4-2-3 Water Resources

(1) Obtainable Amount of Water Resources

Water from the Chongwe river or the Kanakantapa River are the available sources of irrigation water for the training farm. There is a dam downstream of a planned water intake point in the Chongwe River. To take irrigation water from the river careful consideration shall be given not to interfere with the present water right.

At the planned water intake point the river has surface flow even during dry seasons making a reservoir facility unnecessary. On the other hand, the surface flow of the Kanakantapa River disappears during dry seasons and it would be necessary to construct a reservoir facility to take water from this river.

1) Obtainable Amount of Water from the Chongwe River

Based on the discharge record measured at the discharge gauging station location downstream of the dam, the discharge at the planned intake point was estimated according to the ratio of the catchment basin. The results are listed in the following table:

Table 4.2.1 Discharge at Planned Water Intake Point

	Discharge at Gauging Station	Discharge at Planned Water Intake Point
Annual Average Discharge	691,000 m^3/day (8.00 m^3/s)	441,000 m^3/day (5.10 m^3/s)
Annual Average Droughty Discharge	21,000 m^3/day (0.24 m^3/s)	13,000 m^3/day (0.15 m^3/s)
Droughty Discharge for 5 Year Return Period	7,000 m^3/day (0.08 m^3/s)	5,000 m^3/day (0.05 m^3/s)

As the result of the above analyses, the obtainable amount of water was determined as the droughty discharge for 5 year return period $Q = 0.05\ m^3/s$.

2) Obtainable Amount of Water from the Kanakantapa River

Judging from the topography and river channel condition at the planned water intake point, it will be possible to obtain approximately 6 m of the reservoir depth and some 260,000 m^3 of the reservoir volume.

An existing problem is the large amount of sediment material. During the period of farmland development in the resettlement area, approximately 110,000 m^3 per year of sediment inflow is estimated. Thus, the reservoir will be filled with sediment in less than 3 years. Even after completing the farmland development 60,000 m^3/year of sediment inflow is estimated. If a dam is constructed at this point, repeated dredging work would be required to maintain the reservoir. It would be virtually impossible to continue the maintenance work.

In addition to the above, hydrological data of the river has been recorded, making it extremely difficult to estimate the river's flood discharge needed for dam design.

For the above reasons, it would be quite risky and unrealistic to chose the Kanakantapa River for training farm's water source.

(2) Unit Irrigation Requirement

1) Evapotranspiration of Related Crops (ETo)

Evapotranspiration (ETo) of related crops was obtained by using the commonly used Penman Method and the Pan Method (see Table 4.2.2).

Table 4.2.2 *Evapotranspiration of Related Crops, ETo (mm/day)*

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
By Penman Method	3.98	4.93	5.84	6.64	6.25	3.62	3.43	4.42	4.19	4.86	9.72	3.83
By Pan Method	4.65	5.18	6.02	6.09	5.93	4.16	4.58	4.00	4.80	4.88	5.18	4.80
Average Value	4.31	5.05	5.93	6.37	6.09	3.89	4.00	4.21	4.47	4.87	4.45	4.31

(Calculation Method: FAO Irrigation and Drainage Paper 24)

The average values of the methods were adopted for the planned values.

2) Crop Evapotranspiration (ET crop)

Crop evapotranspiration (ET crop) was obtained by multiplying crop coefficient (kc) to ETo value:

ET crop = kc X ETo (mm/day)

Table 4.2.3 Crop Coefficient (kc)

	Growing Stage			
Name of Crop	i	ii	iii	iv
Tomato	0.40	0.75	1.05	0.50
Cabbage	0.40	0.83	0.95	0.80
Onion	0.40	0.83	0.95	0.80
Sunflower	0.35	0.70	1.05	0.40
Maize	0.35	0.70	1.05	0.55
Soy Bean	0.35	0.73	1.10	0.45

ET crop for each cropping pattern was obtained as follows:

First Year (ET crop)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Block 1:		Tomato								Sunflower		
	1.95	2.87	4.12	4.37	5.30	6.23	4.30	--	1.39	3.00	4.42	4.26
Block 2:					Cabbage				Soy Bean			
	--	2.16	3.94	4.09	4.80	5.63	6.05	2.13	3.74	4.08	4.42	4.69
Block 3:			Onion						Maize			
	--	2.15	3.94	4.09	4.80	5.63	6.05	2.13	3.74	4.08	4.42	4.69
Average (mm/day)	0.65	1.67	2.69	3.41	4.57	5.79	5.23	1.52	3.04	3.83	4.49	4.14

Second Year (ET crop)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Block 1:			Onion							Maize		
	--	2.15	3.94	4.09	4.80	5.63	--	--	1.36	3.85	4.30	4.69
Block 2:	Tomato									Sunflower		
	1.95	2.87	4.12	4.37	5.30	6.23	4.30	--	1.39	3.00	4.42	4.26
Block 3:					Cabbage					Soy Bean		
	1.95	1.78	--	1.75	3.61	5.52	5.34	4.87	1.56	4.10	4.63	4.92
Average (mm/day)	1.30	2.26	2.69	3.41	4.57	5.79	3.21	1.62	1.44	3.65	4.45	4.62

Third Year (ET crop)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Block 1:					Cabbage					Soy Bean		
	5.11	1.78	--	1.75	3.61	5.52	5.34	--	1.56	4.10	4.63	4.92
Block 2:			Onion						Maize			
	1.95	2.87	4.12	4.37	5.30	6.23	4.30	--	1.39	3.00	4.42	4.26
Block 3:		Tomato								Sunflower		
	3.77	1.78	2.78	4.12	5.12	6.23	6.69	--	1.39	3.00	4.42	4.26
Average (mm/day)	3.82	1.90	2.24	3.32	4.51	5.79	4.01	0.71	2.23	3.72	4.49	4.62

For each year, the maximum crop evapotranspiration is 5.79 mm/day occurring during September.

3) Effective Rainfall

Monthly average rainfall and monthly effective rainfall for 5 year return period at Kasisi Mission Observation Station are as follows:

(Unit: mm/month)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Monthly Average Rainfall	0.0	0.0	1.3	14.7	71.5	154.5	189.1	141.3	79.8	25.8	1.4	0.0	680.3
Monthly Effective Rainfall	0.0	0.0	1.3	14.3	64.2	102.4	104.6	99.0	70.3	24.5	1.4	0.0	481.9

70% of the total rainfall is expected to be effective rainfall.

4) Irrigation Efficiency (Ep)

Irrigation efficiency Ep can be expressed by the following equation:

$$Ep = Ea \times Eb \times Ec$$

where, Ec: water-conveyance efficiency (the ratio of water flowing from the intake facility. Ec = 0.95 for pipe intake.)

Eb: channel efficiency (the ratio of water delivered by a distribution system to the water introduced into the distribution system. Eb = 0.85 for a lined channel.)

Ea: application efficiency (the ratio of irrigated water to water distributed to the farm. Ea = 0.65 for furrow irrigation)

Thus, Ep was calculated as follows:

$$Ep = 0.95 \times 0.85 \times 0.65 = 0.52$$

5) Unit Irrigation Water Requirement

Unit irrigation water requirement can be obtained by the following equation:

Unit Irrigation water Requirement = (Crops' Evapotranspiration - Effective Rainfall)/Irrigation Efficiency

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Unit Irrigation Requirement (mm/d)	5.78	3.57	4.30	6.39	8.67	11.06	6.82	--	--	0.68	1.84	4.59
(l/s/ha)	0.67	0.41	0.50	0.74	1.00	1.28	0.79	--	--	0.08	0.21	0.52

According to the above results, no irrigation will be required during a November through December period. However, irrigation will be necessary during a January through March period in spite of the rainy season.

The maximum unit irrigation requirement will occur during September. Its value is 1.28 litres/s/ha.

6) Irrigation Area Plan

According to the analyzed possible intake water (50 litres/s) from the Chongwe River and the maximum unit irrigation requirement of 1.28 litres/s/ha, the irrigable areas was calculated as 39 ha.

Instead of taking all of the possible intake water (droughty discharge for 5 year return period), it was decided upon to take 80% of it. As a result, it is planned to irrigate 30 ha (50 x 0.8 ÷ 1.28 = 31 ha).

4-2-4 Building Facilities

After holding a series of discussions related to the Government of Zambia's request with officials concerned of the Government and after examining the necessary facilities for the Project, the Project's building facility plan was prepared.

(1) Design Condition

1) Management Facilities

Necessary management facilities for the Project include a management building, lodging facility for experts and instructors, and a water supply facility.

The design of these facilities is to be made based on the following number of facility users:

Number of Staff Members:		14
Manager:	1	
Accountant:	1	
Farming Experts:	4	
Machinery Operators:	4	
Repair Mechanics:	2	
Farming Instructors:	2	
Labourers:		20 to 60

2) Loging House

Two exparts and one instructor will use the loging house.

3) Garages for Agricultural Machinery and Vehicles

The sizes of garages for agricultural machinery and vehicles to be provided shall be decided upon based on the number of machines and vehicles that need to be stored indoors.

4) Workshop

A storage space for parts and an office are to be built in the workshop. Two repair mechanics will be stationed there.

5) Warehouse

A grain storage and a fertilizer and agricultural medicine storage are to be built in the warehouse. Grain harvested at the training farm will be stored until it is to be marketed. An open shed for sorting and drying farm products is to be constructed.

6) Mill Houses

The mill houses are workshops containing maize mills. Three maize mills will be installed in the Project Area and two mill house will be constructed.

(2) Examination of the Size of Each Facility

The size of each Project facility shall be decided upon by taking into consideration the Government of Zambia's request, Zambian design standards, and Japanese design standards.

