(Korokadi Project)		
• Land Consolidation Work	50,935	4,737
• Irrigation Facility Work	40,784	3,792
• Drainage Facility Work	20,185	1,877
• Road Work	19,162	1,782
Sub total	131,068	12,189
(Dreketi Project)		
• Training House	33,000	3,069
• Laboratory and Equipmet House	67,000	6,231
Sub total	100,000	9,300
Total	436,595	40,603
Overhead Cost (20%)	87,319	8,120
Total	523,914	48,723
Contingency (10%)	52,391	4,872
Total	576,305	53,595
Other Expense (5%)	28,010	2,605
Total	604,315	56,200
Supplied Material (Pump)		8,000
Grand Total		64,200

CONTENTS

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CHAPTER 1 BACKGROUND OF STUDY

CHAPTER 1 BACKGROUND OF STUDY

1-1 Background and Objectives of Study

Since 1987, domestic annual rice consumption in Fiji has exceeded 50,000 tons, and there is a tendency for the consumption is increasing year by year. In other hand, domestic rice sufficiency is about 70% only in 1987, though the domestic rice production is also increasing gradually. Since this condition the Government pays more than F$ 6 millions of valueable foreign currency in every year for the rice import.
For improvement of this condition, Fijian government requested to Japanese government to cooperate The Improvement of Rice Cultivation Technology Project as a technical aid in April, 1985.
This cooperation project is now in the 5th year, then in August 1986 about 20ha of experimetal farms were established in the Koronivia Research Station as the Model Infrastructure Improvement Works.

As a next step in December 1988, the Pilot Infrastructure Improvement Works were completed for demonstration and extension of accumulated technology, namely 16.4 ha of rice field equiped irrigation system in Navua area and 14.3 ha of rainfed rice field in Nausori.
Moreover, it was decided that the project activities are enlarged into Vanua Levu, and it was also decided that pilot farms and extension and training facilities shall be established in Northern Island.

For it, field survey and sites sellection were carried out in 45 days from 20 May 1989, that is 11.6 ha of Tabia pilot farm nearby Savusavu, 9.0 ha of Korokadi pilot farm nearby Votua and training center in existing Dreketi project.
Detail design and construction schedule were prepared for those projects.

1-2 Progress of the Survey

DATE	ITEM
---- 1989 ----	
20 (Mon) ~ 21 (Tue) MAR.	Tokyo - Suva,
21 (Tue) MAR.	Arrival at Suva, Courtesy call to JICA Office and Embassy of Japan, Meeting with Project Team member on survey schedule at KRS.
22 (Wed) ~ 24 (Fri) MAR.	Field survey in Korokadi, Vua and Tabia for candidate sites of pilot farm, and Dreketi for training center.
24 (Fri) MAR.	Deciding of basic Plan for plan and design, Meeting with Mr. V. Nath, Director of D & I.
25 (Sat) MAR.	Meeting with Project Team on basic plan.
26 (Sun) ~ 27 (Mon) MAR.	Preparation of Basic Plan of Improvement Works (Leader's letter).
28 (Tue) MAR.	Courtesy call to Minister of Primary Industries and holding the official meeting.
29 (Wed) MAR.	Leader Mr. K. Nagayoshi leaving for Japan, Inspecting of existing Model and Pilot Infrastructure Improvement Projects, Meeting with Project Team on components of basic plan.
30 (Thu) MAR.	Submitting of Team Leader's Letter (Basic Plan), Meeting with D&I Division staff on the work schedule. Consultant staff leave for Labasa in Vanua Levu.
31 (Fri) MAR.	Team menber Mr. N. Usuki leaving for Japan.
31 (Fri) MAR. ~ 1(Tue) MAY	Executing of detail field survey, data collection and basic design in Tabia and Korokadi Pilot Areas and Dreketi Training Center

1 (Tue) MAY Submitting of Field Report.

2 (Wed) ~ 3 (Thu) MAY Consultant staff leaving for Japan.

1-3 Major Persons Involved

---- Fijian Government ----

Mr. Vieiame Gonelevu	Minister,	Ministry of Primary Industries
Mr. John Teaiwa	Acting Permanent Secretary,	〃
Mr. Tui Cavuilati	Dupity Permanent Secretary,	〃
Mr. Vijay Nath	Director, D&I Division	〃
Mr. Satiya Suwami	Principal Engineer, D&I Div.	〃
Mr. R. N. Duve	Director, Research Division	〃
Mr. Jagat Singh	Director, Northern Division	〃
	Agricultural Office	〃
Mr. Latchman Mudaliar	Farm Manager, Dreketi Proj. NDAO	〃
Mr. Samisoni Ulitu	Office Manager, Savusavu NDAO	〃

---- Japanese Embbasy ----

Mr. S. Nishimura	Councilor,
Mr. N. Ueshima	Secretary,
Mr. T. Nitta	Secretary,

------ JICA Offic -------

Mr. Y. Yoshida	Resident Representative,
Mr. S. Mizuochi	Assistant Resident Representative,

---- Project Team JICA ----

Dr. H. Watanabe	Team Leader,
Dr. S. Miura	Specialist, (Soil and Fertilizer)
Mr. M. Hikichi	Specialist, (Extension Plan)
Mr. M. Uda	Specialist, (Cultivation)
Mr. K. Masumi	Specialist, (Coordination and Training)
Dr. T. Hiratsuka	Short Term Specialist, (Extension)
Dr. J. Harada	Short Term Specialist, (Weeds Control)

CHAPTER 2

DESIGN PRINCIPLES OF PILOT INFRASTRUCTURE

CHAPTER 2 DESIGN PRINCIPAL OF PILOT INFRASTRUCTURE

In 1985, the Model infrastructure Improvement Works were executed in Koronivia Research Station. This time, it is decided that Pilot Farms are established for verification, evaluation, demonstration, extension and training of the results of research.

2-1 Tabia Pilot Project

1. Site Sellection

Within the existing Tabia rice field area about, 12 ha were sellected as the pilot farm which is located for North-East 20 km of Savusavu in Vanua Levu (Northern Island).

2. Basic Plan of Pilot Farm

Basic plan of the pilot farm is as follow, in which Japanese Specialists shall utilize for extension and training for local farmers.

1) Secondary and tertiary irrigation canals and drainage canals are arranged.
2) Scale of a unit plot is decided according to consider both of present animal plowing and future mechanized plowing.
3) Farm roads are arranged against each plot to carry in and out various materials and products.
4) Pilot area is belonging to the village common, then to change any band (levee) or drain are no objection.
5) Water source of irrigation is Tabia river and it shall be supplied by the pumping system.

2-2 Korokadi Pilot Project

1. Site Sellection

Within the existing Korokadi rice field area, about 9 ha were sellected as the Pilot farm, which is located in North-West of Vanua Levu.

2. Basic Plan of Pilot Farm

Basic plan of the pilot farm is as follows.

1) Secondary and tertiary irrigation canals and drainage canals are arranged.
2) Scale of a unit plot is decided according to consider both of present animal plowing and future mechanized plowing.
3) Farm roads are arranged against each plot to carry in and out various materals and products.
4) Pilot area is cultivated by 5 farmers as the leased farm, then each boundary is not changed.

2-3 Dreketi Training Center

1. Site Sellection

Project site is sellected within the office area of Dreketi rice production project, which is the central project of rice production in Northern Island. Total acreage of project site is about 2,500 sq. m, and it is in front of a main road, moreover surrounding view is good.

2. Basic Plan of training Center

1) One building is constructed for extension and training of the rice cultivation, its capacity is for about 20 persons.
2) Another building is for laboratory and equipment storage house.

CHAPTER 3

DETAILED DISIGN OF TABIA PILOT PROJECT

Chapter 3 Detailed Design of Tabia Pilot Project

3-1 Physical Condition

1. Topography

The proposed site of the pilot farm occupies an area of 12 ha and is made up of approximately 7 ha of paddies and 5 ha of wasteland at the eastern edge of approximately 50 ha of land already under cultivation. A special feature is the rocky hill at the centre of the site.

The area under cultivation at present, with hills to the north, slopes down gently towards the coast to the south and the elevation of the land is between 1 m and 3.5 m above sea-level. The area of each plot is small and ranges between 5 a and 50 a.

2. Climate

As meteorological observations are not carried out at Tabia, the records at Savusavu, approximately 20 km to the southwest are given here for reference. The average annual rainfall at Savusavu over the past 6 years (1983 to 1988) was 2,218 mm, of which 1,522 mm, or approximately 70%, fell during the rainy season between November and April, while the remaining 30% fell during the dry season from May to October. The heaviest rainfalls occur during March, April and December when monthly rainfalls of 300 mm or so are observed, while the month with the least rainfall is June with 70 mm. It has to be noted, however, that there is considerable variation in the figures from year to year.

Records of temperatures and durations of sunshine are given below. There is little variation throughout the year in both of these. The figures for the duration of sunshine are those observed at Wainigata, halfway between Savusavu and Tabia.

	Rainy Season (Nov. to Apr.)	Dry Season (May to Oct.)
Average Daily Maximum Temperature	32 ℃ (Feb.)	29℃ (May)
Average Daily Minimum Temperature	23 ℃ (Nov.)	20℃ (Aug.)
Average Monthly Duration of Sunshine	162 hours	141 hours

3. Soil

Samples collected on site indicate that the soil on the proposed site of the pilot farm is gley soil, which is the soil most suited to cultivation of rice in paddies. According to the results of the trial excavation at 3 points on site, the surface soil down to approximately 30 to 40 cm below ground was high-quality clay loam, suitable for cultivation of rice. There will be no treatment of surface soil, except when moving soil about 5 to 10 cm in depth.

4. Irrigation Water

Tabia River will be used as the source of water for irrigation. High values for salt content were observed in the water sample taken at the proposed site of the pump, as the river bed at the site is low (-0.60 m) and the site is located within the area subject to tides. A further reason for the high salt content lies in the fact that the sample was taken at high tide.

pH : 6.28

EC : 96.4 ms/cm

The water is slightly acid but the figure above is within the permissible range of pH 6 to pH 8 for irrigation water and is thought not to present problems. Measures will need to be taken, however, to reduce the inflow of salt, for example, by taking in water at low tide, as the source is located near the mouth of the river with the elevation of the river bed below sea level.

5. Drainage

There are 4 drains to the west of the land under cultivation at present and water from 35 ha, amounting to approximately 70% of the total area under cultivation, is drained through these channels, named Drains T1 to T4, and flow into a tributary of Tabia River.

3-2 Farm Consolidation Plan

1. Land Use Plan

The proposed site of the pilot farm includes the approximately 7 ha of land near the settlement on the eastern part of the land already under cultivation and approximately 5 ha of the adjacent wasteland. The land, called mataqali, is owned jointly by the inhabitants of the settlement and is cultivated by the villagers themselves. There are no problems with regard to change of boundaries between plots under the plan. Sizes of the plots at present vary between 5 a and 50 a and their shapes and directions too are not uniform.

Together with realignment of plot divisions and adjustment of plot sizes, provision of irrigation water and laying of branch water channels for irrigation and drainage and branch roads will be carried out under the project.

The water for irrigation will be drawn from pumps on Tabia River. The water,

once pumped up, will be conveyed to the farm pond within the pilot farm by natural pressure through a delivery pipe and distributed from there throughout the farm.

Land use will be as follows.

Paddies	9.7 ha
Roads & Waterways	1.9 ha
Total	11.6 ha

2. Division of Fields and Plots

The proposed site of the pilot farm, centred around a rocky hill, is of a square shape, extending approximately 400 m both from north to south and from east to west. The sizes of plots within the site at present vary from 5 a to 50 a and their shapes too are not uniform.

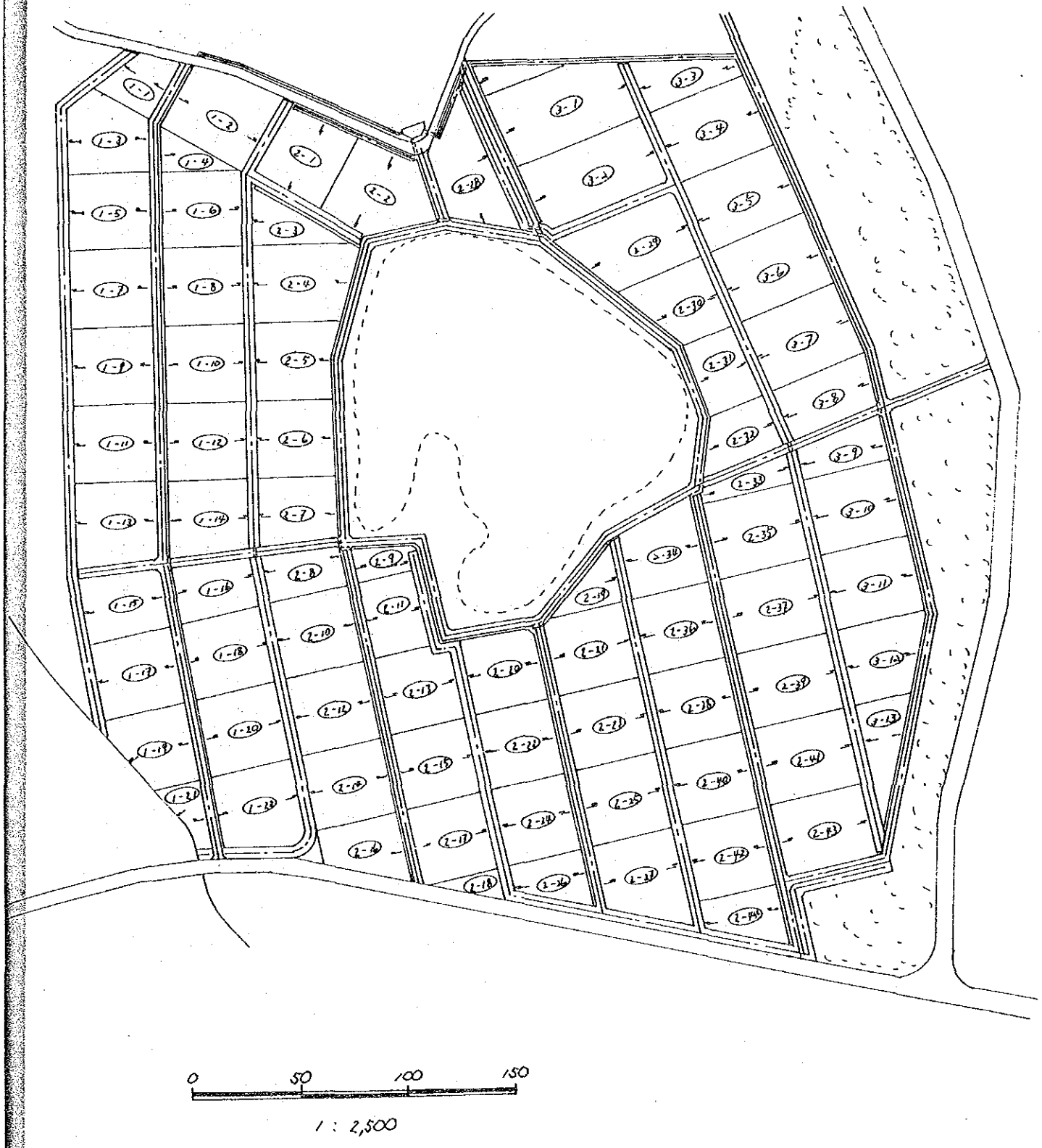
In the past, in establishing new farms in Fiji, large plots of about 2 ha had been created with a view to use of large farming machinery, but the scale of each plot has been revised has been reduced to a medium size of 0.4 ha (1 acre), taking account of the management scale of the farmers, the levels of techniques for cultivation of rice and the area of the standard plot in areas being equipped with irrigation at present.