Office Space:	4.0 m^2/person
Experts' Office:	6.0 m^2/person
Manager's Room:	16.0 m^2/person
Meeting Room:	2.0 m^2/person
Janitor's Room:	9.0 m^2/person
Lavatory:	2 unit
Dining Room:	1.5 m^2/person

1) Management Building

Room	Basis of Floor Space Calculation	Planned Space(m^2)
Mancger's Room	Including desk and stock space	16.0
Office	4 Clerks + 4/2 Operators	
	6 x 4	25.0
Exparts' Office	3 Exparts x 6.0	18.0
Meeting Room	12 parsons x 2.0	25.0
Janitor's Room	9 x 2.0	17.0
Corridor, Hall,		
Lavatory, Others		57.0
Free Purpose Area		36.0
Total		196.0

2) Loging House

Bedroom	16 m^2 x 3	= 48.0 (m^2)
Washroom	6 x 3	= 18.0
Dining Room	20 parson x 1.5 m^2/parson	
	+ kichin	= 36.0
Corridor		= 30.0
Total		132.0

3) Garage for Agricultural Machinery and Vehicles

The machinery and vehicles to be provided can be classified into those for land reclamation and those for managing and operating the training farm. No garage will be provided for the bulldozers and motor grader that will be used for land reclamation.

Dimensions and number of machines and vehicles are as follows:

Equipment Name	Dimensions Length & Width (mm)	Number of Units	Remarks
For Land Clearing:			
Bulldozer	7,300 x 5,300	2	No Garage
Motor Grader	8,300 x 3,700	1	No Garage
Vibrating Roller	5,200 x 2,300	1	
Backhoe	7,200 x 2,500	1	
Sprinkler Truck	8,200 x 2,500	1	
For Traing Farm Ops			
Wheel Tractor	3,500 x 1,900	2	
Disc Harrow	1,700 x 2,400	2	
Disc Plough	2,100 x 1,000	2	
Chisel Plough	800 x 1,800	2	
Planter	800 x 1,800	2	
Trailer	4,900 x 2,200	2	
Truck (6-ton)	8,000 x 2,300	1	
Pickup Truck	4,500 x 1,700	1	
Bicycle		30	

Garages shall be designed based on the above equipment units and vehicles.

4) Workshop

By taking into consideration the number of agricultural machinery units and the Zambian standard design plan, the repair work space, parts and tool storage space, and office space shall be 180 m^2, 30 m^2, and 15 m^2 respectively.

5) Warehouse

A grain storage and a fertilizer and agricultural medicine storage shall be built in one building. The types of grain to be stored include maize, sunflower seeds, ground nuts, and soy beans. However, the seize of the warehouse shall be decided upon based on maize, the staple crop in the Project Area.

By presuming that one half of the maize produced on 30 ha of farmland is to be stored, the required storage spaced was calculated as follows:

30 ha x 2 tons/ha x 1/2 = 30 tons

Since one bag of maize weights 90 kg, the number of bags are:

30 x 1,000 x 1/90 = 333 bags

By placing 8 bags in one block, each block will have 5 stacks of bags as shown Fig. 4.2.1.

A fertilizer and agricultural medicine storage shall be wide enough to store 13,250 kg of fertilizer for dry season use.

By assuming that fertilizer is packed in 50 kg bags, the required space for storage will be as shown in Fig. 4.2.2. No special storage will be provided for agricultural medicine which will be placed in locked boxes.

6) Mill Houses

The overall dimensions of each maize mill unit are

2,100 mm (width) x 3,000 mm (length) x 1,835 mm (height)

The size of the mill house shall be planned to accommodate a maize mill unit and sufficient working space.

7) Pump House

Room	Area Plan
Pump room 2 unit of Pump	22.5 m^2
Instrument room	10.0 m^2
Working space	12.5 m^2
Total	45.0 m^2

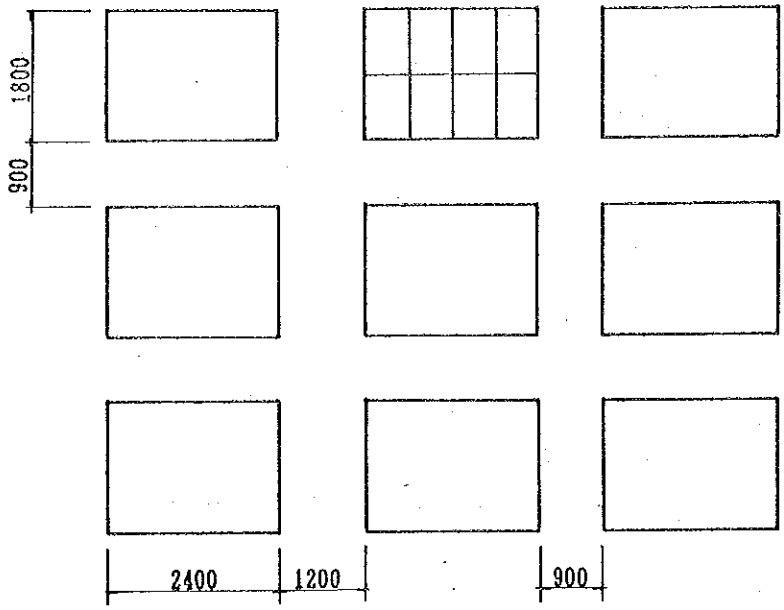


Fig. 4.2.1 Grain Bag Stacking

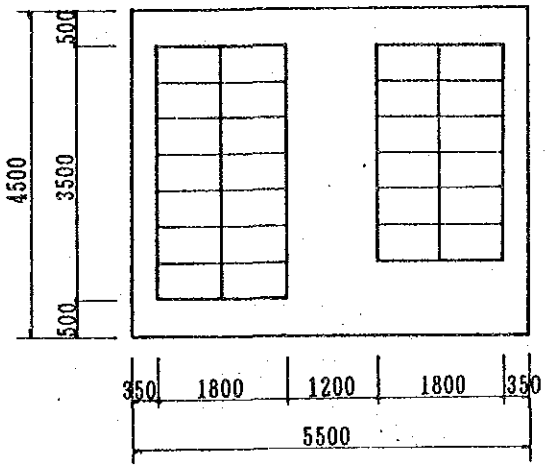


Fig. 4.2.2 Fertilerzer Bag Stacking

4-3 Basic Plan

4-3-1 Site and Layout Plan

The Project consists of constructing an access road, a training farm (including an irrigation system), and building facilities.

The arrangement of these facilities was decided upon based on field investigations and the area topography. In particular, the following aspects were carefully examined for preparing the arrangement plan:

(1) For selecting the route of an access road, a new road construction section is to be as short as possible and the road route is to be easily usable by nearby villagers.

(2) For selecting the training farm site, the area shall have suitable soil, it shall be close to the resettlement area, and water and electricity shall be easily obtainable.

(3) For selecting the locations of building facilities, the locations shall be convenient for managing and operating the training farm. Each building shall be so arranged that it will have sufficient space (as indicated in the design criteria) and can provide adequate working conditions.

The planned facility arrangement is shown in Basic Design Drawings.

4-3-2 Road Facility

The road standard was selected by forecasting the traffic volume and by examining the road maintenance agency's capacity and the area's future road network improvement plan.

(1) Traffic Volume Forecast

1) Traffic Volume Forecast

The movement of 800 settler families (approximately 10,000 people), shipping of farm products yielded from 3,200 ha of the settlers' farmland, and the movement of 100 families (approximately 1,000 people) who reside along the road outside the

area and the farm products yielded by their 1,400 ha of farmland were examined.

1. Traffic Volume Caused by the Movement of Settler Families;

   By assuming that each of the 10,000 residents will travel to Lusaka or a nearby village for shopping or personal business once a month, the total number of people travelling during one year will be:

   10,000 x 12 = 120,000 persons/year

   If they use buses having 50 seats, the number of buses will be:

   120,000 x 2 ÷ 50 = 4,800/year

2. Traffic Volume Caused by Shipping of Farm Products Yielded from 3,200 ha of Settlers' Farmland:

   By assuming that 1,100 ha of the 3,200 ha of land is used for growing maize and 2,100 ha is for cash crops, the following harvest may be expected:

Maize:	1,100 ha x 2.5 tons/ha =	2,700 tons
Cash Crops:	2,100 ha x 10.3 tons/ha =	21,360 tons
	TOTAL	24,110 tons

   One settler will consume 225 kg of maize; total consumption will be 2,250 tons. The remaining farm products (24,110 - 2,250 = 21,860 tons) will be shipped out of the area for marketing. If 6-ton trucks are used for shipping, the total number of trucks will be:

   21,860 ÷ 6 = 3,643

   For round trips:

   3,643 x 2 = 7,286/year

3. Traffic Volume Caused by Transporting Farming Materials into the Project Area:

   By assuming that seeds, fertilizer, and other farming materials represent 10% of the harvest amount, the number of trucks required will be

   7,286 x 0.1 = 728/year

4. Traffic Volume Caused by the Movement of People Residing Outside of the Project Area:

   If 1,000 people living in Kumpuln Village and along the access road outside of the project area travel to Lusaka for shipping or personal business once a month by buses having 50 seats, the number of buses will be:

   1,000 x 12 x 2 ÷ 50 = 480/year

5. Traffic Volume Caused by Shipping Farm Products Yielded Outside of the Project Area:

   By assuming that 1,400 ha of farm land existing along the access road outside of the project area will grow maize and that the maize will be shipped to Lusaka for sale, the number of trucks needed for shipping will be as follows:

   1,400 ha x 2.5 tons/ha = 3,500 tons
   3,500 tons ÷ 6 tons x 2 (round trip) = 1,167/year

6. Traffic Volume Caused by Transporting Farming Materials into the Area Along the Access Road Outside of the Project Area:

   By assuming that seeds, fertilizer, and other farming materials to be transported represent 10% of the harvest in the area, the number of trucks required will be:

   3,500 x 0.1 x 2 ÷ 6 = 117/year

As the result of the above calculations, the total number of 6-ton trucks and 50 seat buses that will use the access road will be as follows:

4,800 + 7,286 + 728 +480 + 1,167 + 117 = 14,587/year
14,587 ÷ 365 = 39 vehicles/day

2) Traffic Network Plan

The Department of Resettlement places the access road as the arterial road connecting the Project Area and Lusaka and expects to start bus services in the future.

To entrust the road's management and maintenance work to the Public Works Department of the Lusaka District, the agency responsible for rural roads, is being taken under consideration.

3) Standards for the Access Road

For selecting the standards for the access road, the estimated traffic volume and area conditions, the Japanese road structure standards were examined.

According to the present Japanese road structure standards, the construction of a road having a carriageway of less than 5.0 m is permitted in special cases only if the daily traffic volume on the road is less than 500 cars in a sparsely populated rural area and if the traffic volume is not expected to increase in the future. When the standard was initially established, the carriageways of rural roads in flat areas were to be 5.5 m wide to allow two-way vehicle passing (see Table 4.3.1). On the other hand, Zambian road standards specify that roads having daily traffic volumes of from 20 to 50 cars are to have gravel pavement.

In Zambia, all of the land is owned by the Government. Thus, if a notice of road construction is given to farmers prior to the harvest season, the Government can procure the land after the harvest and commence the construction work. The farmers are not required to be compensated for the land.

Table 4.3.1 Road Width

Class	Geographical feature	Traffic volume in unit section (vehicles/day)			Width (m)
		A < 10 %	10 % ≦ A < 40 %	A > 40 %	
I	Plain	～ 5500	～ 4000	～ 2500	7
		5500～ 7500	4000～ 6500	2500～ 5000	9
		7500～11000	6500～10000	5000～ 7500	11
		11000～18000	10000～15000	7500～11000	14
		9000×(N-1)～N			7×N
	Mountainnous direct	～ 3000	～ 2000	～ 1500	6
		3000～ 4500	2000～ 3500	1500～ 2000	7.5
		4500～ 6000	3500～ 5000	2000～ 4000	9
		6000～12000	5000～10000	4000～ 7000	12
		6000×(N-1)～N			6×N
II	Plain	～ 4500	～ 4000	～ 2500	6.5
		4500～ 6000	4000～ 6500	2500～ 5000	7.5
		6000～ 7500	6500～10000	5000～ 7500	9
		11000～18000	10000～15000	7500～11000	11
		9000×(N-1)～N			5.5×N
	Mountainnous direct	～ 3000	～ 3000	～ 2000	5.5
		3000～ 4500	3000～ 4000	2000～ 2500	6.5
		4500～ 7500	4000～ 6500	2500～ 5000	7.5
		7500～11000	6500～10000	5000～ 7500	9
		11000～18000	10000～15000	7500～11000	11
		6000×(N-1)～N			
III	Plain	～ 3000	～ 2000	～ 1500	5.5
		3000～ 4500	2000～ 3000	1500～ 2500	6.5
		4500～ 6000	3000～ 4000	2500～ 5500	7.5
		6000～ 8000	4000～ 7000	5500～ 8000	9
		8000～13000	7000～11000		11
	Mountainnous direct	～ 1500	～ 1200	～ 900	5.5
		1500～ 2500	1200～ 2000	900～ 1500	6.5
		2500～ 3500	2000～ 2500	1500～ 2000	7.5
		3500～ 5500	2500～ 4500	2000～ 4000	9
		5500～10000	4500～ 8500	4000～ 6500	11
IV		～ 5500	～ 4000	～ 2500	6.5
		5500～ 8500	4000～ 5000	2500～ 3500	7.5
		8500～12000	5000～ 8500	3500～ 6000	9
		12000～16000	8500～12000	6000～ 9000	11
		16000～20000	12000～14000	9000～12000	13
		20000～24000	14000～18000	12000～14000	16
		10000×(N-1)～N			6.5×N
V		～ 3000	～ 2000	～ 1500	5.5
		3000～ 5500	2000～ 4000	1500～ 2500	6.5
		5500～ 8500	4000～ 5000	2500～ 3500	7.5
		8500～12000	5000～ 8500	3500～ 6000	9
		12000～16000	8500～12000	6000～ 9000	11

Table 4.3.2 Design of Speeds, Road Width & Gradients

ROAD CLASSIFICATION		Class I Bituminous			Class II Gravel	Class III Gravel
		A	B	C		
Average daily traffic estimated for nine year after construction(ADT)		1,500 to 5,000	500 to 1,500	Up to 500	Up to 150	20 to 50
Width of surfaced carriage-way (metres)		7.30	6.70	6.10	Min 6.10	Min 5.50
Shoulder widths (metres)		3	2-3	2	2	1
Flat Topography	Design Speed km/h	100	100	100	80-100	60-80
	Limiting Grade %	4	5	6	6	8
Rolling to Rolling to Hilly Topography	Design Speed km/h	100	80-100	80	60-80	50-60
	Limiting Grade %	6	6	7	8	10
	Maxinum length of lmiting Grade metres	220	220	180	150	N.A.
untain-s pography	Design Speed km/h	80	60-80	60	50-60	30-50
	Limiting Grade %	7	8	8	10	12
	Maxinum length of lmiting Grade metres	180	150	150	150	N.A.

Note: 1. Where difficulty is encountered in obtaining length of limiting grade less than the maximum length stated in Table 5.3.3 , reference should be made to the Director of Works(Road).

2. Shoulder widths for Class IB roads should be chosen according to traffic needs and economics.

Table 4.3.3 Road Classification

CLASS	Formation Width at Finished Surface Level Metres	Carriageway Width Metres	Type of Surgface
CLASS 1A	13.30	7.30	Bituminous
CLASS 1B	10.70 to 12.70 According to Traffic needs	6.70	Bituminous
CLASS 1C	10.10	6.10	Bituminous
CLASS II	10.10	Min 5.50	Gravel
CLASSIII	7.50	Min 5.50	Gravel where necessary for all weather standard
UNCLASSIFIED	Cleared and stumpt track of 5.50 minimum width and Skeleton Drainage		Earth with 3.50 metre gravel surface where essential

Note:When , in rare exceptional cases, the limits imposed by economic and traffic needs call for a bituminous surface d of a geometric and / or structural standard lower than Class IC , it shall be classified as Class ID.

By taking into account the above conditions, it was decided upon to adopt Zambian road standard Class III. The specifications for the Project's road construction are as follows:

- New construction section: 4.3 km; Section to be improved: 6.2 km
- Formation: 7.5 m (5.5 m carriageway with 1.0 m shoulder on both sides)
- Gravel pavement
- Crossfall: 5%

(2) Chongew River Bridge

The Chongwe River's catchment area at the bridge construction site is approximately 1,700 km^2. The river's annual average discharge at this point is estimated as 4.7 m^3/s; its average discharge during a January through March period (the rainy season) is form 20 to 30 m^3/s. The maximum discharge during the past 17 years is estimated as being approximately 450 m^3/s. It is believed that the river stage rose about 6m above the riverbed.

Since the bridge will be the most important facility for gaining access to the Project Area and for maintaining the flow of traffic during the rainy season, it was decided upon to build the bridge as a first class simple-beam type.

Design Load: T20
Bridge Length: 72 m (24 m x 3 spans)
Effective Width: 4 m

(3) Kanakantapa River Submersible Bridge

The Kanakantapa River's catchment area at the submersible bridge construction site is approximately 440 km2. The river's annual average discharge is 3.1 m3/s. But, the surface flow disappears during the dry season. The river's average discharge during a January through

March period is estimated to be 9.7 to 18.2 m3/s. The average flood discharge is estimated to be 48 m3/s.

The submersible bridge will be a major transportation point in the Resettlement Area. Since the river's discharge is small, the submersible bridge shall be a quadruple box culvert (1.5 m x 3.5 m).

Design Load:	T20
Bridge Length;	14.5 m
Effective Width:	5.0 m

4-3-3 Training Farm

After land reclamation, the training farm (30 ha) shall be divided into 50 m x 100 m lots. On their long-chord sides, gated pipes for furrow irrigation shall be installed. For the furrow irrigation, each lot of land shall have a 1/100 slope on its width direction.

The farm roads and drainage shall be arranged at 100 m interval respectively.

By taking into consideration the irrigation plan, the training farm is to be largely divided into three blocks. Irrigation will be rotated to each block. The arrangement of the farm blocks, roads, and channels is shown in Basic Design Drawings.

4-3-4 Irrigation Facilities

(1) Water Intake Facility Plan

1) Water Intake Method and Intake Point

As the elevation of the training farm is approximately 40 m higher than the Chongwe River's low water level, pump intake is required. To allow stable intake during the dry season, a weir shall be constructed.

The Chongwe River's water contains a large amount of sand particles. Thus, the sand shall be removed before delivering the water to the farm by constructing a settling basin. In general, a settling basin is located in the immediate vicinity of the water intake point. However, due to the topographical condition of the intake site, it is extremely difficult to construct a settling basin close to the intake point. For this reason, it is planned to locate the basin at a point slightly more distant from the intake point and pump the river water into it. After the sand particles settle in the basin, water will be delivered to the farm with the use of pumps.

In the Chongwe River there are tow alternative water intake points: one at the planned access road crossing point; the other at the nearest point to the training farm. These two points are approximately 2 km apart. The former point is about 2.6 km away from the training farm; the latter point is about 1.7 km away. The latter point requires a short water conveyance distance. However, that point is located in the wide flood plain of the river and extensive river improvement work would be required to construct an intake facility there.

For the sake of management and maintenance of the water conveying pipeline and power lines for the intake facility, a point closer to a road would be more favourable.

For the above reason, the former point was selected for the water intake facility construction site.