In the project area, to prevent large-scale transfer of land, to allow cultivation using animal power as at present and to avoid major alterations of the directions of the plots, plots of around 15 a (0.4 acres) will be used. In the event of of mechanisation, when it is judged appropriate to enlarge the sizes of each plot, the levees between the fields can be removed to create plots of 30 a (0.8 acres) or 45 a (1.1 acres).

The division of plots will be as shown in Figure 3-1.

3. Creation of Fields

Fig.3-1 Farming Plot Plan



(1) Elevation of Fields

As a principle, the ground within each plot will be maintained level and the plots will become lower as one goes south.

(2) Design Elevation

As mentioned above, the design elevations adjustments through cutting and banking will be carried out between 2 adjacent plots. The elevation of the ground will be made to be about 10 cm above the elevation of bed of irrigation channels and 50 cm above the bed of the drains.

(3) Soil Surface Treatment

According to the results of the soil profile survey, there is surface soil rich in humus reaching down to 20 cm to 30 cm below ground in the paddies at present. Where the depth of the soil subjected to cutting and banking work is less than 10 cm, no soil surface treatment will be carried out. Only where the depth of the soil subjected to cutting and banking exceeds 10 cm will soil surface treatment be implemented.

(4) Soil Transportation

In principle, the ground within each plot will be made level. Where soil needs to be transported from one plot to another, combinations that will minimise the distance over which soil is transported will be used.

(5) Design for Ancillary Works

Ancillary works will include those for the banking of the levees and the access roads. The structures of these will be as shown in Figure 3-2.

3.3 Road Plan

1. Road Network

There is a national road to the south of the project site, a farm road to the north and a road running to the settlement beyond the coconut palm grove to west of the site. Construction of 5 farm roads running from north to south and 1 road running from east to west is planned under the project to allow access to each of the plots. These roads will connect on to the existing roads and will be used to facilitate access to the fields for cultivation. The road network plan will be as shown in Figure 3-3.

2. Road Structure

(1) Road Widths

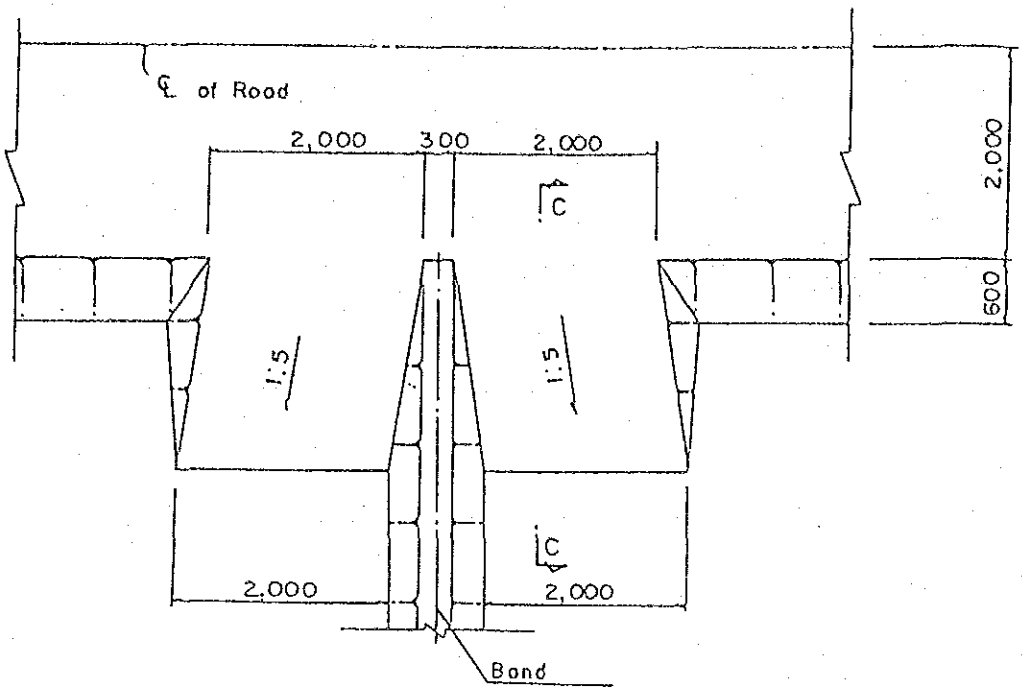
The roads will be designed to allow passage of cattle, medium-sized tractors and 2 ton lorries for purposes of transporting agricultural machinery and produce.

The design widths are as follows.

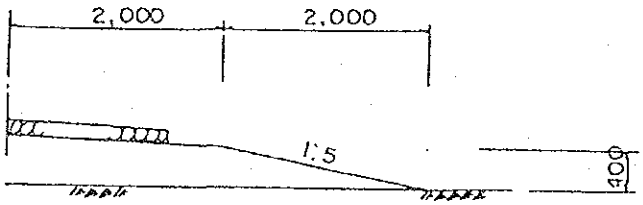
Effective Width : 3.0 m
Width of Shoulder : 0.5 m
Total Width : 4.0 m

(2) Road Structure

Fig.3-2 Related Facilities Plan



C-C SECTION
S=1/50



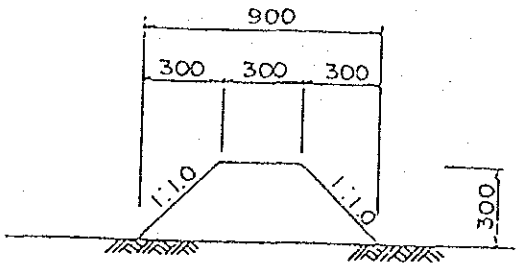
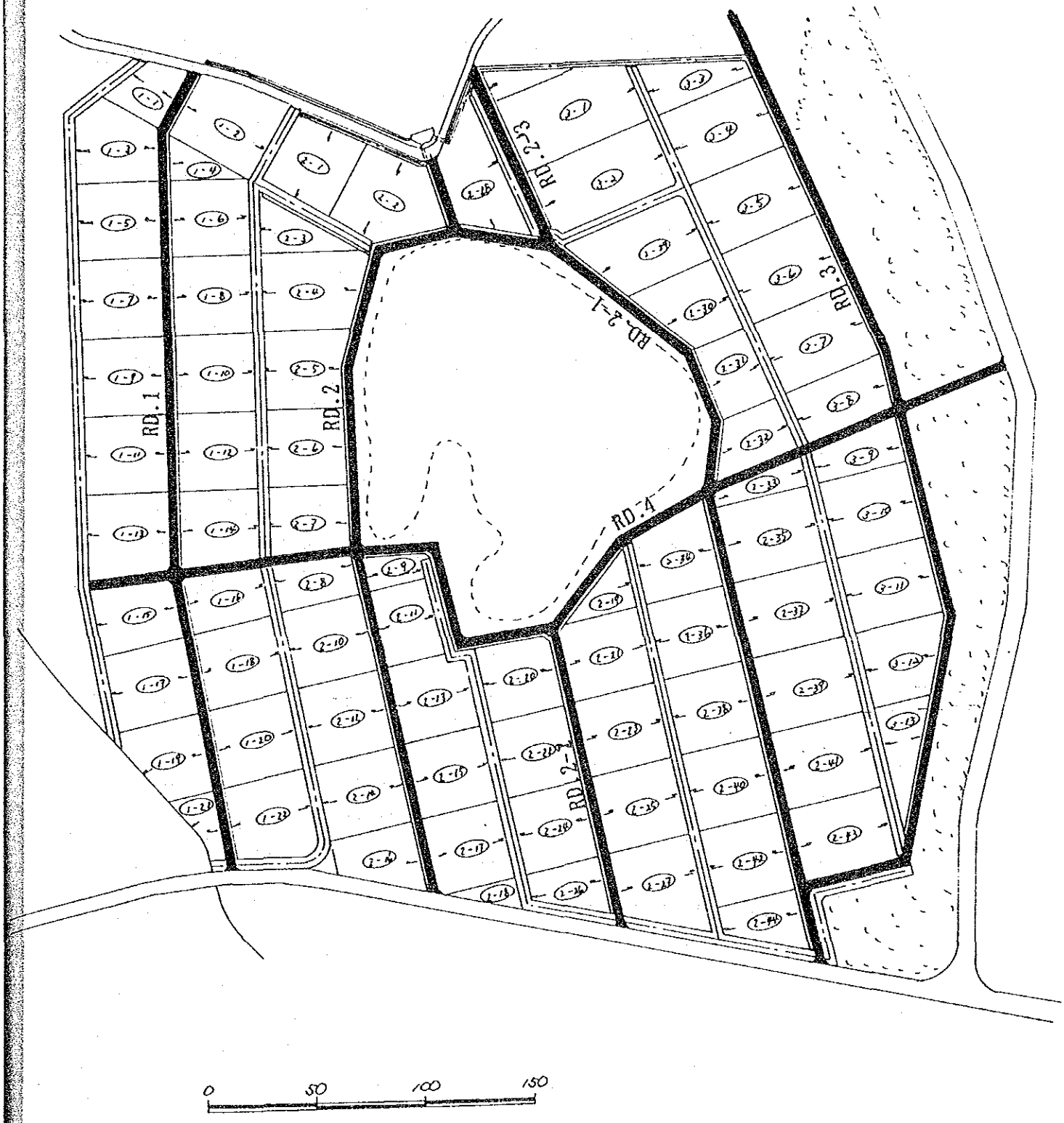


Fig.3-3 Road Network Plan



The roads will be raised 40 cm or more above the level of the fields and the excess soil cut in creation of the fields will be used in the construction of the roads. The slope gradient of the embankment will be 1:10 and the part within the effective width will be paved with gravel to a depth of 10 cm.

The vertical gradient of the road will be kept below 8% and the crossfall below 5%.

The road structure is shown in Figure 3-4.

3-4 Pumps Plan

Irrigation water for the pilot farm will be taken using pumps from Tabia River in the vicinity of the settlement and will first be conveyed to the delivery tank at the back of the settlement. The water will need to be conveyed from the delivery tank to the farm pond through the settlement. Since it will be difficult to select a route with suitable elevations, the water will be conveyed naturally through a pipe line.

The details for the pump, irrigation facilities, water pipes and the delivery tank are given below.

(1) Lift at Pump

The lift at the pump will be decided taking account of the water level required at the furthest point on the pilot farm. Judging from the design of the water channels, the required water level at the furthest point on the pilot farm is (+) 7.9 m.

Allowing for a water level variation (depth of tank) of 1 m at the delivery tank, the elevation of the delivery tank at the pump will be 8.9 m.

Since the minimum water level at the intake point is 0.00 m, the actual lift at the pump will be 8.90 m (= 8.90 m - 0.00 m). Adding to this the loss in conveyance, the total lift will be 9.2 m.

Fig.3-4 Typical Road Section

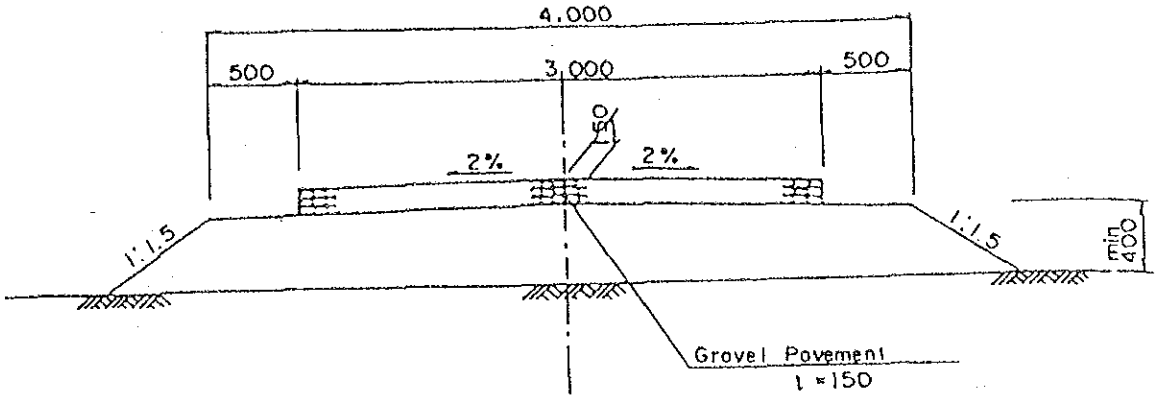


Fig.3-6 Typical Irrigation Canal Section

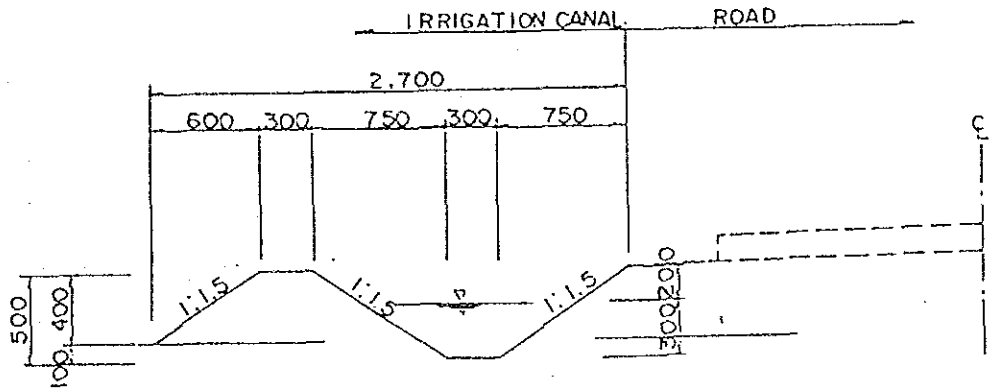
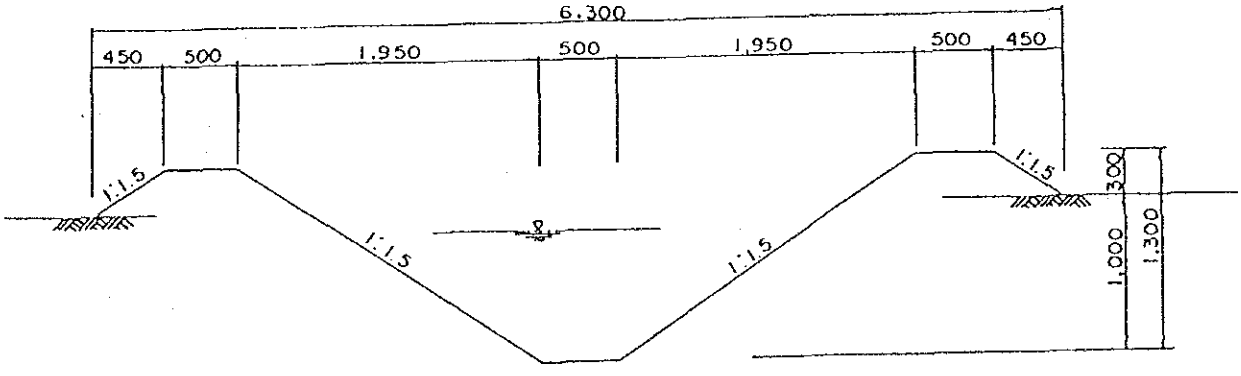


Fig.3-10 Tyipical Drainage Canal Section



(2) Calculation of Quantity of Water to be Raised

The quantity of water to be pumped up will be calculated from the quantity of irrigation water required on the pilot farm.

a) Dimensions of Irrigation Facilities

A = 11.6 ha (area under cultivation : 9.7 ha)

q = 20 mm/day

b) Net Quantity of Water Pumped Up (Qn)

$Qn = 0.02 \times 116,00 \div 86,000 = 0.027\ m3/s\ (0.022)$

c) Irrigation Efficiency (Ep)

$Ep = Ea \times Eb \times Ec$

where,

Ea : application efficiency 0.9

Eb : waterway efficiency 0.7

Ec : conveyance efficiency 0.7

whence,

$Ep = 0.9 \times 0.7 \times 0.7 = 0.44$

d) Design Water Supply (Gross Irrigation Requirement)

$Qg = Qn/Ep$

$= 0.022/0.44$ (0.22/0.44)

$= 0.050\ m^3/s = 3.00\ m^3/min$

(3) Selection of Pump

The following 3 types of pumps will allow for a total lift of 9.2 m and pumping of 3.00 m^3/min of water.