2) Diversion Weir

To prevent sand particles from flowing into the intake pump and causing frequent pump shutdowns, the intake mouth should be in a sufficient depth of water. According to the pump capacity and the pump's suction level, it is necessary to dam up the river water 1.0 m. Thus, it would be sufficient to construct a weir only in the low water section of the river. Stop logs shall be built in the weir to flush out the sediment deposit. The logs shall be removed during

the rainy season and shall be reinstalled when the river stage becomes low during the dry season.

3) Intake Pump

For a short pump operating period, 24-hour continuous operation would be economical. However, since the dry season is quite long, a shutdown period will be provided. Thus, the maximum possible water intake amount form the river will be entirely drown during a continuous pump operating period per day.

The river's maximum possible intake amount is 50 litres/s and the required amount of irrigation water is 40 litres/s. Accordingly, the required pump operating hours per day will be:

$$24 \text{ hr} \times \frac{40}{50} = 19.2 \text{ hours}$$

Specifications for the intake pumps are as follows:

Type: Lift-type submersible sewage pump (removable pump)

Pumping Capacity: 1.5 m^3/min x 2 units = 3.0 m^3/min
(Two units will be installed for diversification of risks)

Suction Pipe:	Diameter		200 mm
	Total length:		80 m
Lift:			11 m
Actual Lift:			7 m
Suction Elevation:		EL	988 m
Discharge Elevation:		EL	995 m
Friction Head Loss in Discharge Pipe:			0.9 m
Friction Head Loss in Pump's Section and Discharge Pipes:			2.0 m
Other Friction Head Loss:			1.1 m
Discharge Pipe Diameter:			100 mm
Power:			11 kw/unit

4) Settling Basin

Dimensions of the settling basin shall be as follows:

$$L = K \times Q/(B/Vg)$$

where, L = settling basin length(m)
K = safety factor, 1.5 to 2.0
Q = design flow of settling basin (0.05 m^3/s)
B = settling basin width (3.0 m)
Vg = 0.01 m/s for particle diameter of 0.2 mm

Thus,

$$L = (1.5 \text{ to } 2.0) \times 0.05/3.0 \times 0.01$$
$$\fallingdotseq 3.0 \text{ to } 5.0 \text{ m}$$

However, considering the portion of mixing particle in the peak being assumed 0.5%, the settling basin length is decided 20 m (effective settling length) for the volume of two days sedimentation.

Settled sand will be flushed out through an open channel into the Chongwe River.

5) Delivery Pump

Delivery pumps will be installed at the settling basin. Specifications for the delivery pumps are as follows:

Type: Centrifugal
Pumping Capacity: 1.5 m^3/s x 2 units = 3.0 m^3/s
(Two units will be installed for diversification of risks)

Lift:		54 m
Actual Lift:	EL	39 m
Suction Elevation:	EL	994 m
Discharge Elevation:	EL	1033 m
Friction Head Loss in Discharge Pipe:		10.9 m
Friction Head Loss in Pump's Section and Discharge Pipes:		2.9 m
Other Friction Head Loss:		1.2 m

Diameter: Suction: 125 mm, Discharge: 100 mm
Power: 30 kw/unit

6) Water Conveyance Pipeline

Specifications for the pipeline from the settling basin to the farm pond shall be as follows:

Discharge: Q = 50 litres/s (= 0.05m^3/s)

Length: 2,500 m

Elevation Difference: h = 36.7 m

Installation Method: Buried (in soil bed)

Diameter: d = 250 mm
(d = 250 mm was selected by taking into consideration the flow velocities, V = 1.59 m/s in d = 200 mm pipe, and V = 1.02 m/s in d = 250 mm pipe)

Flow velocity: V = 1.02 m/s

Water Pressure in Pipe: Max. 10.8 kg/cm^2

Discharge Head at Farm Point
(Remaining Pressure Head): 3.3 m

Pipe Type: Ductile iron pipe
(For pipe pressure requirement, polyvinyl chloride pipe, ductile iron pipe or steel pipe would be usable. In view of their prices, safety factors, and bearing ground condition, ductile iron pipe is selected)

7) Farm Pond

The farm pond functions to adjust the time and quantitative differences between water being delivered to the farm and water being used at the farm.

The farm pond is to be constructed at the highest elevation point within the training farm. Water from the pond will be distributed to the farm by gravity.

Since the water intake pump's daily operating time is 19 hours and farm irrigation time is 10 hours a day, the capacity of the farm pond shall be 0.05 x (19 - 10) x 3,600 = 1,620 m^3. Including the freeboard and dead water allowance, the total pond's wall height is to be 3.5 m. The dimensions of the pond will be 25 m x 25 m. The pond should be made of reinforced concrete.

(2) Irrigation Plan

1) Irrigation Method

Furrow irrigation is to be adopted for the following reasons:

1. The farmland is comparatively flat, has sandy roam soil and a small water intake rate. Thus, furrow irrigation is suitable for the farmland.

2. Sprinkler irrigation requires high facility cost and high management and maintenance costs.

In the furrow irrigation method, water is distributed into furrows trenched between crops and then infiltrates into the crops' root zone. Therefore, the farmland surface shall be carefully finished with a uniform slope.

Irrigation water will be distributed from the farm pond to the farmland through a buried 200 mm diameter pipe.

A 150 mm aluminum gated pipe will be installed at the upstream side of each farmland to control the irrigation water in accordance with the irrigation plan.

Required pressure for the gated pipe is 2.0 m.

However, Sprinkler irrigation system will be installed for experimentation of cash crop.

2) Irrigation Interval

When the average soil moisture within limited soil layers decreases from the field capacity to the moisture that inhibits plant growth, the total moisture consumed by the plant within the soil layers is called the "total readily available moisture" (TRAM).

A design irrigation interval can be obtained by dividing TRAM by the design water requirement.

The amount of water for one-time irrigation application can be obtained by multiplying the daily water requirement to the irrigation interval.

From the results of soil examination, the soil of the training farm may be estimated as sandy rome. Considering the soil condition and proposed crops irrigation interval is estimated as follows.

Crop	Tomato	Onion	Cabbage
* Readily Available Moisture (mm/m)	60	35	65
* Rooting Depth (m)	0.7	0.5	0.5
TRAM (mm)	42.0	17.5	32.5
Water Requirement (mm/day)	6.23	4.80	5.52
Irrigation Interval (day)	6	3	5
Dayly Irrigation Area (ha)	2.0	3.5	2.0
Irrigation Water Amount for 1 time (mm)	37.4	14.8	27.6

Note * Source Crop Water Requirement
(FAO IRRIGATION AND DRAINAGE PAPER 24)

3) Irrigation Rotation Block

Each rotation block is 10 ha and will be irrigated at 3 - 6 day intervals.

4) Irrigation Area

Within one rotation block, the irrigated area per day is 2.0 - 3.5 ha and the irrigation block is 0.5 ha. The one-time irrigation application area within the block is 0.1 ha. In the entire training farm, the daily irrigated area is 15 irrigation blocks and the area being irrigated is 7.5 ha/day.

Irrigation area for respective crop area shown below:

	Tomato	Onion	Cabbage	Total
Irrigation area for day (ha)	2.0	3.5	2.0	7.5
Number of irrigation block	4	7	4	15
Irrigated area for one time(ha)	0.4	0.7	0.4	1.5

5) Irrigating Time

The duration of the irrigation will be 2 hours. There will be a total of 10 hours per day.

6) Water Distribution Plan

Topographically, open channel is not feasible for distributing water from the farm pond to each farm block. Thus, the pipe distribution system is adopted.

1. Maximum Discharge

Since there will be 10 irrigation hours per day, the peak discharge should be as follows:

$$Q = 1.28 \text{ litres/s/ha} \times 30 \text{ ha} \times (24 \text{ hr}/10 \text{ hr})$$
$$= 92.2 \text{ litres/s}$$

2. Pipe Arrangement

As a general rule, one pipe is to be installed for every 4 irrigation blocks of farmland. Pipes shall be installed belong the new farm roads that are to be constructed. Gated pipes for applying water will be installed at 100 m intervals.

3. Pipe Type and Diameter

Pipe diameters were decided as follows by calculating the necessary diameters to have a minimum head of 2 m at the supply points:

- 250 mm diameter pipe: 170 m
- 200 mm diameter pipe: 1950 m
- 150 mm diameter pipe: 480 m

It was decided upon to use polyvinyl chloride pipes because they are the most economical for the above pipe diameters.

7) Sprinkler Irrigation System for Experimentation

Sprinkler irrigation system is installed for experimentation of vegetables. As water delivery system is pressure piping system, this system must be separate from the water distribution system for fallow irrigation. Non-fixed type sprinkler is applied and 0.5 ha of farm land must be irrigated for one day. As 6 days of irrigation interval can be expected, the sprinkler irrigation system shall be installed for 3.0 ha of farm land where are the nearest lots to administration center.

1. Delivery Pump

The potable pump is applied and water is supplied from farm pond.

Maximum Discharge	: 0.21 m^3/min
Total Head	: 33 m
Diameter	: ϕ40 mm
Motor Power	: 3.7 kw

2. Delivery System

Polyvinyl chloride pipe	: ϕ65 mm, 600 m (approx.)
Distribution valve	: 6 unit
Blow off	: 1 unit

3. Sprinkler Set

One sprinkler set is composed of 8 sprinkler for one line (100m)and 3 line is irrigated fro one day.

Sprinkler	: 8 unit (middle pressure)
Aluminum pipe	: 23 unit

(2) On-farm Road

The width of on-farm road is designed with consideration of safety passing of tractor and other vehicles as shown in following equation.

Effective width (Tractor x 2 + Passing space) + the shoulders
= (2.0 x 2 + 0.5) + 0.5 x 2 = 5.5 m

Other dimensions are as follows.