Vertical Shaft Axial Flow Pump

Incline Pump

Underwater Pump

Taking the topography and maintenance requirements into account, it is thought to be appropriate to use an underwater pump.

As for the dimensions of the pump, 1 pump with a discharge opening 200 mm in diameter or 2 pumps with discharge openings 100 mm in diameter will be required. 2 pumps will be used here to allow for breakdowns and maintenance.

(4) Selection of Generator

Since Tabia District has not yet been electrified, a generator will be required as the power source for the pumps. Since 7.5 kW will be needed to operate an underwater pump with an opening diameter of 150 mm, the capacity of the generator will be 15 kW. Since, in general, maximum power is required when starting up the pumps, the generator selected will be capable of generating 20 kVA, sufficient to put one pump into motion, while the other is in operation.

(5) Appurtenance

A switchboard will be added as an appurtenance.

(6) Pump Hut

A pump hut will be built to accommodate the generator and the switchboard. Judging from the space required to accommodate these 2 equipments, a floor area of 3 m × 4 m and a height of 2 m will suffice. The switchboard will consist of a switch hung on the wall and a breaker.

Taking account of the noise created by the generator, the hut will built halfway up the hill behind the settlement (below the delivery tank).

The hut will be a wooden structure with a galvanised iron roof.

(7) Water Suction Tank

A concrete water suction tank will be installed at the location of the pumps. The tank will occupy an area of 1.2 m × 1.0 m and a pipe, 300 mm in diameter, conveying the water from the river will be attached. A bar screen will be installed for removal of dirt where the water from the river enters the tank through the pipe.

(8) Delivery Tank

The water conveyed from the pumps through pipes with diameters of 200 mm will first be discharged into a delivery tank located at a point 8.0 m above sea-level halfway up the hill at the back of the settlement. The tank will be of a concrete box, with the bottom at + 0.8 m and the top at + 9.5 m. The dimensions of the inside of the tank will be 2.00 m × 1.50 m.

The pipe running to the tank from the pumps will be fixed near the top of the tank to discharge water in mid-air, while a concrete pipe, 300 mm in diameter, will be attached to a point at the bottom of the tank to convey water

to the farm pond using natural pressure.

(9) Water Pipes

Since there is no suitable route through the settlement for an open water channel, water will conveyed from the delivery tank to the farm pond using natural pressure through a concrete pipe, 300 mm in diameter. The route of the pipe descends the slope of the hill and runs to the farm pond through the settlement. There will be at least 1.2 m of ground above the pipe where it runs underneath roads and at least 1.0 m where it is found underneath the settlement and cultivated land.

(10) Farm Pond

The farm pond will be located on the northern side of the pilot farm. It will be of an irregular hexagonal shape, formed by the combination of a trapezium with its top 4 m, its base 10 m and its height 3 m and a rectangle 10 m by 2 m. The walls themselves will be of an upside-down T shape, 1.8 m wide at the base and 2.5 m high. The effective reservoir volume of the pond will be 61.5 m^3 within the effective reservoir range between 0.3 m and 1.8 m below the top of the walls. The part between 1.8 m and 2.0 m is set aside as the dead water part.

3-5 Irrigation Plan

1. Quantity of Irrigation Water

(1) Volume of Water Required

Since there are no other irrigation projects in the vicinity of the project

site and there are no unit water quantities available for reference, the daily water consumption of 20 mm derived from the field survey was used in calculations.

(2) Irrigation Canal Network

The irrigation canal network plan will be as shown in Figure 3-5.

2. Irrigation Channels

(1) Types of Channels

Since the soil is of clay, as confirmed in the field survey, the channels will be of soil with a side slope of 1:1.0. The width at the base will be 30 cm and that at the top 30 cm. The gradient will be set at 1/1,000 to 1/3,000 with the purpose also of retaining water within the channels.

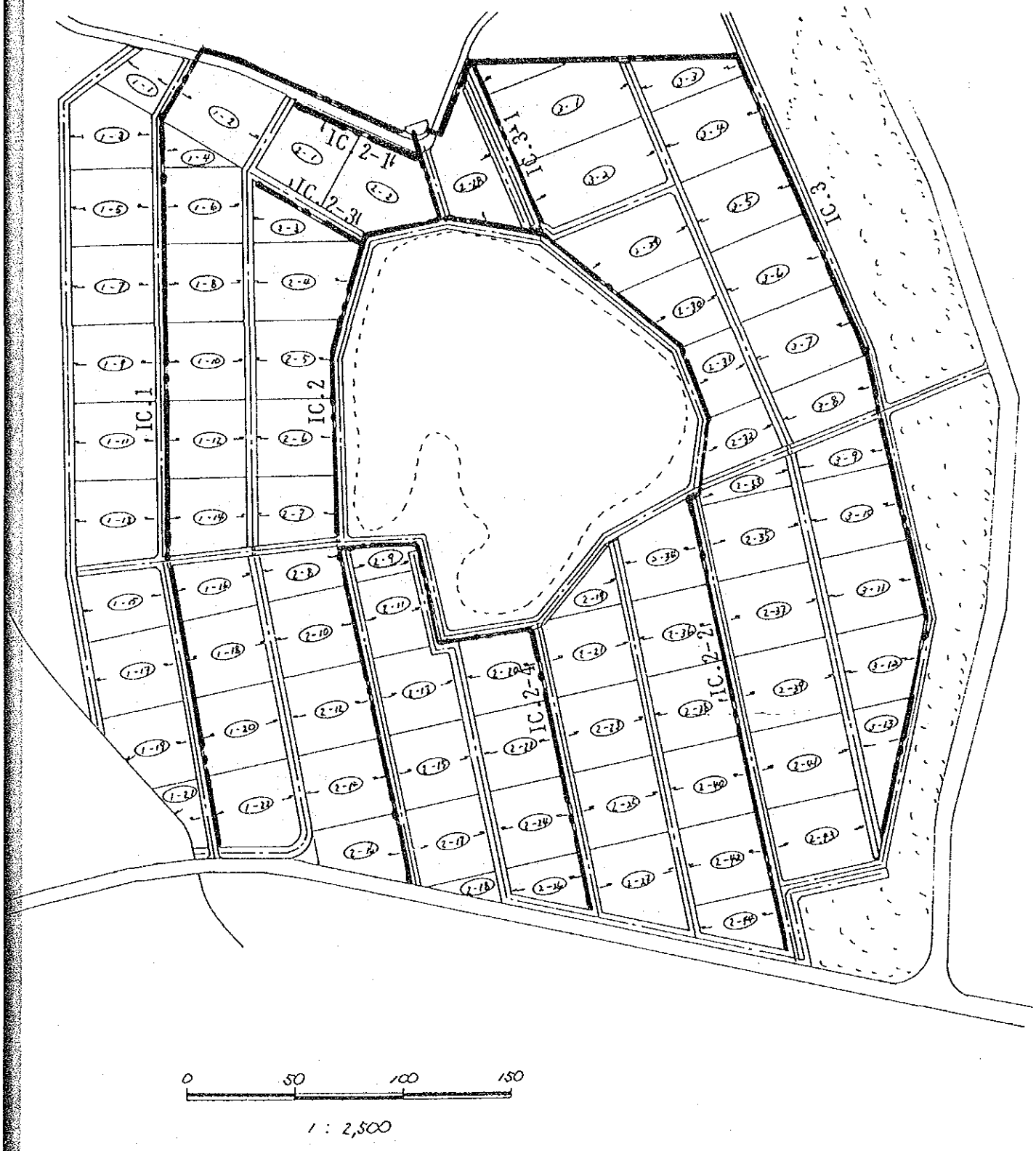
(2) Cross-Section of Channels

Although the quantities of water passing through the channels will be between 0.67 l/s and 14.25 l/s, canal cross section channels will be designed quantities to allow for irrigation efficiency. Since the total length of below 500 m is small, the channel section will be given uniform cross-sections throughout, except where there are branch lines.

In the hydraulic investigation, the value given for the maximum passage of water was 32 l/s, with Manning's coefficient of roughness at n = 0.030 and with the standard cross-section of the channels as shown in Figure 3-6, satisfying the requirements for passage of water in each of the channels.

(3) Ancillary Works

Fig.3-5 Irrigation Canal Network Plan



Ancillary works for the water channels include diversion works from branch waterways, inlets to each of the plots, drops and works for where they traverse the roads. The structures for each of these will be as follows.

a) Diversion Works

The structure of the works for diversion of water from the branch waterways will be such that they will allow control of the quantity of water being diverted and will contain diversion gates. Diversion points under consideration here are the diversion points for branch lines 2-2 and 2-4 on the branch waterway No.2 and, since the gates will be located both on the main line and the branch line, there will be 4 gates in all.

b) Inlet Works

The inlets into each of the fields will be of the type generally used in Fiji, as shown in Figure 3-7, in order to allow for facility in distributing water the fields and to avoid causing hindrance to maintenance work.

c) Drops

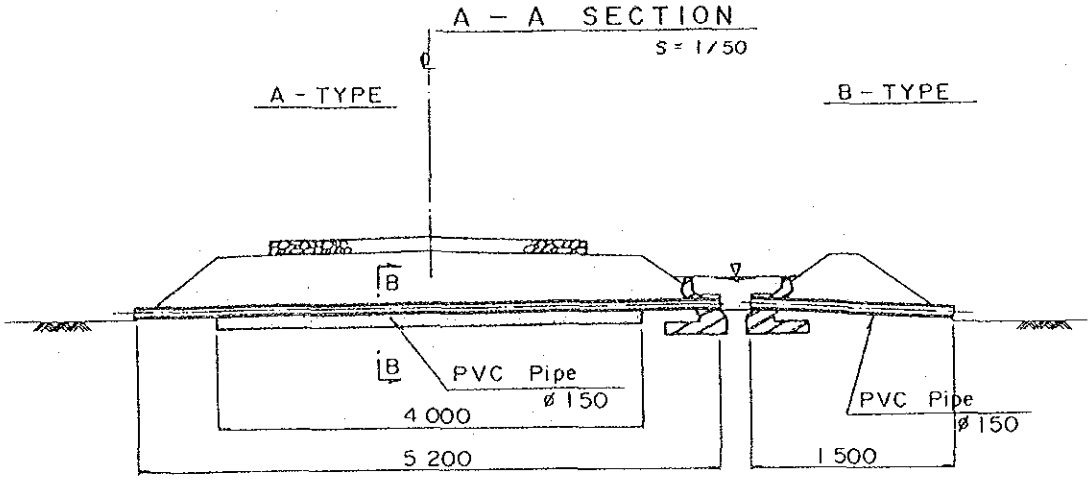
Drops will be installed where the elevation of the ground in the fields drop greatly in the direction of flow in the water channels. The works will be of a box structure with openings on the upstream and downstream sides, both connecting on to the waterways. The standard structural plan of the drops is given in Figure 3-8.

d) Road Crossings

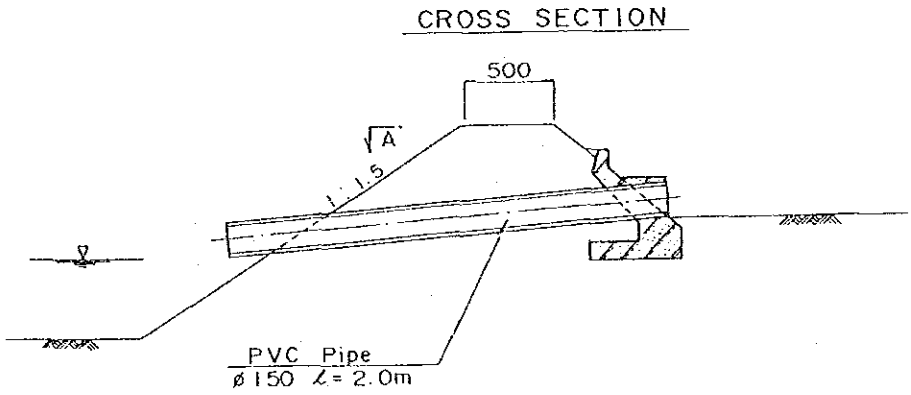
Where the water channels cross roads, concrete pipes, 300 mm in diameter,