Total Length :	7.9 km
Gravel Pavement:	t = 10 cm
Sectional Slope:	6.0%

(3) Drainage Plan

The direct run-off from rainfall with be stored temporary in the farm land and will be drained. As vegetable for sale will be cultivated, the inundation which is 30 cm or more, for 4 hr or more, caused by maximum 24 hours rainfall for 5 year return period, must not be allowed. the drainage canal is installed on west side of farm lot, and two outlet will be constructed for every 1 ha of farm land. The peak run-off discharge for each farm lot (0.5 ha) can be calculated using following equations.

$Q = F \times I \times A/3.6$

Where Q: Peak Run-off Discharge (m3/s)
F: Run-off Coefficient (0.8)
I : Rainfall Intensity (mm/hr)
A : Catchment Area (0.005 ha)

$I = R/24 \times (24/T)^{n}$

Where R : Maximum 24-hour Rainfall (mm)
T: Duration Time (hr)
n : Coefficient (2/3)

$t = C \times A^{(0.22)} \times (F \times I)^{(-0.35)}$

Where t : Duration Time (min)
C: coefficient (100)

Using 78.1 mm/day which is the maximum 24-hour rainfall for 5 year return period, the results are below:

Rainfall Intensity	I = 122.0 (mm/hr)
Duration Time	T = 0.105 (hr)
Peak Run-off discharge	Q = 0.136

The drainage discharge from farm land to drainage canal can be calculated using following equation.

$Qi = 1.70 \times b \times h^{(3/2)}$

Where Qi: Drainage Discharge (m^3/s)
b: Width of flow (1 m)
H: Depth of Inundation (m)

Using the peak run-off discharge, duration time and this equation, the result are below:

Peak Drainage Discharge Qi = 0.0066 (m^{33}/s)
Maximum Depth of Inundation H = 9.7 (mm)
Inundation Period over 5 mm : 27 (min)

As there are 10 outlet for one drainage line, the design drainage discharge is 0.066m^3/s. Considering the soil material (sandy loam), the maximum design velocity must be less than 0.90 m/s.
Dimensions are summarized as below:

Coefficient of Roughness :0.04
Bottom Width : 0.30 m
Sectional Slope :1/1.0
Longitudinal Slope : 1/50 (Existing land slope)
Disign Depth : 0.18 m
Design Velocity : 1.653 m/s
Free Board : 0.05d + hv + (0.05 to 0.15 < 0.10 m
(d: Water depth, hv: Velocity head)
The height of drainage canal is 0.3m including free board.

- Total length 3.4 km
- Related structure: Outlet 60 unit
Crossing culvert 31 unit (ϕ500 concrete pipe)

4-3-5 Building Facilities

(1) Site and Arrangement Plan

By taking into account easy management of the Project's building facilities, and area adjacent to the training farm was selected as the site for the buildings.

The management building is arranged facing the entrance of the site. The warehouse is arranged to the right of the management building. The garage for agricultural machinery and vehicles and the workshop building are arranged behind the management building.

To allow a smooth vehicle flow, an estate road is planned to circle around the management building and the parking lot. An entrance to the training farm is also planned.

(2) Floor Plan

1) Management Building

In the management building there will be a manger's room, an office, a experts' office, a meeting room, a janitor's room, and a common use hall which will be used by staff members and farm workers.

2) Garage for Agricultural Machinery and Vehicles

Agricultural machinery units and vehicles can be classified into those for land reclamation and those for training farm use. The garage is planned only for the machinery units and vehicles that require shelter. Garage is planned for large machinery and vehicles (9.0 m long). The entrance widths of the garage is planned to be 4.0 m respectively.

3) Workshop

The workshop will have an office, parts storage, repair space, assembling space, and tire repair space. An open floor (no roof) is also planned for tire repair work.

4) Warehouse

The warehouse will have a grain storage and a fertilizer and agricultural medicine storage. These storage spaces are arranged in one building by dividing it with a wall.

The grain storage is planned to have sufficient space to store one half of the maize that will be harvested at the training farm. Rat-proofing measures are also planned for the grain storage space.

The fertilizer and agricultural medicine storage is planned to have sufficient space for keeping the amount of fertilizer that will be used during the dry season.

5) Mill Houses

Each mill house is planned to be 6.0 m x 4.0 m.

6) Yard Plan

The estate road is planned to be gravel pavement. Kerbstones will be installed at the sides of the road.

Lights will be installed within the site for security purposes.

(3) Section Plan

The height of each building roof was decided upon by taking into consideration the heights of the machinery and vehicles and the required working space.

Building opening sizes were determined by considering natural lighting and natural ventilation.

Roofs are planned to have sufficient slopes to handle concentrated rainfall during the rainy season.

(4) Structural Plan

1) Design Policy

The structure type generally used in Zambia and the building type that is easy to construct were adopted for the design of building facilities.

2) Ground

Soil at the facility construction site is laterite type sandy loam. It is well compacted and can have a bearing strength of 10 tons/m^2. For safety purposes it was decided upon to adopt 6 tons/m^2 as the allowable design load.

3) Structure design

Mat foundations, a direct foundation type, were adopted. Reinforced concrete-block structure types having light-weight steel frame roofs will be used for the management building, workshop, and mill houses. Warehouses having large spans were designed as reinforced concrete structures with lightweight steel truss roofs.

As the British Standards (BS) are generally used in Zambia, the following standards were adopted for facility design:

- Fixed Load and Live Load : BS 63999PART I
- Wind Load : BS CP3 CHAPTER V
- Reinforced Concrete Block Structure : Japanese Arhitectural Standard Specification
- Reinforced Concrete Structure : Japanese Arhitectural Standard Specification

The following loads were adopted :

- Fixed Load : Reinforced concrete : 2.4 tons/m^3
  Reinforced concrete block : 2.0 tons/m^3
- Live Load :
  Office Floor : 225 kg/m^2
  Dining Room : 225 kg/m^2
  Meeting Room : 306 kg/m^2
- Wind Speed (Load): 35 m/s (monsoon region standard)
- Earthquake Load : None (no earthquakes have been recorded in Zambia)

(5) Facility Plan

1) Design Policy

By taking into consideration Zambian social conditions, the way of living, natural conditions and the conditions of the infrastructure in the Area, the facility plan was prepared to provide adequacy.

2) Electrical Facility Plan

Electricity will be taken by connecting cables to and existing power-line pole in the Area. However, presently there is no power beir supplied up to the pole. Maintenance of the electrical cables shall be undertaken by the Government of Zambia until power is supplied to the area. 11 kv of power is to be supplied.

The necessary electrical facilities for the Project are as follows :

1. Main High Voltage Line

   High voltage electricity will be needed for the workshop and the irrigation pumps. 380 volts will be required.

2. Lighting and Outlet Fixtures

   The lighting and outlet fixtures will be 240 volts. Fixture installation is planned in accordance withe British Standards. The average intensity of illumination for each room is as follows :

   Office and Meeting Room : More than 300 luces
   Dining Room : More than 200 luces
   Warehouse : More than 70 luces

Following is the approximate power capacity :

Name of Building or Facility	Name of Use Purpose	Floor Area X Use capacity (VA/m^2) X Power Facot X Use Rate (W)	Power Capacity (KW)
Management Bldg.	Lighting & Outlet Equipment	196.0 X 30 X0.8 X0.8 =3,763.2	4.0 1.5
Lodging house	Lighting & Outlet		30.0
Garage	Lighting & Outlet	288.0 X 15 X0.8 X0.6 =2,073.6	2.0
workshop	Lighting & Outlet High Voltage Equipment	240.0 X 30 X0.8 X0.6 =3,456.0	4.0 30.0
Warehouse	Lighting & Outlet	198.0 X 15 X 0.8 X 0.5 = 1,188.0	2.0
Deep Well	Pump		15.0
Irrigation Facility	Pumps		85.7
Yard	Lighting		5.0
TOTAL			179.2

3) Water Supply and Sewage Facility Plan

1. Piping Installation

For maintenance purposes, piping will be installed above ground. This installation method is most widely used in Zambia.

2. Water Supply Facility

Water will be supplied to each building facility from an elevated tank to which water will be pumped up from a deep well.

3. Sewage Facility

Waste water will be handled by the infiltration method. Sewage will be treated by a septic tank and them infiltrated into the ground.

No special facility is designed for storm drainage.

4) Lightning Conductor

Since thunderstorms occur frequently in the Project Area, lightning conductors will be installed on the management building, workshop, and pump houses.

5) TV Antenna

A TV antenna will be installed on the management building.

6) Telephone Equipment

Telephone equipment will not be installed as part of the Project. However, for future installation, conduits for telephone cables will be installed.

Telephone lines presently run along National Road T-4. Thus, it will be necessary to connect a cable to that line to enable telephone equipment to be installed in the management building in the future.

7) Wireles Facilities

It is difficult to expect the installation of telephone system in the study area.

Wireles facilities are installed at administration building and Resettlement Office for communication between exparts, instructor and office.

Handtalkie is used for communication among administratin building and the study area.

8) Fuel Tanks

A gasoline tank and a diesel oil tank will be installed to store fuel for the agricultural machinery and vehicles. Each tank is designed to have a 3 m^3 capacity.

(6) Building Material Plan

1) Materials to be Used

It is planned to use local materials as much as possible. Only such materials that are locally unobtainable or whose qualities are unacceptable for Project use will be imported from Japan or other countries.

1. Concrete

Ordinary portland cement made in Zambia will be used. The design standard strength of concrete is to be 180 kg/m^2. Its slump is to be from 10 to 15 cm.

2. Reinforcing Bars

SD30, SR24, or equivalent reinforcing bars will be used. Bars less than 13 mm in diameter shall be round shaped. Bars larger than 13 mm in diameter shall be deformed shaped.

3. Wood

Zambian wood will be used for structural members and finish material.

4. Roof Material

Asbestos slate that is most common in Zambia will be used.

5. Exterior Finish Material

Steel sash will be used for windows and doorways. Exterior will be covered with a mortar coating and finished with paint to increase their durability.

6. Interior Finish Material

The floors of rooms will be finished with terrazzo. Other floor areas will have a mortar finish. Additionally, the mortar finished floor in the workshop shall be painted to make it easy to distinguish small parts placed on it. The floor is to be non-skid.

Interior walls shall be coated with mortar and then painted.

Ceilings shall be finished with locally available material, such as tap board, to prevent heat radiation from the roofs.

2) Major Building Materials to be Procured on the Local Market

For Buildings :

Cement, sand, gravel, concrete blocks, reinforcing bars, form material, steel sash, glass, wood, paint, tile terrazzo, slate, and caulking material

For Electrical Facility :

Power-line poles

For Water Supply and Sewage Facility :

Water tank (elevated)

3) Building Materials to be Procured in Japan:

For Buildings :

Special metal carpentry fixtures, floor paint, sliding doors

For Electrical Facility :

Cable conduit, cables, switches, panels, lighting fixtures

For Water Supply and Sewage Facility :

Polyvinyl pipes, water faucets, pump, sanitation earthwares

4) Building Materials to be Procured in Other Countries

For Buildings : Lightweight steel material

For Electrical Facility : non

For Water Supply and Sewage Facility : non

4-3-6 Equipment Plan

(1) Land Rreclamation Machinery

Land reclamation machinery units to be provided include bulldozers (D8 class), a motor grader (155 hp), a backhoe (0.4 m3 capacity), a vibrating roller (4-ton class, self-moving type) and a sprinkler truck. The capacities and the number of units of the equipment were examined as follows:

1) Conditons

Land Slope: Approximately 1/100, some steeper points exist

Trees: About 500 per hecrate (from 20 cm to 40 cm trunk diameter; bean-family hardwood)

Operation Season: Rainy season

Depth of Roots: 1.5 to 2.0 m

Unit area of machinery clearing: 100 m x 100 m

2) Bulldozers (D8 Class)

In the Kanakantapa Resettlemnt Area a combination of two D8 Class bulldozers and one motor grader are presently conducting land reclaiming operations, such as tree root pulling and removal, and land clearing and levelling.

The capacity and number of bulldozer units to be provided for the Project were examined as follows:

1. Tree Root Pulling

Tree roots shall be pulled out by a rake dozer.

$$T = T' \times E$$

where, T : Operating time per hectare (hr/ha)
T' : Standard operating time per hectare (hr/ha)
E : Work efficiency = 0.85

The standard operating time per hectare and the work efficiency are seelcted form Tables 4.3.4 through 6. Then, the stnadard operating time for a certain class are to be adjusted as follows:

Adjustment factor: D6/D8 = 1/1.6

The standard operating time of D8 is

14 hr/ha x 1/1.6 = 8.75 hr/ha

Thus, the operating time per hectare of D8 is

8.75 hr/ha x 0.85 = 7.4 hr/ha

2. Tree Root Removal

Tree root removal time was obtained from Tables 4.3.7 through 24 as follows:

$$T = T' \times E$$

where, T : Operating time per hectare (hr/ha)

T' : Standard operating time per hectare (3.60hr/ha)

Adjustment for equipment size

= 3.6 x 1/1.6 = 2.25hr/ha

E : Work efficiency = 0.85

Thus, T = 2.25 x 0.85 = 1.9 hr/ha

Table 4.3.4 Standard Operation Time (unit:hr/ha)

Dencity of Tree (unit/ha)	500	750	1,000	1,250	1,500	1750.0	2,000	2,250	2,500	2,750	3,000	3,250	3,500	3,750	4,000
Avarage Diameter 6 cm	7.1	7.2	7.3	7.4	7.6	7.8	8.0	8.3	8.5	8.8	9.2	9.5	9.9	10.4	10.8
〃 8 cm	7.5	7.6	7.7	7.8	8.0	8.2	8.4	8.6	8.9	9.2	9.6	9.9	10.3	10.8	11.2
〃 10 cm	8.0	8.0	8.1	8.3	8.4	8.6	8.9	9.1	9.4	9.7	10.1	10.5	10.9	11.3	11.8
〃 12 cm	8.5	8.6	8.7	8.8	9.0	9.2	9.4	9.7	10.0	10.3	10.7	11.1	11.5	11.9	12.4
〃 14 cm	9.2	9.3	9.4	9.5	9.7	9.9	10.1	10.4	10.7	11.0	11.4	11.8	12.2	12.7	
〃 16 cm	9.9	10.0	10.1	10.3	10.5	10.7	10.9	11.2	11.5	11.9	12.2	12.7	13.1		
〃 18 cm	10.8	10.9	11.0	11.1	11.4	11.6	11.8	12.1	12.4	12.8	13.2	13.6			
〃 20 cm	11.8	11.9	12.0	12.1	12.3	12.6	12.8	13.1	13.5	13.8	14.2				
〃 22 cm	12.8	12.9	13.1	13.2	13.4	13.7	13.9	14.3	14.6	15.0					
〃 24 cm	14.0	14.1	14.2	14.4	14.6	14.9	15.2	15.5	15.9						

Table 4.3.5 Effecincy

Site Condition	good	regular	poor
Rake Dozer 21t	0.65	0.85	1.05
Rake Dozer 15t	0.80	1.00	1.20
Rake Dozer 11t	1.15	1.35	1.55

Table 4.3.6 Evaluation Standard for Site Condition

Item	Classitication	Score
Slope	0° ～ 3°	0
	3° ～ 8°	1
	8° ～	3
Tree Deacity	0 ～ 10%	0
	11 ～ 50	1
	50 ～ 100	2
Dencity of Baby tree	0 ～ 1,000unit/ha	0
	1,001 ～ 2,000	1
	2,001 ～ 3,000	2
	3,001 ～	3
Soil Condition	sundy	0
	lomy	1
Others	regular	0
	worxe	1
	bad	2

Table 4.3.7 Standard Operation Time (unit : hr/ha)

Dencity of Tree (unit/ha)		500	750	1,000	1,250	1,500	1,750	2,000	2,250	2,500	2,750	3,000	3,250	3,500	3,750	4,000
Interval of Lund Clearing	30 (m)	1.8	2.3	2.7	3.0	3.4	3.7	4.0	4.3	4.5	4.8	5.0	5.3	5.5	5.7	5.9
	40 (m)	2.1	2.7	3.2	3.6	4.0	4.4	4.7	5.0	5.2	5.4	5.9	6.2	6.5	6.8	7.0
	50 (m)	2.4	3.1	3.6	4.1	4.6	5.0	5.4	5.7	6.1	6.4	6.8	7.1	7.4	7.7	8.0
	〃 60 (m)	2.7	3.4	4.0	4.6	5.1	5.5	6.0	6.4	6.8	7.2	7.5	7.9	8.2	8.6	8.9
	〃 70 (m)	3.0	3.7	4.4	5.0	5.6	6.1	6.5	7.0	7.4	7.9	8.3	8.6	9.0	9.4	9.7
	〃 80 (m)	3.2	4.0	4.8	5.4	6.0	6.6	7.1	7.6	8.0	8.5	8.9	9.3	9.8	10.1	10.5
	〃 90 (m)	3.4	4.3	5.1	5.8	6.4	7.0	7.6	8.1	8.6	9.1	9.6	10.0	10.4	10.9	11.3
	〃 100 (m)	3.6	4.6	5.4	6.2	6.8	7.5	8.1	8.6	9.2	9.7	10.2	10.7	11.2	11.6	12.0
	〃 110 (m)	3.9	4.9	5.7	6.5	7.2	7.9	8.5	9.1	9.7	10.2	10.8	11.3	11.8	12.2	12.7
	〃 120 (m)	4.1	5.1	6.0	6.9	7.6	8.3	9.0	9.6	10.2	10.8	11.3	11.9	12.4	12.9	13.4
	〃 130 (m)	4.3	5.4	6.3	7.2	8.0	8.7	9.4	10.1	10.7	11.3	11.9	12.4	13.0	13.5	14.0
	〃 140 (m)	4.4	5.6	6.6	7.5	8.3	9.1	9.8	10.5	11.2	11.8	12.4	13.0	13.5	14.1	14.6
	〃 150 (m)	4.6	5.8	6.9	7.8	8.7	9.5	10.2	10.9	11.6	12.3	12.9	13.5	14.1	14.7	15.2
	〃 160 (m)	4.8	6.1	7.1	8.1	9.0	9.8	10.6	11.4	12.1	12.8	13.4	14.0	14.6	15.2	15.8
	〃 170 (m)	5.0	6.3	7.4	8.4	9.3	10.2	11.0	11.8	12.5	13.2	13.9	14.5	15.2	15.8	16.4
	〃 180 (m)	5.2	6.5	7.7	8.7	9.7	10.6	11.4	12.2	12.9	13.7	14.4	15.0	15.7	16.3	16.9
	〃 190 (m)	5.3	6.7	7.9	9.0	10.0	10.9	11.8	12.6	13.4	14.1	14.8	15.5	16.2	16.8	17.5
	〃 200 (m)	5.5	6.9	8.1	9.3	10.3	11.2	12.1	13.0	13.8	14.5	15.3	16.0	16.7	17.4	18.0
	〃 210 (m)	5.6	7.1	8.4	9.5	10.6	11.5	12.5	13.3	14.2	15.0	15.7	16.5	17.2	17.9	18.5
	〃 220 (m)	5.8	7.3	8.6	9.8	10.9	11.9	12.8	13.7	14.6	15.4	16.2	16.9	17.7	18.4	19.1