Fig.3-7 Inlet, Outlet Work Plan

INLET WORK



OUTLET WORK



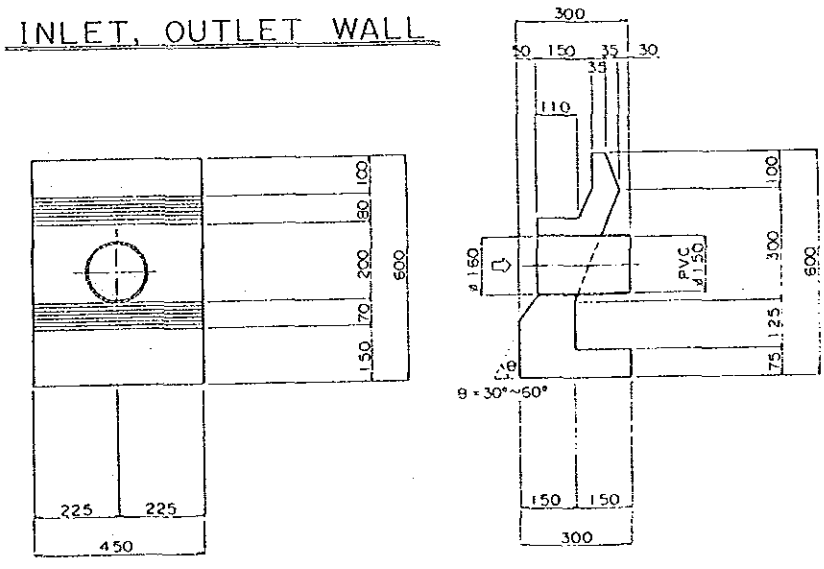
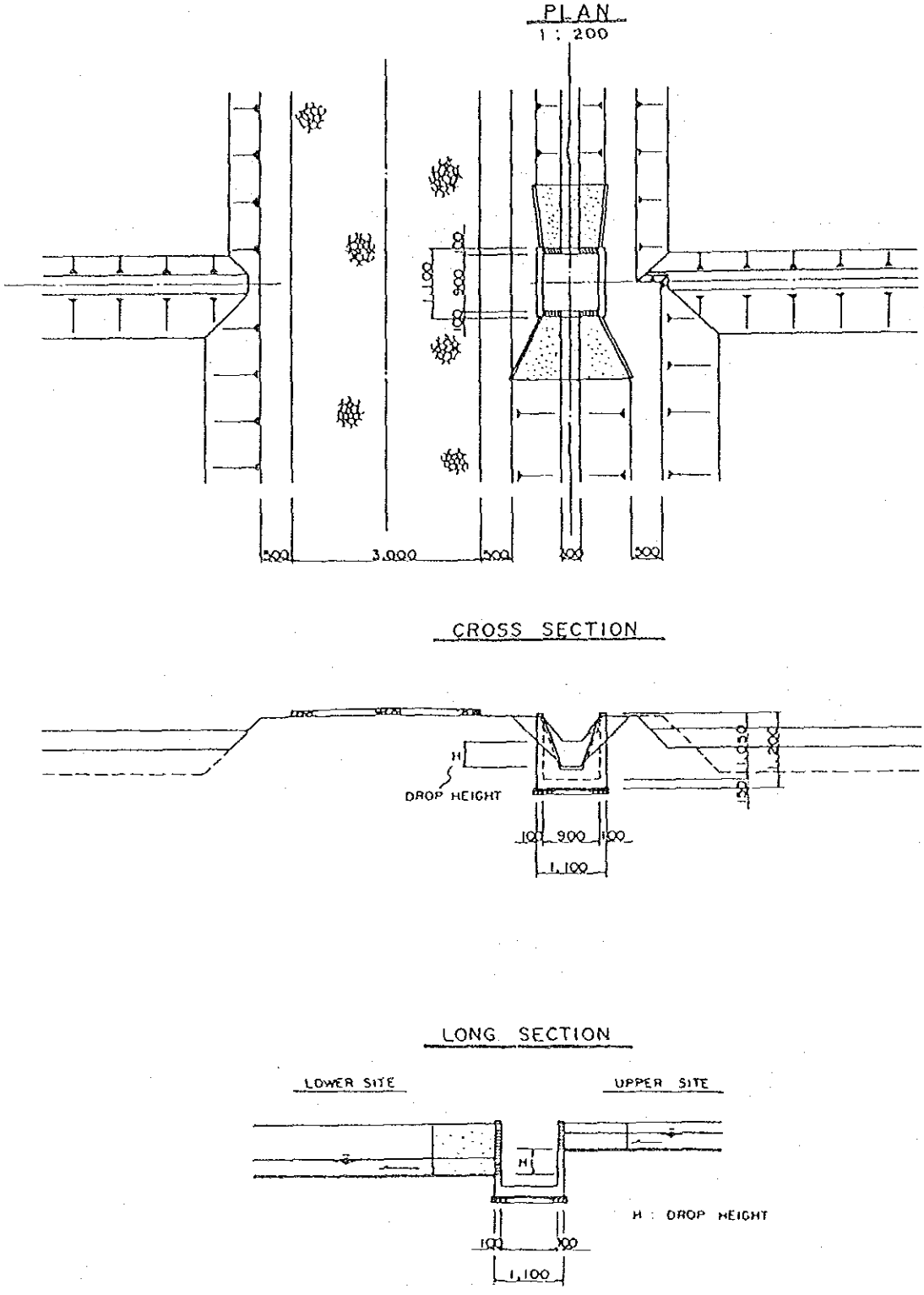


Fig.3-8 Drop Work Plan



will be installed. Retaining walls will be constructed at either end of the pipe and concrete lining will be provided along the connecting waterways for 1 m.

3-6 Drainage Plan

1. Drains

(1) Unit Volume of Drainage

The standard unit volume in Fiji for drainage of q = 12 l/s/ha will be used.

(2) Drainage Canal Network

The drainage canal network plan will be as shown in Figure 3-9.

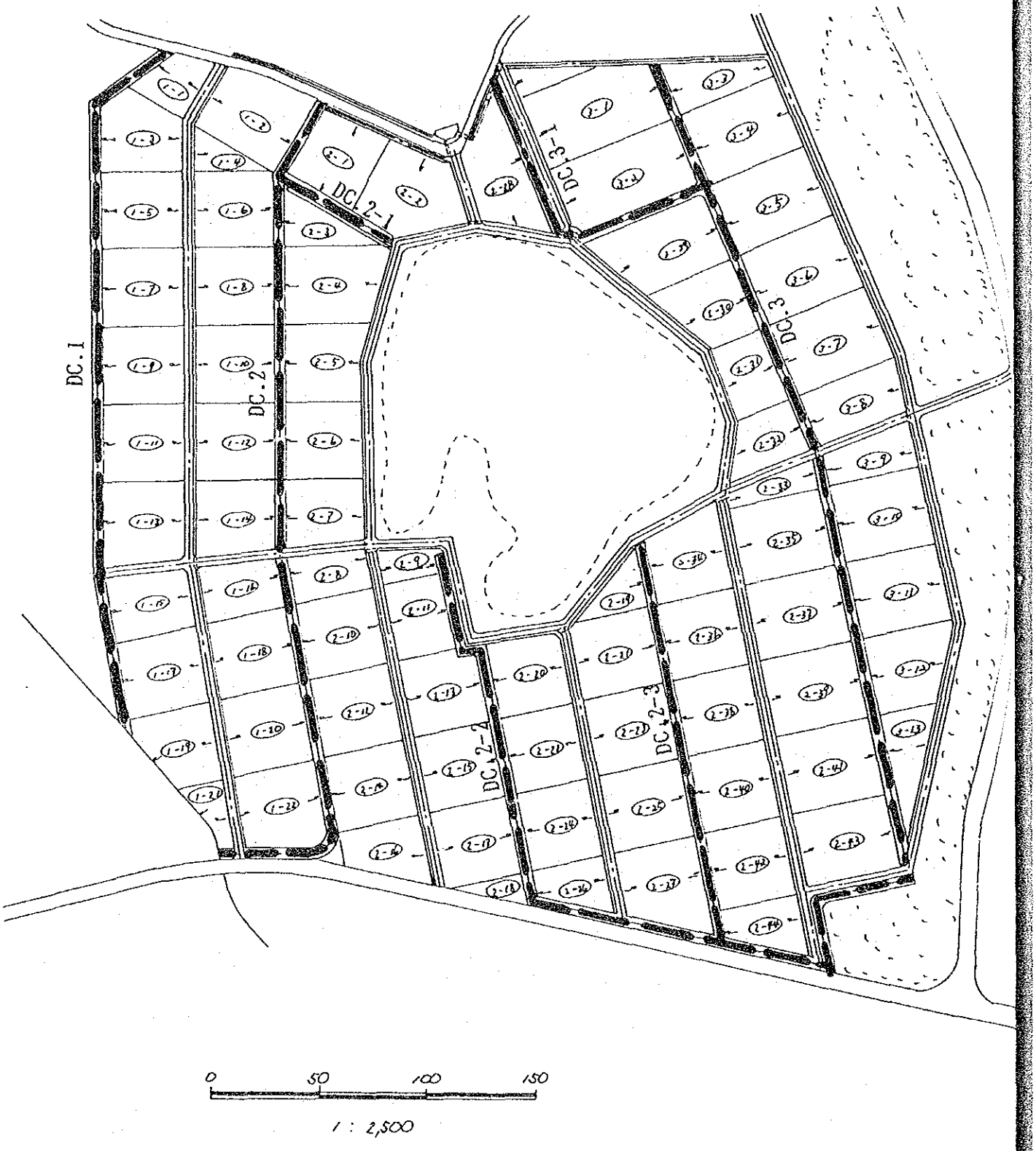
2. Drains

(1) Type of Drains

The drains will be made of soil, with side slopes of 1:1.0. The new branch drains will flow from north to south and the Branch Drains 1, 2 and 2-1 will connect on to the existing Drain T1, while the Branch Drains 2-2, 2-3, 3 and 3-1 will connect on to a tributary of Tabia River. Since there is nowhere for water from the Branch Drains 2-2, 2-3, 3 and 3-1 to flow into, a connecting waterway will be constructed for the 100 m or so up to the tributary of Tabia River. Where the drains cross the national road, concrete pipes, 450 mm in diameter will be installed as at points where the drains cross the road at present.

(2) Cross-Section of Drains

Fig.3-9 Drainage Canal Network Plan



To enable satisfactory drainage of the fields, the depths of the drains will be no less than 1 m. The volumes of drainage on the drains range between 13.94 P/s and 46.74 P/s. Setting the gradient at 1/500 to 1/3,000 in accordance with the morphology of the ground and the standard cross-section as shown in Figure 3-10, the uniform flow depth will be 0.10 m to 0.25 m, providing sufficient capacity for passage of water.

(3) Ancillary Works

Ancillary works for the drains include outlet works, drops and works for road crossings, whose structures will be as follows.

a) Outlet Works

Outlets works, which have the function, as well as of facilitating outflow of water from the fields, of stopping the water, will be of the same type as the inlet works. The structure is same as Figure 3-7.

b) Drops

Where the elevation of the fields is great, drops will be installed along the direction of the flow in the branch drains. Their structure will be of box types with holes facing the upstream and downstream sides, as with the head works on the irrigation channels. The structure is same as Figure 3-8.

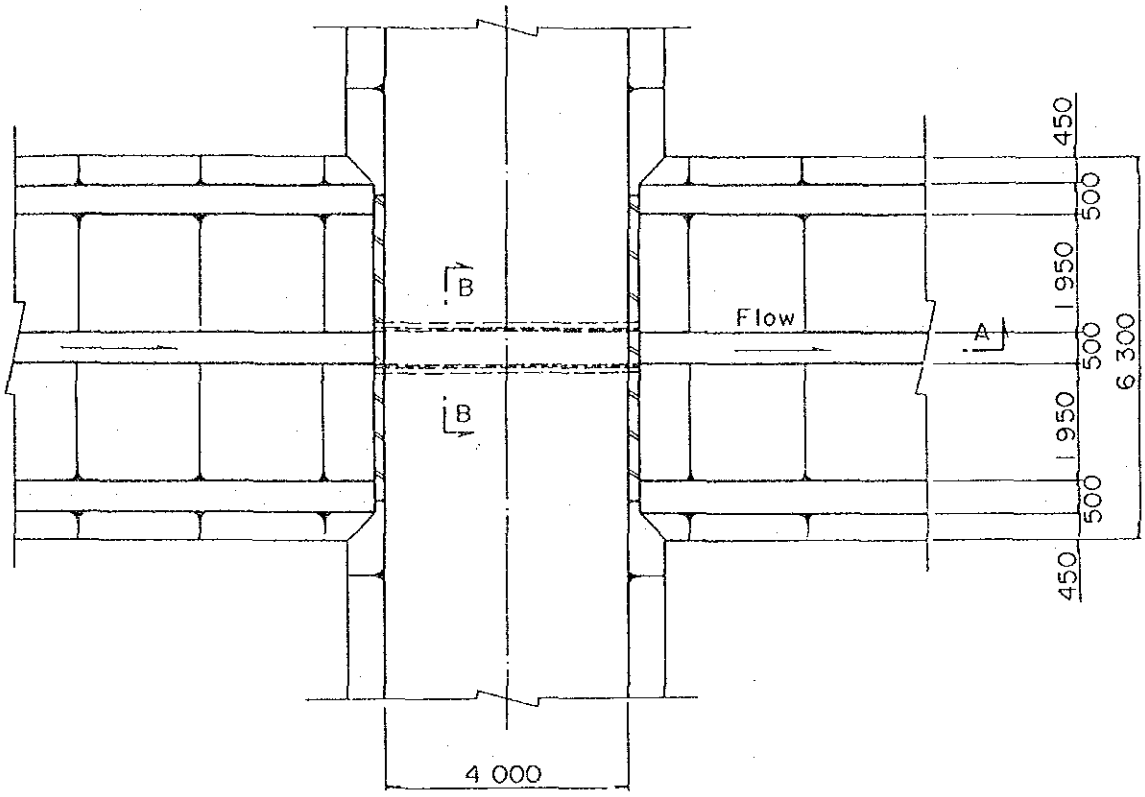
c) Road Crossings

Concrete pipes, 450 mm in diameter, will be installed where the drains cross roads. Retaining walls will be constructed at either end of the pipe and

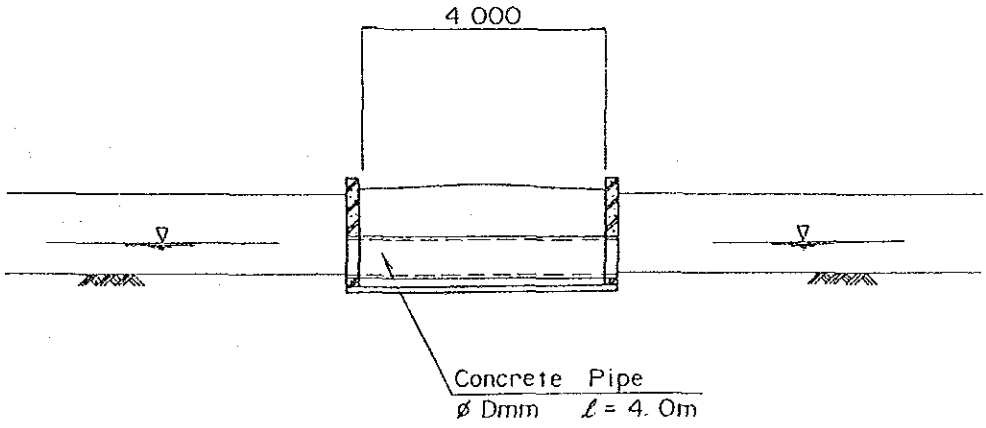
concrete lining will be provided along the connecting waterways for 1 m on either side. A structural drawing is given in Figure 3-11.

Fig.3-11 Road Crossing Work

PLAN



A – A SECTION



3-7 Tabia Head Works Plan

In the alluvial plain along the lower reaches of Tabia River, there are approximately 90 ha on the left bank and 60 ha on the right-hand bank, of cultivated or cultivable land. Only 50 ha of this on the right-hand bank is under cultivation at present. The remaining 100 ha, including the coconut farm on the left bank, can easily be used as paddy fields if irrigation can be secured and much development can be expected of this area.

Either pumps or head works may be used for supply of water to the land on either bank, including the land suitable for rice production, but if pumps were to be used, they would be of a considerable scale requiring much work in construction of facilities for generation of power and in maintenance. Since the use of head works is thought to be of greater advantage in the long run, even if it involves more initial investment, a summary plan for the head works is given here.

Besides the topographical survey, detailed surveys on the soil, water flow and changes in the water level are needed in planning construction of head works. These will need to be implemented after the plan to use head works has been confirmed, before carrying out implementation design.

1. Location of Head Works

Proposed site A was selected from the existing topographical map (1/50,000) and areal photographs, and proposed site B was selected from the field reconnaisance. For these two sites, the drawn up of each summary head wark plans were carried out as follows.

The location of proposed sites were shown in Figure 3-12 and the comparison of two plans was shown in Table 3-1

Fig.3-12 Location Map of Proposed Head Work

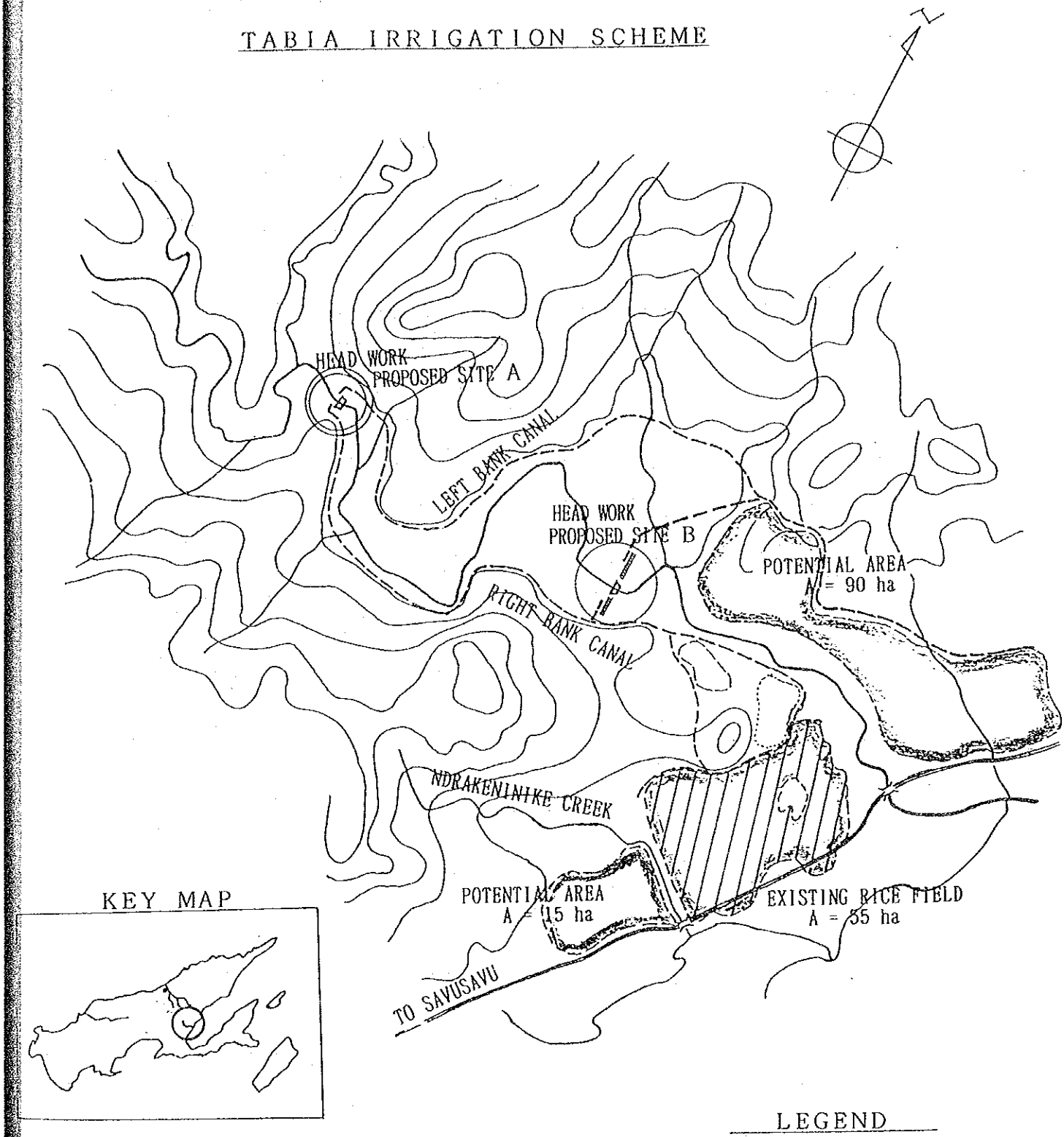


TABLE 3-1 COMPARISON OF HEAD WORK PLAN A AND B

ITEM	PLAN A	PLAN B
HEAD WORK		
- Location	3.0 km upper stream site of Tabia village	1.2 km upper stream site of Tabia village
- Length	B = 15 m	B = 15 m
- Elevation	H = 1.0 m	H = 4.3 m
CONNECTION DIKE		
- Length	—	Left Bank : L = 100 m Right Bank: L = 150 m
- Elevation	—	H = 0 ~ 4.3 m (Ave. 2.2m)
HEAD RACE		
- Length	Left Bank : L = 3.5 km Right Bank: L = 4.1 km	Left Bank : L = 1.7 km Right Bank: L = 2.0 km
ITEM TO BE SURVEYED	- Detailed topograhical Surveying - Route of Road and Canal	- Detailed topographical Surveying - Route of Road and Canal - Borrow-pit for embankment

Others : For the construction cost, road and head race works account for high ratio in Plan A, connection dike cost account for high ratio in Plan B.

Therefore, it is neccessary to carry out the detailed surveying before the detailed design of head work.

2. Outline of Head Work Plan A

1) Elevation of Weir

The elevation of the river bed is calculated as follows from the gradient of the river bed (approx. 1/400).

Relative Elevation : 3,000 m × 1/400 = 7.50 m

Elevation of River Bed : - 0.36 m + 7.50 m = 7.14 m

Plans are made assuming the water depth at drought water level to be 0.10 m and the water level of the river (minimum water level) to be 7.24 m.

The water level required is calculated as follows from the design longitudinal slope of the water channel (1/1,500) and the water level required at the settlement (6.17 m).

Difference Required in Water Head :

3,000 m × 1/1,500 = 2.00 m

Water Level Required : 6.17 m + 2.00 m = 8.17 m

Hence the elevation of the weir -

Elevation of Weir : 8.17 m - 7.24 m = 0.93 m ≒ 1.0 m

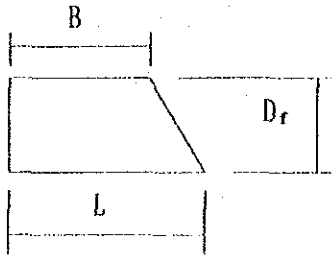
The cross-section of the river at the proposed site has a depth of 2 to 2.5 m and the weir elevation of 1 m is thought not to involve problems. A concrete fixed weir will be used as the weir elevation and the width of the river are small and head works located on both banks on the upstream side of the weir.

2) Cross-Section of Diversion Weir

(1) Shape of Weir

The cross-section is determined using Bligh's equation from the maximum overflow depth of 1.5 m.

$$B = \frac{h1 + hv}{\sqrt{\gamma}}$$



$$L = \frac{Df + h1 + hv}{\sqrt{\gamma}}$$

where,

h1: maximum overflow depth above top of weir = 1.5 m

hv: velocity head (2g/v2) = 0.013 m

Df: weir elevation = 1.0 m

q : specific gravity of weir materials = 2.35 t/m3

$$B = \frac{1.5 + 0.013}{\sqrt{2.35}} = 0.986 \fallingdotseq 1.0 \text{ m}$$

$$L = \frac{1.0 + 1.5 + 0.013}{\sqrt{2.35}} = 1.639 \fallingdotseq 1.7 \text{ m}$$

B and L, however, were set, in the end, at B = 1.164 m and L = 1.864 m

upon investigation on the shape of the downstream side of the weir.

(2) Stability of Weir

α = B/Df = 1.0/1.0 = 1.0 OK

m = L/Df - α = 1.7/1.0 - 1.0 = 0.7 OK

(3) Apron Length

Downstream : $l1 = 0.6 \times C \times \sqrt{D1}$

where,

C : Bligh's C = 9

D1: elevation of top of weir on downstream side

$l1 = 0.6 \times 9 \times \sqrt{1.0} = 5.4$ m

Upstream : l2 = 1.0 m

3) Intake Works

As intake works for water for irrigation on both the left and right banks, pipes with gate will be installed on the upstream side of the weir and these will function as the starting points of the trunk water channels. The pipes will be 0.8 m high, 1.0 m wide and 4.0 m long and a screen and a control gate will be attached to the front of the pipes.

There will be a conversion box at the exit from the pipes which will also function as sedimentation tanks and the trunk water channels for the left and right banks will start here.

Drawings for the head works and intake works described above are given in Figures 3-13 and 3-14.

3. Outline of Head Work Plan B

1) Elevation of Weir

The elevation of the river bed is calculated as follows from the gradient of the river bed (approx. 1/400).

Relative Elevation : 1,200 m × 1/400 = 3.00 m

Elevation of River Bed : - 0.36 m + 3.00 m = 2.64 m

Plans are made assuming the water depth at drought water level to be 0.10 m and the water level of the river (minimum water level) to be 2.74 m.

The water level required is calculated as follows from the design longitudinal slope of the water channel (1/1,500) and the water level required at the settlement (6.17 m).

Difference Required in Water Head :

1,200 m × 1/1,500 = 0.80 m

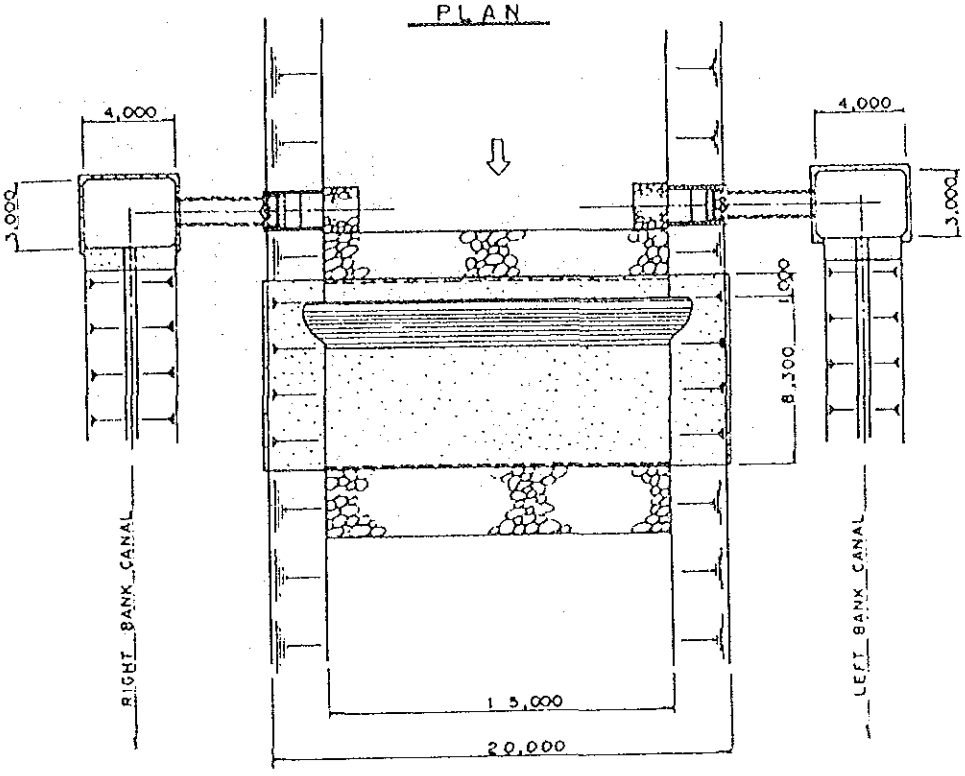
Water Level Required : 6.17 m + 0.80 m = 6.97 m

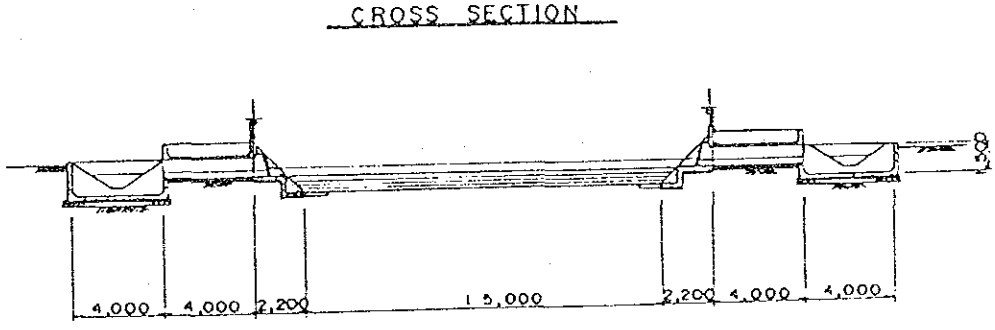
Hence the elevation of the weir -

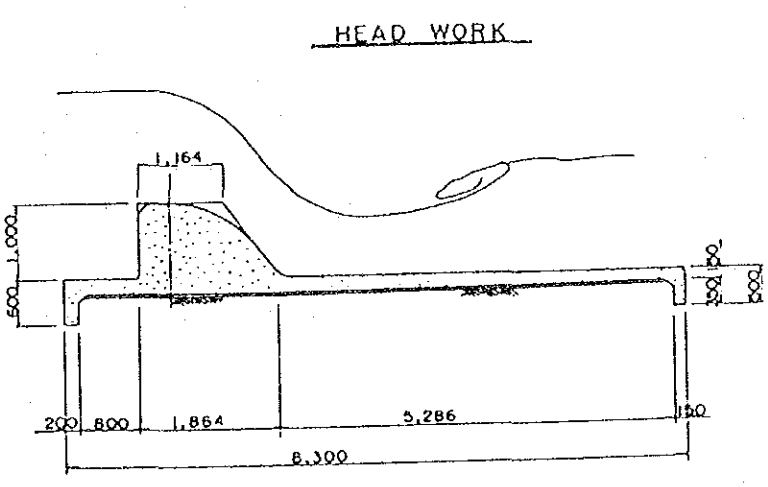
Elevation of Weir : 6.97 m - 2.74 m = 4.23 m ≒ 4.3 m

The cross-section of the river at the proposed site has a depth of 2 to 2.5 m, therefore the weir elevation of 4.3m and earth embankment as connection dike between concrete weir and hill foot of both sites.