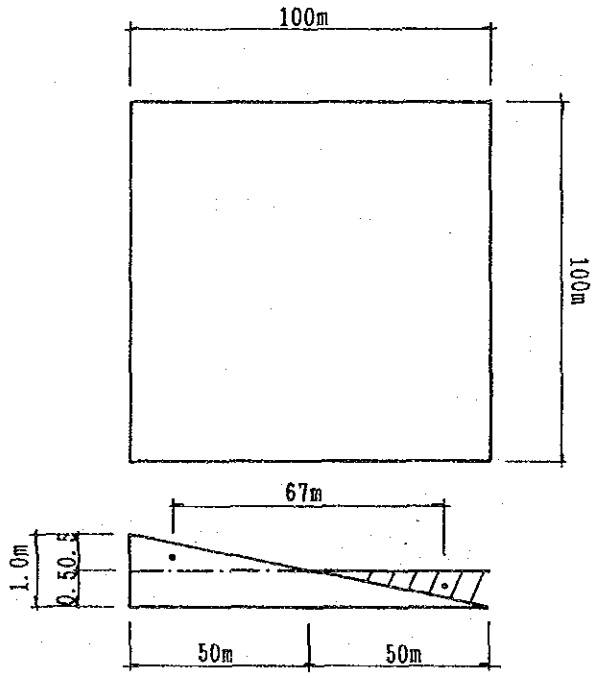
3. Land Leveling

The amount of earth work required to clear a unit of 100 m x 100 m of land was obtained. The total cut and fill amount would be 2,500 m^3 and the distance to move the earth would be 2,500 m^3 and the distance to move the earth would be approximately 67 m because the centers of the earth to be cut or fill locate the center of the triangular to be cut or filled.

Cut volume: 50 m x 0.5 m x 1/2 x 100 m = 1,250 m^3
Fill voluem: 50 m x 0.5 m x 1/2 x 100 m = 1,250 m^3

TOTAL: 2,500 m^3

Moving distance: 2/3 X 50 X 2 + 67 m



From Fig. 4.3.1, the land clearing capability of a D8 Class bulldozer is 350 m3/hr for an average moving distance of 67 m. Thus, the bulldozer operation time to clear 1 ha of land is

2,500 ÷ 350 = 7.1 hr

The total operating time for root pulling and removal, and land clearing per one hectare is

7.4 + 1.9 + 7.1 = 16.4 hr

To clear 750 ha of land, a D8 Class bulldozer's operating time will be

750 ha x 16.4 hr/ha = 12,300 hr

According to the Construction Machinery Depreciation Calculation Table prepared by the Japanese Ministry of Construction, a D8 Class bulldozer's annual operating time and durable years are 890 hr and six years respectively. Thus, its lifetime operating hours will be 890 hr/year x 6 years = 5,340 hr. Therefore, the number of bulldozer units necessary to clear the 750 ha of land would be

12,300 ÷ 5,340 = 2.3 units

As a result, two D8 Class bulldozer units will be provided.

3) Motor Grader

The land levelling capability of a motor grader can be calculated by the following equation:

$$A = \frac{W \times V \times E}{N}$$

where, W = Effective width of the blade or the scarifier:
2.9 m for a 3.7 m Class grader
V = Operating speed: 2,150 m/hr
N = Ranking or levelling repeating time: 4 times
E = Work efficiency: 0.75

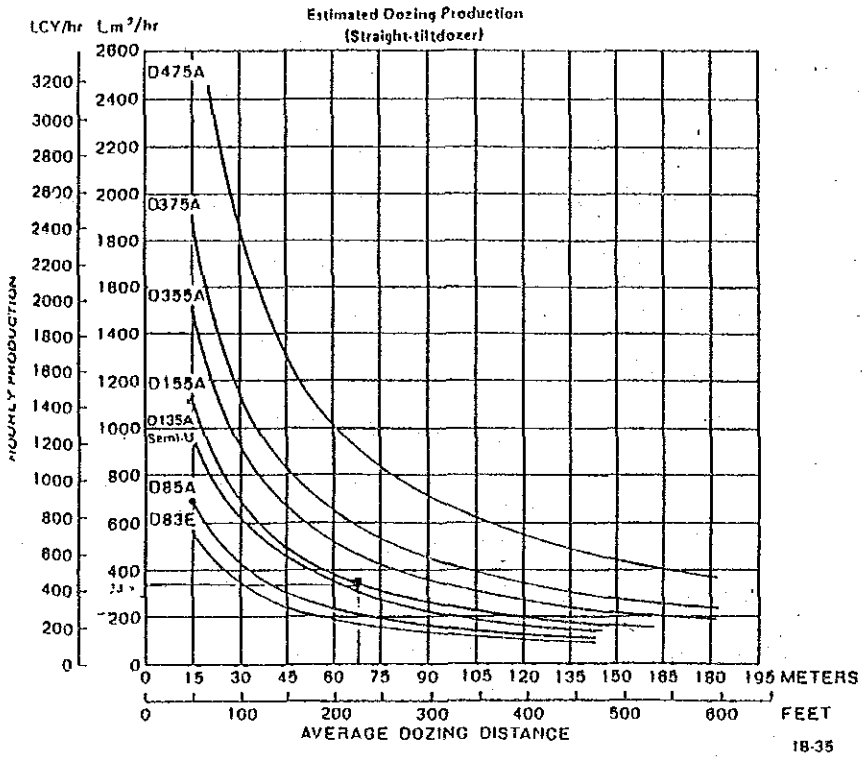


Fig 4.3.1 Workability of Bull Dozer

Table 4.3.8 Effenciency

Site Condition	good	reguial	poor
Rake Dozer 21t	0.55	0.85	1.15
Rake Dozer 15t	0.70	1.00	1.30
Rake Dozer 11t	1.05	1.35	1.65

Table 4.3.9 Evaluation Standard of site Condition for Lond Clearing

Item	Classification	Score
Slope	0° ～ 3°	0
	3° ～ 8°	1
	8° ～	3
Dencity of Baby Tree	0 ～ 1,000unit/ha	0
	1,001 ～ 2,000	1
	2,001 ～ 3,000	2
	3,001 ～	3
Anoumt of Tree	25,000 unit/ha	0
	25,000 ～ 45,000	1
	45,000 ～	2
Other Condition	regural	0
	morse	1
	bad	2

Table 4.3.10 Operating Coefficient of Motor Grader

Working Condition	E1		Applicable Work Condition
	Ripping and Scarifying	Grading	
Good	0.75	0.65	Road traffic is completely stopped. Road's route and base course conditions are quite good and no obstruction exists. Continuous operation is possible.
Average	0.65	0.55	Road has average route and base course conditions. Not many obstructions exist. General work type.
Poor	0.55	0.45	Passing traffic and existing obstructions hinder work. Comparatively small size work such as access road constructoin

Therefore,

$$A = \frac{2.9 \times 2150 \times 0.75}{4} = 1{,}169 \text{ m}^2/\text{hr}$$

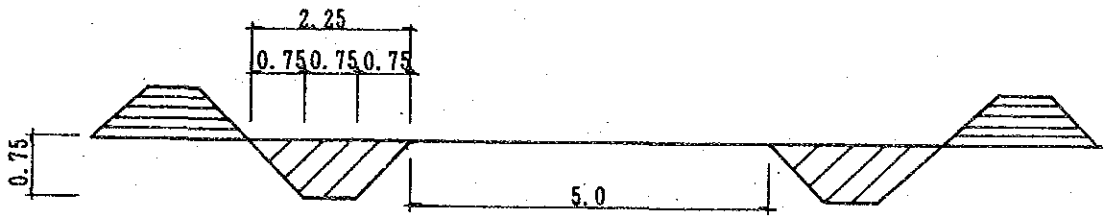
Operating time for levelling 1 ha of land: 10,000 ÷ 1,169 = 8.6 hr/ha
Average time for levelling entire planned area:
750 ha x 8.6 hr/ha = 6,450 hr
Durability of a motor grader: 7 years
Standard operating time per year: 660 hr
Lifetime operating hours: 7 x 660 = 4,620 hr

The number of required motor graders is 6,450 ÷ 4,620 = 1.40
Thus, two motor graders will be provided.

4) Backhoe

A backhoe will be used to trench the side ditches of a total of approximately 40 km of new farm raods to be constructed and a total of about 37 km of existing farm roads to be improved in the Resettlement Area.

The side ditches are shown below.



Side ditch excavation amount:

Cross sections = 0.75 x 0.75 x 2 x 2 = 2.25 m^3/m.

Excavation amount = 2.25 m2 x 77,000 m = 173,250 m^3

The amount of work that can be performed by one backhoe in one hour can be calculated by the following equation:

$$Q = \frac{3600 \times q \times f \times E}{Cm}$$

where, Q = Amount of work per hour (m^3/hr)

q = Excavation volume per one cycle (m)

$q = q_o \times k$

q_o = rated capacity

k = loading coefficient, 0.98

f = Unit convension coefficient (1.3)

E = Work efficiency

Cm = Time required for one cycle operation (sec)

Time required for Once Cycle Operatoin, Cm

Turning angle (ϕ)	45°	90°	135°	180°
Cm	28 sec	30 sec	32 sec	35 sec

Work Efficiency (E)

Working Condition	Original Ground Excavation & Loading			Loading of Loose Soil		
Soil Type	Good	Average	Poor	Good	Average	Poor
Sandy or Sandy Soil	0.80	0.65	0.50	0.85	0.70	0.55
Sandy or Gavelly Soil	0.75	0.60	0.45	0.80	0.65	0.50
Rock Fragments	-	-	-	-	-	-

From the above tables,

$q = 0.4 \times 0.98 = 0.39$

$f = 1.3$

$E = 0.6$

$Cm = 30$ sec

$$Q = \frac{3600 \times 0.39 \times 1.3 \times 0.6}{30} = 36.5 \text{ m}^3/\text{hr}$$

Thus, the total operating time will be

$173{,}250 \text{ m} \div 36.5 \text{ m/hr} = 4{,}746.6 \text{ hr}$

Since a backhoe's durability is 6 years and its annual operating time is 690 hr, its lifetime operating hours are $6 \times 690 = 3{,}540$ hr. Therefore, the number of backhoe units for Project work is

$4{,}746.6 \div 3{,}540 = 1.3$

Accordingly, one bakchoe will be provided.