Fig.3-13 Head Work Plan







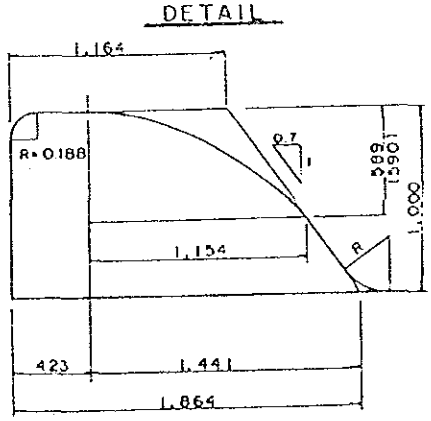
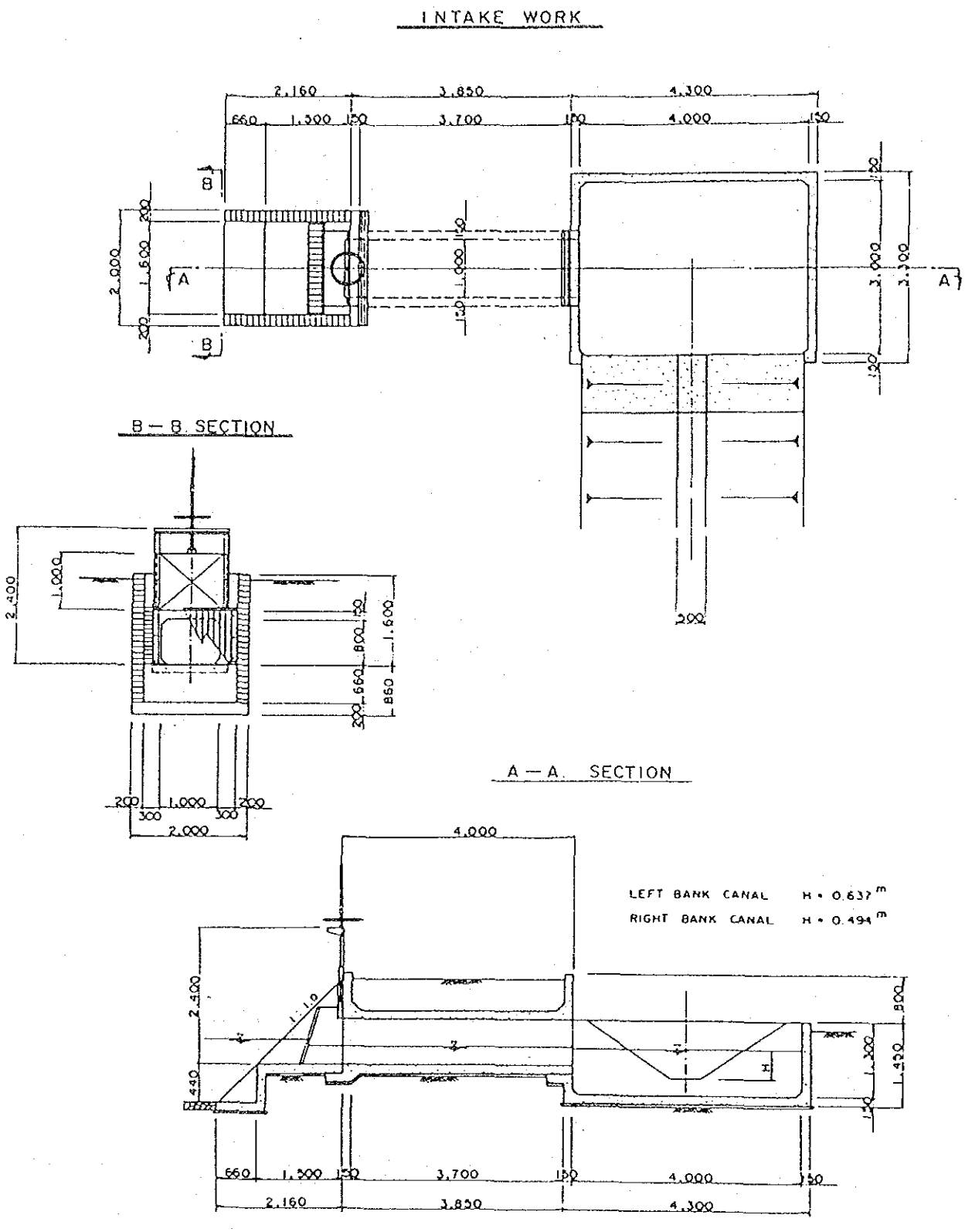


Fig.3-14 Intake Work Plan

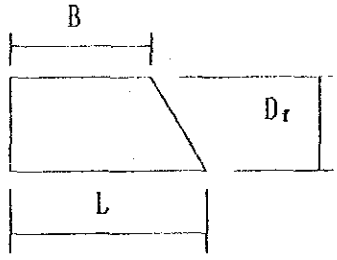


Intake works will be located on both banks on the upstream side of the wier.

2) Cross-Section of Diversion Weir

(1) Shape of Weir

The cross-section is determined using Bligh's equation from the maximum overflow depth of 1.5 m.



$$B = \frac{h1 + hv}{\sqrt{\gamma}}$$

$$L = \frac{Df + h1 + hv}{\sqrt{\gamma}}$$

where,

h1: maximum overflow depth above top of weir = 1.5 m

hv: velocity head (2g/v2) = 0.013 m

Df: weir elevation = 1.0 m

q : specific gravity of weir materials = 2.35 t/m3

$$B = \frac{1.5 + 0.013}{\sqrt{2.35}} = 0.986 \fallingdotseq 1.0 \text{ m}$$

$$L = \frac{4.3 + 1.5 + 0.013}{\sqrt{2.35}} = 3.792 \fallingdotseq 3.8\ m$$

B and L, however, were set, in the end, at B = 3.00 m ,L = 5.40 m and Df = 4.30 m upon investigation on the shape of the downstream side of the weir.

(2) Stability of Weir

α= B/Df = 3.0/4.3 = 0.7 OK

m = L/Df - α = 5.4/4.3 - 0.7 = 0.56 OK

(3) Apron Length

Downstream : l1 = 0.6 × C × $\sqrt{D1}$

where,

C : Bligh's C = 9

D1: elevation of top of weir on downstream side

l1 = 0.6 × 9 × $\sqrt{4.3}$ = 11.198 ≒ 11.50 m

Upstream : l2 = 1.0 m

3) Connection Dike

Aneccessary crest elevation of connection dike is as follows.

(Dike EL) = (Weir Crest EL) + (Overflow Water Depth) + (Clearance)

= EL 2.64 + 4.30m + 0.50m

= EL 7.44m

4) Intake Works

As intake works for water for irrigation on both the left and right banks, pipes with gate will be installed on the upstream side of the weir and these will function as the starting points of the trunk water channels. The pipes will be 0.8 m high, 1.0 m wide and 4.0 m long and a screen and a control gate will be attached to the front of the pipes.

There will be a conversion box at the exit from the pipes which will also function as sedimentation tanks and the trunk water channels for the left and right banks will start here.

Drawings for the head works and intake works described above are omitted dueto same as Plan A

CHAPTER 4

DETAILED DISIGN OF KOROKADI PILOT PROJECT

Chapter 4 Detailed Design of Korokadi Pilot Project

4-1 Physical Condition

1. Topography

Approximately 9 ha of land within the site of the Korokadi Project being implemented in Vua district on the western part of Vanua Levu Island was selected. In this project area, trunk irrigation channels are located on either side of the trunk drain at the centre and the project area as a whole consists of approximately 200 ha of irrigated land, elongated in shape.

2 farm divisions (2 irrigation divisions) on the upstream part of the project area was selected as the site of the pilot farm. The area of the upstream farm division is 4.6 ha and that of the downstream division 4.5 ha, making up a total of 9.1 ha. The land in question slopes down from the trunk irrigation channel side towards the trunk drain and the difference in elevation is approximately 4.5 m, the elevation by the irrigation channel being (+)73 m and that on the side by the drain (+)68.5 m. The slope becomes steep near the irrigation channel. Several branch water channels and drains run vertically through the district, though their routes are unclear, and there are hardly any farm roads within the divisions. The plots vary in size from 1 a to 50 a and their shapes too range from squares to elongated strips. Because the levelling of each plot is inadequate, some parts are not supplied with sufficient water while others are badly drained.

2. Climate

Since there is no observatory at Korokadi, the figures taken at the Dreketi Project Site, 20 km to the east are given for reference.

The average annual rainfall over the past 15 years (1974 to 1988) of 2,162

mm is similar to that at Savusavu. Of this, 1,650 mm, or 76%, fell during the rainy season between November and April and the remaining 512 mm, or 24%, during the dry season between May and October.

The maximum monthly rainfall of 336 mm was observed in January, while the minimum monthly rainfall is that of July at 42 mm. Temperatures and sunshine hours, according to the records of the past 2 years, are as follows. The temperatures are those taken at Labasa.

	Rainy Season (Nov. to Apr.)	Dry Season (May to Oct.)
Average Daily Maximum Temperature	32.4℃ (Feb.)	31.6℃ (May)
Average Daily Minimum Temperature	20.9℃ (Nov.)	17.5℃ (Aug.)
Average Monthly Duration of Sunshine	178 hours (Jan.)	193 hours (Oct.)

3. Soil

According to the results of the soil profile survey by trial excavation, brown latosol continues for over 70 cm from the ground surface in Division A and there was no specific boundary with the surface soil.

In Division B, the latosol is found only in the zone 20 cm or so from the ground surface. Black reduced layer of latosol is found in the zone between 20 cm and 40 cm below ground and clay latosol is to be found below that. In terms of soil layers, Division B is thought to be of better quality.

4. Irrigation Water

The water for irrigation will taken from the trunk irrigation channel as at present. The water in the channel is taken at the head works upstream from the area and there are no problems with regard to its quality and quantity.

5. Drainage

Drainage water from the project area is gathered in the drain running through the low ground at the centre of the area. There are several drains running through the site of the pilot farm and joining the trunk drain at present but these are functionally inadequate.

4-2 Farm Consolidation Plan

1. Land Use Plan

The site of the pilot farm occupies an area of approximately 9 ha, consisting of 2 farm divisions, within the Korokadi Project Site. Although the site is served by trunk irrigation channels and drains, the branch waterways and agricultural roads within the area, as well as the levelling of each plot, are inadequate, hindering access of water to terminal points and satisfactory drainage.

Under the present plan, improvement of the plots, including rectification of plot sizes and levelling and construction and servicing of branch irrigation channels and drains will be implemented.

Land use on the site in question (Divisions A and B) will be as follows.

Paddies	: 8.3 ha
Roads & Waterways	: 0.7 ha
Total	: 9.0 ha

2. Field Lot and Plot Divisions

The site of the pilot farm consists of 2 farm divisions and is of a square shape 350 m to 450 m from north to south and 340 m to 410 m from east to west. For the purpose of servicing with branch waterways and roads, both divisions will be subdivided lengthwise into 4 field lots. These field lots will be named A-1 to 4 and B-1 to 4 and their areas will be as follows.

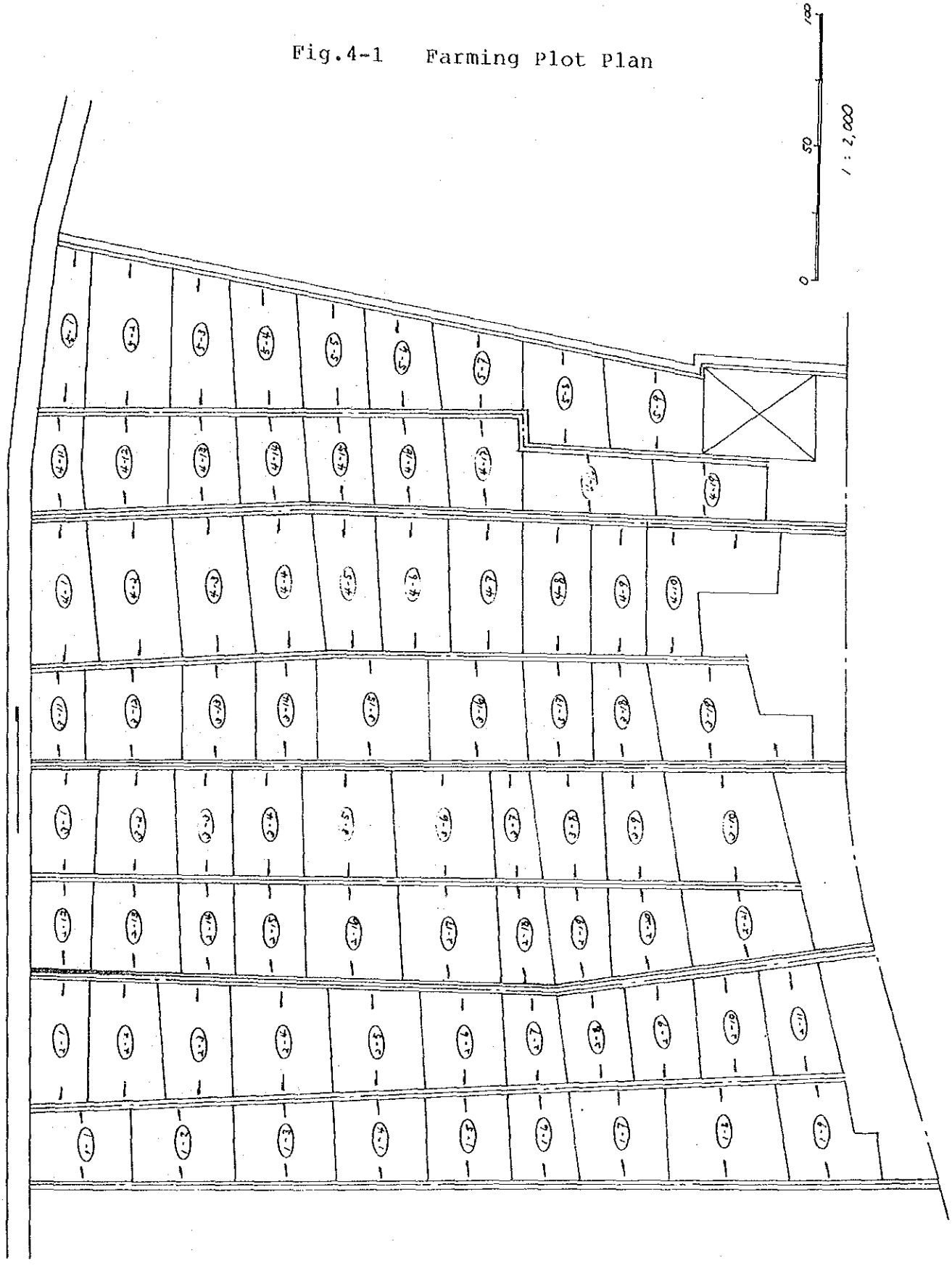
	Area
A-1	1.15 ha
A-2	1.25 ha
A-3	1.04 ha
A-4	1.27 ha
Total A	4.71 ha
B-1	1.13 ha
B-2	1.45 ha
B-3	0.91 ha
B-4	1.20 ha
Total B	4.69 ha

As regards the size of each plot, because of the large slope, there will be a maximum of 2 to 3 plots, taking account of the difference in the elevation of the field lots. Each plot will be of approximately 10 ha near the trunk irrigation channels where the slope is steep and 12 to 13 ha making maximum use of the levee boundaries in parts near the drains where the slope is gentler.

Division of the field lots and plots is shown in Figure 4-1.

3. Field Creation

Fig.4-1 Farming Plot Plan



(1) Elevation of Fields

As a principle, the ground within each lot will be maintained level and the plots will become lower as one goes from the trunk irrigation channel in the east towards the trunk drain in the west.

(2) Design Elevation

The design elevations adjustments through cutting and banking will be carried out between the plots. The elevation of the ground will be made to be about 10 cm above the elevation of bed of irrigation channels and 50 cm above the bed of the drains.

(3) Soil Surface Treatment

Since, according to the results of the soil profile survey, there are no soil layers that can be distinguished from the surface layer in Division A, no treatment of the soil surface will be carried out. As the surface soil goes down to approximately 20 cm below ground in Division B, soil surface will be treated here when cutting and banking are carried out.

(4) Soil Transportation

In principle, the ground within each plot will be made level. Where soil needs to be transported from one plot to another, combinations that will minimise the distance over which soil is transported will be used.

(5) Design for Ancillary Works

Ancillary works will include those for the banking of the levees and the access roads. The structures of these will be as shown in Figure 4-2.

4-3 Road Plan

1. Road Network

A trunk road runs along the trunk waterways within the site of the pilot farm but access roads to the fields within the farm are inadequate. Under the project, roads will be constructed at the centre and at both ends of Division A and at the centre and at the northern end of Division B to facilitate access to each of the fields and enable passage of agricultural machinery and vehicles for transportation of the produce. The road network plan will be as shown in Fig.4-3.

2. Road Structure

(1) Widths

The roads will be designed to allow passage of medium-sized tractors and 2 ton lorries for purposes of transporting agricultural machinery and produce.

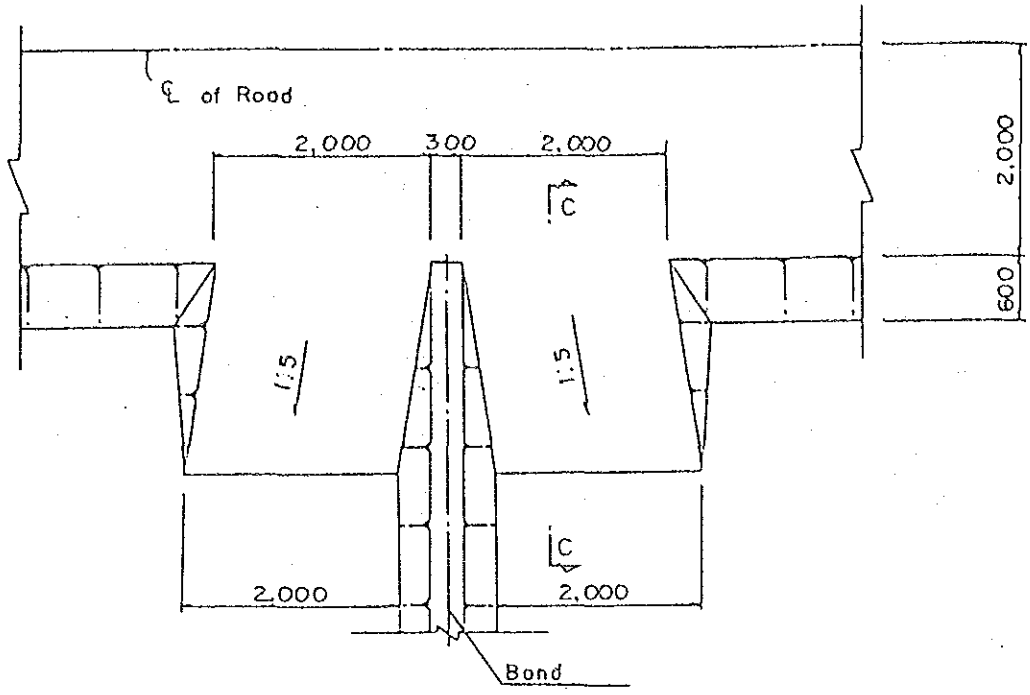
The design widths are as follows.

Effective Width	: 3.0 m
Width of Shoulder	: 0.5 m
Total Width	: 4.0 m

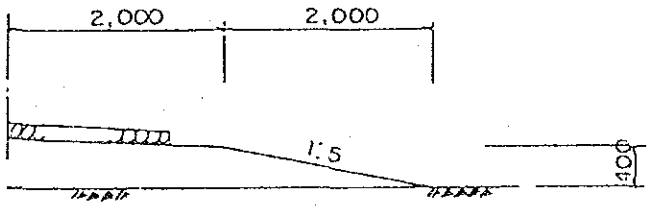
(2) Road Structure

The roads will be raised 40 cm or more above the level of the fields and the

Fig.4-2 Related Facilities Plan



C-C SECTION
S=1/50



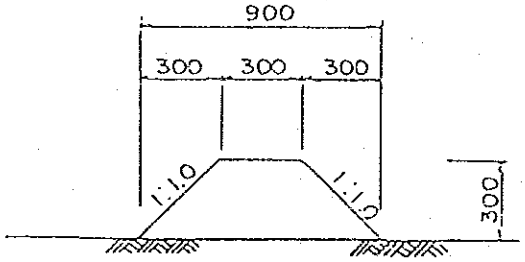
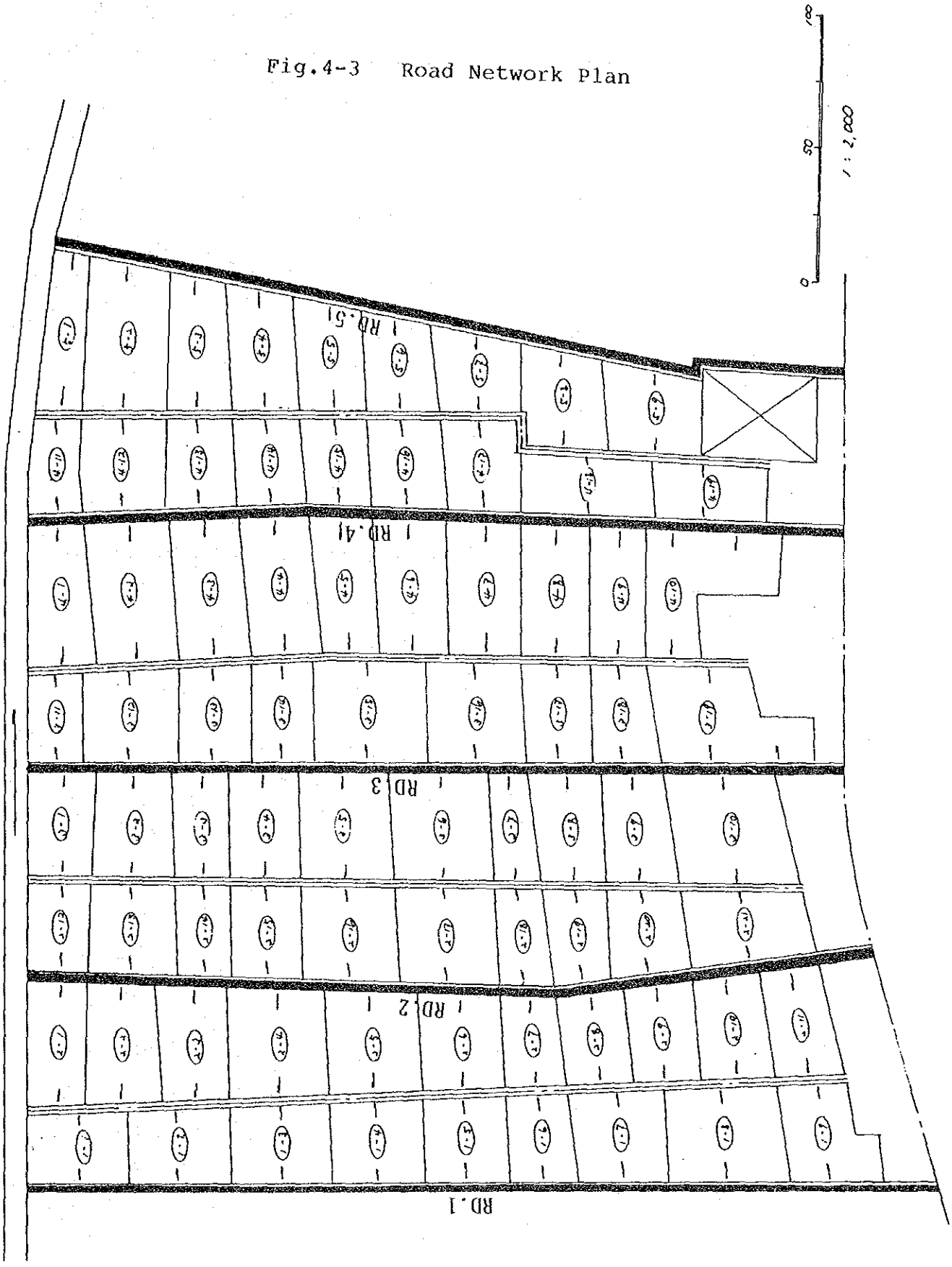


Fig.4-3 Road Network Plan



surface soil cut in creation of the fields will be used in the construction of the roads. The gradient of the embankment will be 1:10 and the part within the effective width will be paved with gravel to a depth of 10 cm.

The gradient of the road will be kept below 8% and the crossfall below 5%.

The road structure is shown in Figure 4-4.

4-4 Irrigation Plan

1. Quantity of Irrigation Water

(1) Volume of Water Required

The daily water consumption of 20 mm derived from the field survey was used in calculations.

(2) Irrigation Canal Network

The irrigation canal network plan will be as shown in Figure 4-5.

2. Water Channels

(1) Types of Channels

According to the soil survey, the soil in the area is of latosol type. In view of this and taking account of the past example in the construction of the trunk irrigation channel, the side slope of the channels will be 1:1.0. The vertical gradient will be set at 1/1,000 to 1/3,000 with the purpose also of retaining water within the channels.

(2) Cross-Section of Channels

Fig.4-4 Typical Road Section

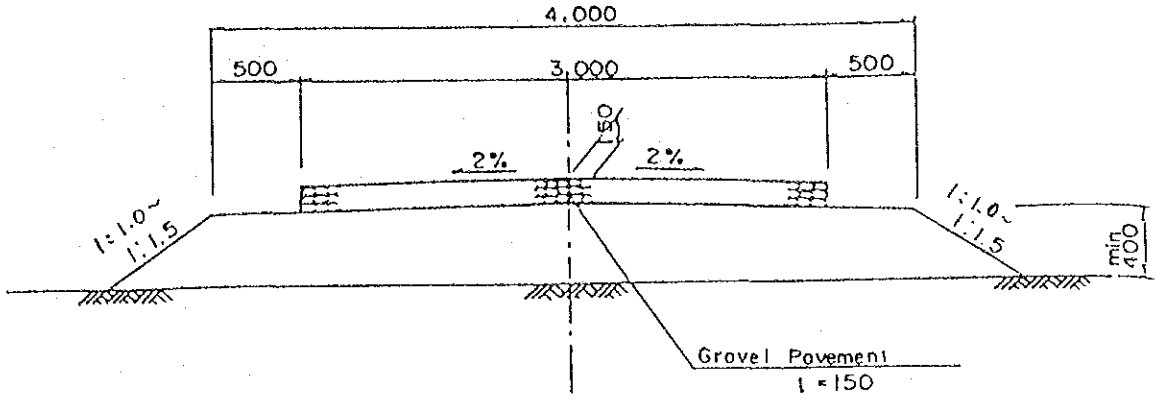


Fig.4-6 Typical Irrigation Canal Section

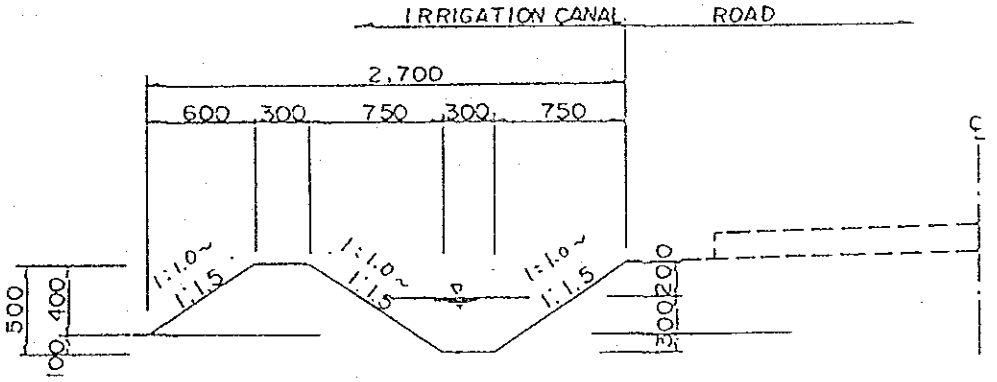


Fig.4-10 Typical Drainage Canal Section

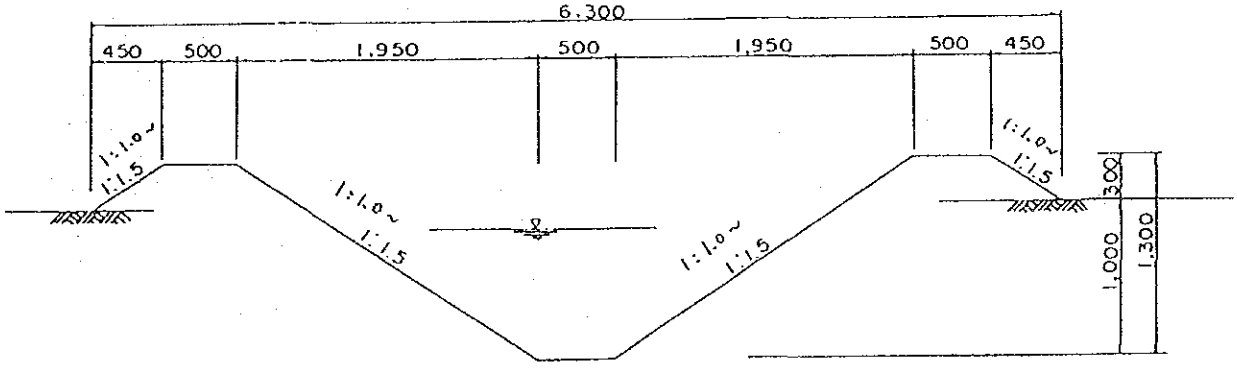
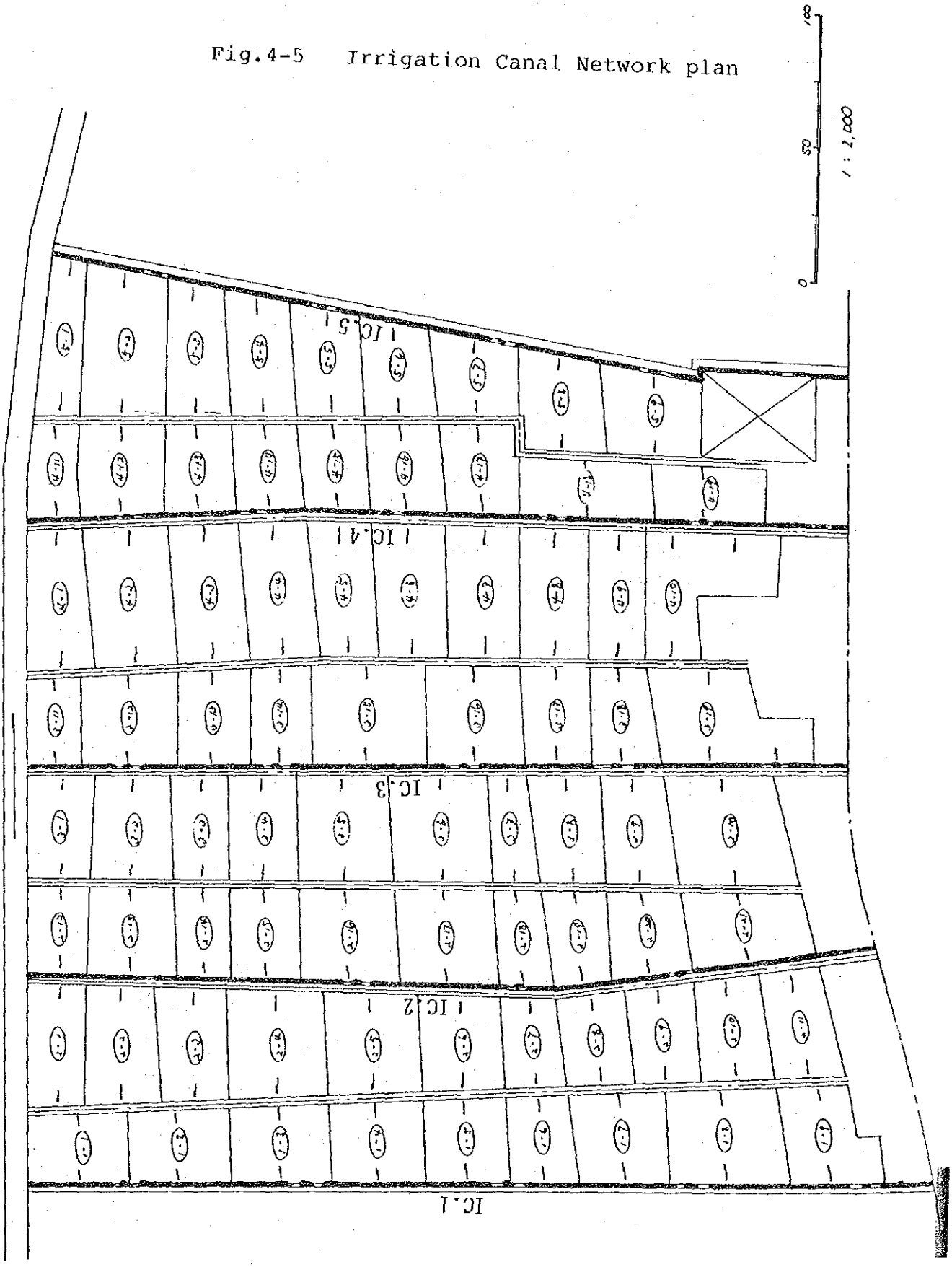


Fig.4-5 Irrigation Canal Network plan



Although the quantities of water passing through the channels will be between 2.3 l/s and 5.4 l/s channels will be designed to allow these quantities to allow for irrigation efficiency.

Since the total length of below 500 m is small, the channel section will be given uniform cross-sections throughout.

In the hydraulic investigation, the value given for the maximum passage of water was 32 l/s, with Manning's coefficient of roughness at n = 0.030 and with the standard cross-section of the channels as shown in Figure 4-6, satisfying the requirements for passage of water in each of the channels.

(3) Ancillary Works

Ancillary works for the water channels include inlets to each of the fields and drops. The structures for each of these will be as follows.

a) Inlet Works

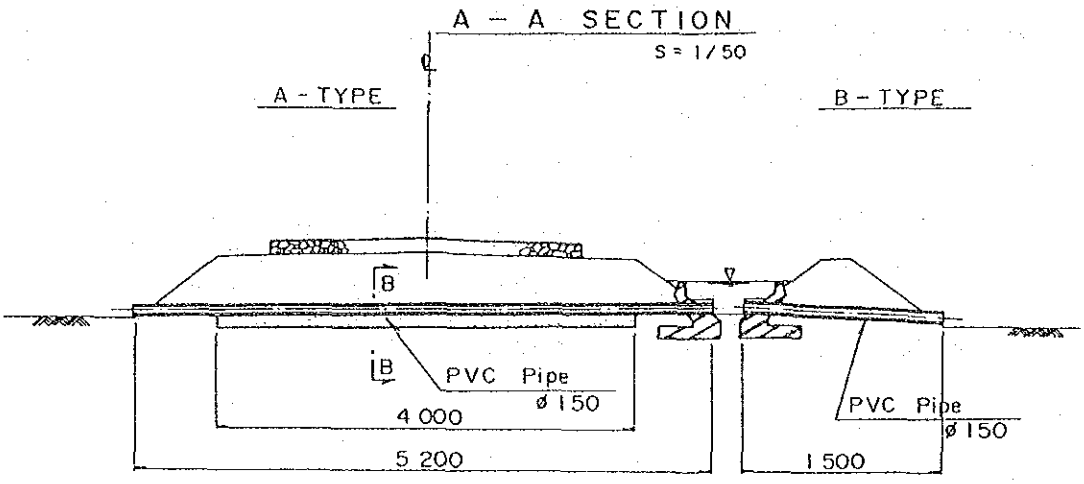
The inlets into each of the fields will be of the type as shown in Figure 4-7, in order to allow for facility in distributing water to the fields and to avoid causing hindrance to maintenance work.

b) Drops

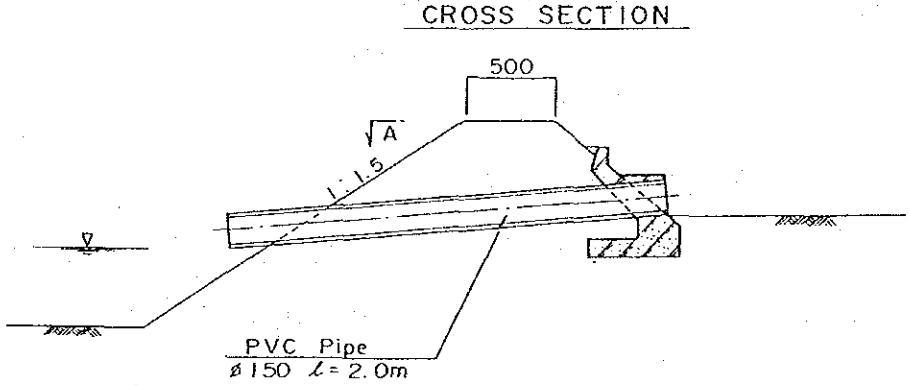
Drops will be installed where the elevation of the ground in the fields drop greatly in the direction of flow in the water channels. The works will be of a box structure with openings on the upstream and downstream sides, both connecting on to the waterways. The standard structural plan of the drops is given in Figure 4-8.

Fig.4-7 Inlet, Outlet Work Plan

INLET WORK



OUTLET WORK



INLET, OUTLET WALL

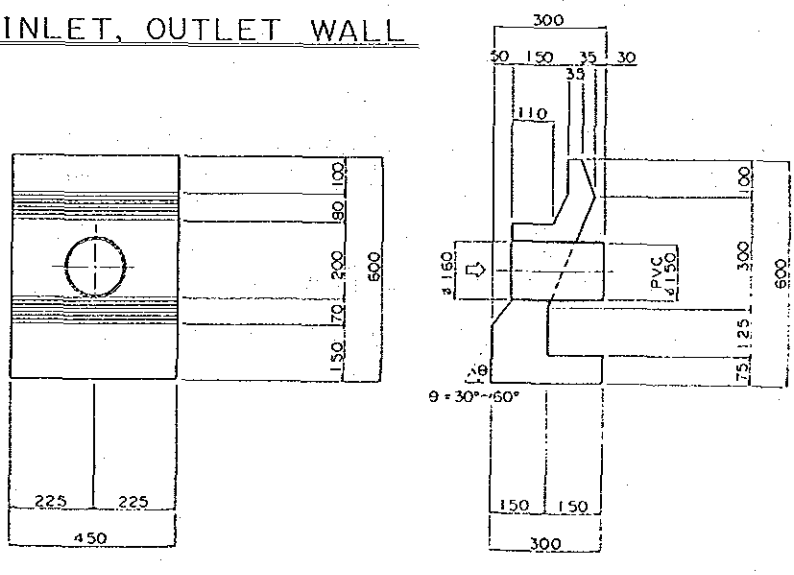
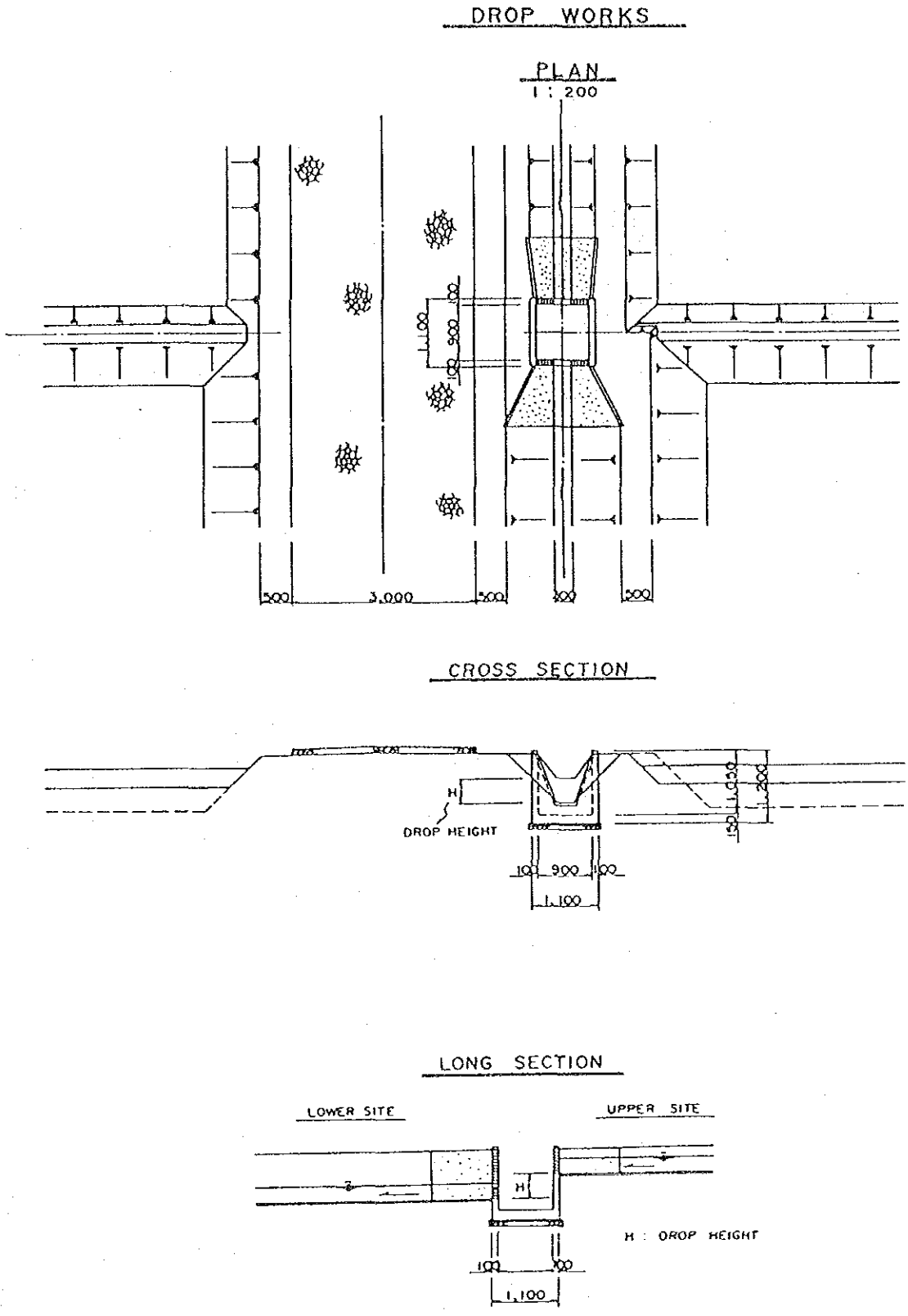


Fig.4-8 Drop Work Plan



4-5 Drainage Plan

1. Drains

(1) Unit Volume of Drainage

The standard unit volume in Fiji for drainage of q = 12 P/s/ha will be used.

(2) Drainage Canal Network

The drainage canal network plan will be as shown in Figure 4-9.

2. Drains

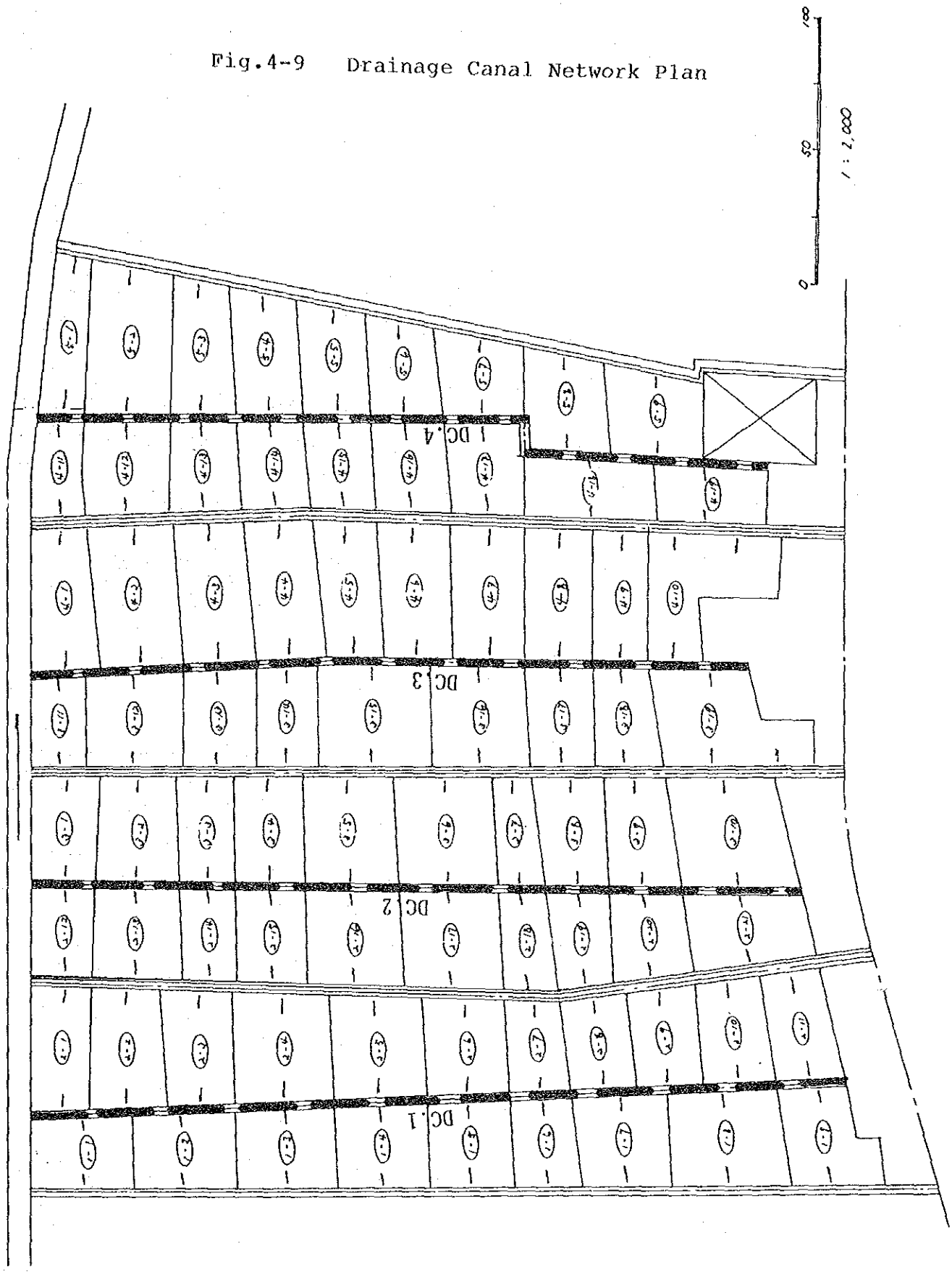
(1) Type of Drains

The drains will be made of soil. Taking account of the type of soil at the site and existing waterways, the side slope of 1:1.0 will be adopted. Their depths will be over 1 m to allow for morphological conditions and reformation of the fields into well-drained paddies.

(2) Cross-Section of Drains

The volumes of drainage on the drains range between 23.4 l/s and 30.2 l/s. Setting the gradient at 1/500 to 1/3,000 in accordance with the morphology of the ground and the standard cross-section as shown in Figure 4-10, the uniform flow depth was 0.10m to 0.25m, providing sufficient capacity for passage of water.

Fig.4-9 Drainage Canal Network Plan



(3) Ancillary Works

a) Outlet Works

Outlet works which control drainage from each of the fields, need not only to facilitate outflow of water from the fields but also to have the function of stopping the water. They will be of the same type as the inlet works. The standard drawing is as given in Figure 4-7.

b) Drops

Where the difference in elevation of the fields is great, drops will be installed along the direction of the flow in the branch drains. Their structure will be the same as that on the irrigation branch lines. The standard drawing is the same as that given in Figure 4-8.