5) Vibrating Roller

The working capability of a vibrating roller can be obtained by the following equation:

Hourly accomplishment (indicated by compacted area of base course):

$$A = \frac{W \times V \times E}{N}$$

where, A = Compacted area per hour (m^2/hr)
W = One time effective compaction width (0.95 m)
V = Operating speed (1,000 m/hr)
E = Compaction time (5 times)

Thus,

$$A = \frac{0.95 \times 1000 \times 0.5}{5} = 95 \text{ m}^2/\text{hr}$$

The total area to be compacted is 5 x (40,000 + 37,000) = 385,000 m^2. Required vibrating roller operating time is 385,000 ÷ 95 = 4,052 hr. A vibrating roller's durability is 6 years and its annual operating time is 450 hrs. Therefore, its lifetime operating hours will be 450 x 6 = 2,700 hr.

The number of vibrating roller units required for Project road construct is 4,052 ÷ 2,700 = 1.5

Accordingly, one 10-ton Class vibrating roller will be provided.

6) Sprinkler Truck

Sprinkler truck wil be used fro compaction works and dust control on the construction and improvement of the road. Large scale sprinkler truck with more than 6.3 m^3 of tank storage volume will be used. Working capacity is explained using following formula:

$$Q = \frac{60 \times q}{.Cm} \quad (1/hr)$$

$$Cm = \frac{2 \times d}{V} + t1 + t2 + t3 + t4$$

where

Q	:	sprinkler discharge (l/hr)
q	:	storage volume of tank (6,300 l)
Cm	:	cycle time (min/one time)
d	:	distance for water source (3,000 m)
V	:	truck velocity (500 m/min)
t1	:	hose taking on/off time (5 min)
t2	:	water intake time (large scale 18 min)
t3	:	waiting time (5 min)
t4	:	sprinkler time (large scale 10 min)

Thus,

$$Cm = \frac{1}{500}(2 \times 3{,}000) + 5 + 18 + 5 + 10 = 50\text{min/time}$$

$$Q = \frac{60 \times 6300}{50} = 7{,}560\text{l/hr.}$$

The standard sprinkler discharge is determined as 5 l/m^2 and 10% of it is added. Total sprinkler discharge volume required can be calculated as below:

$$77{,}000\text{ m} \times 5\text{ m}^2\text{/m} \times 5.5\text{ l/m}^2 = 2{,}117{,}500\text{ l}$$

The total sprinkler time is calculated as follows:

$$2{,}117{,}500\text{ l} + 7{,}560\text{ l/hr} = 280.09\text{ hr}$$

In the road works, road bed is divided into two layer and 5 times of compaction is carried out for each layer. Sprinkler work is required one time for each layer and following sprinkler time will be required for all road works.

$$280.09 \times 2 = 560.18\text{ hr}$$

On the other hand, considering the maintenance of road after the completion of road works, one sprinkler work for every weak will be required during six months of the dry season for the road which is located along villages (average road length is approximately 1 km for each village). For this sprinkler work, the required total sprinkler discharge and required total working time are calculated as follows;

11 village x 1,000 m x 5 m x 5.5 l/m^2 x 26 weeks = 7,865,000 l

7,865,000 l ÷ 7,560 = 1,040 hr/year

Sprinkler truck will be working not only for the road construction but also for the irrigation of the wind break forest. On the other hand, as the durable year of sprinkler truck is 5 years and annual working hours of it is 1,000 hours/year, total durable hours of it is 5,000 hours. Therefore, total durable hours will finish approximately 4 years later from the following calculation.

$$(5{,}000 - 560) \div 1{,}040 = 4.27$$

From the consideration mentioned above, one large scale sprinkler truck will be provided.

(2) Agricultural Machinery for the Training Farm

The capacities and number of units appropriate for the size of the training farm shall be selected. Accessory units suitable for the mounting-type tractors that will be the main farming equipment shall also be selected.

1) Mounting-type Tractor

1. Capacity of Mounting-type Tractor

The relationship between the tractor size and the minimum land area to be cultivated by the tractor is listed in Table 4.3.11. The size of the training farm is 30 ha. If the farm will be cultivated by dividing it into three cropping units, one cropping will correspond to Class I size. If the farm will be cultivated as one lot, it will correspond to Class III. Therefore, a 30 HP or 60 HP class tractor is adoptable for the training farm.

According to the cropping plan of the training farm, the annual necessary tractor operating time of a 40 HP Class tractor is 702 hours. The operating time of a 60 HP Class tractor is 496 hours.

As the soil of the training farm is a laterite type fine sand mixed with clay and becomes very hard when it is dry, it was decided upon to adopt 60 HP Class mounting-type tractors.

2. Examination of the Units of Mounting-type Tractors

As described in the above paragraph, the annual operating time of a 60 HP Class mounting-type tractor for cultivating the training farm is 496 hours. It is generally mentioned that an agricultural use tractor's annual operating time is from 120 to 150 hours. According to the Depreciation Year Table (Table 4.4.12) prepared by the Japanese Ministry of Agriculture, Forestry, and Fisheries, a tractor has 8 durable years.

Table 4.3.11 Condition to introdude tractor

Classification	Capacity of Tractor	Organization	Limitation of Area				
			Paddy field	field	Fruit garden	Mulberry garden	Glass land
I	30 PS	Co-operative use and grouping trust system	10 ha	10 ha	Depending on combination use with the speed sprayer	5 ha	—
II	40 PS and 50 PS	Co-operative use and grouping trust system	15 ha	15 ha	Depending on combination use with the speed sprayer	—	Depending on combination with the harvest and processing Equipment
III	60 PS 70 PS and 80 PS	Co-operative use and grouping trust system	20 ha	25 ha	—	—	Depending on combination with the harvest and processing Equipment
IV	more than 90 PS	Co-operative use and grouping trust system	—	40 ha	—	—	Depending on combination with the harvest and processing Equipment

Source: Basic low of introducing high performance agricultural machine 20/mar. 1990

Table 4.3.12 Exsample of endurance of agricultural machine (Ordiance)

Item	Details	Endurance	Items	Details	Endurance
Motive Power	Electric motor	10 years	harvesting and processing machine	Reaper, Self-feeding comb-ine	5 years
	Diesel engine			Threster, Huller	8
	Kerosene engine			Conventional combine	
	Gasoline engine	8		Harvester, Mower	5
Equipment of Cultivation and Grand levering Equipment	Riding tractor	8		Air drier , Winnower	8
	Walking tractor and Power cultivator	5		Vice	
	Accesaries	5		Rice grader, fruit grader	
				Rice-cleaning machine	10
Management Q/M Equipment	Feltilizer applicator	5	Farm transportation machien	Truck	3
	Seeding machine			Car (Total exhaust≦21)	3
	Transplanting machine			Car (Total exhaust≧21)	5
	Potato planting machine			Tri-wheeled vehicle	3
	Cultivator			Two-wheeled vehicle	3
	Water lift machine	8		Rear-car (include Trailer)	4
	Sprinkler			Bicycle	2
Prevention machine	Speed sprayer	5			
	Sprayer	5			
	Duster, Mist blower				

Source: Basic low of introducing high performance agricultural machine 20/mar. 1990

Table 4.3.13 Tractor Annual Operating Time and Standard Durability, by Culpin (excerpt)

Equipment Name	Annual Use Hours	25	50	100	200	300
Tractor	Durable Operating hours	500	750	1,000	1,500	2,000
	Durable Years	More than 15 years	12 years	10 years	8 years	6 years

Source: Basic Method of High-performance Agricultural Machinery Introduction and References, by the Japanese Ministry of Agriculture, Forestry and Fisheries, March 20, 1990

The area of the training farm is 30 ha and it would take 496 hours of tractor operating hours to cultivate it. Since the durable year of a tractor is 8 years (according to the figure set down by the Japanese Ministry of Agriculture, Forestry and Fisheries), its corresponding annual use hours and durable operating hours are listed in the above Table.

The annual use hours is 200 hours and the durable operating hours is 1,500 hours. As the estimated operating hours of mounting-type tractors for cultivating the farm are 496, the number of necessary tractor units is

$496 \div 200 \fallingdotseq 2.4$

Therefore, two 60 HP mounting-type tractors will be provided.

2) Examination of the Capacities and Number of tractor Accessory Units

According to the standards of the Japanese Ministry of Agriculture, Forestry, and Fisheries, the durability of a tractor's accessory units is 5 years. This figure indicates that the accessory units' durability is shorter than the tractor itself and that the wear and tear on them is quite severe.

According to the standards, it is recommended to use suitable type accessory units for a tractor unit. For this reason, a set of

accessories for each 60 HP Class tractor will be provided. The accessory units will include disc ploughs, rotary harrows, chisel ploughs, planters, ridger and trailers.

3) Small-size Farming Equipment and Bicycles

Together with large agricultural machinery, small-sized farming equipment units are absolutely necessary for operating the training farm. According to the cropping plan that is prepared based on the management plan of the training farm, the number of small-sized farming equipment units to be provided was decided upon.

As for the number of necessary workers for each month in each work category that were calculated based on the cropping plan (not including the February and March periods), the minimum number of person in November is 280, and the maximum number of 1,790 persons in June.

It is estimated that a total of 9,600 persons will be working at the training farm each year. Table 4.3.14 lists the average number of workers to be mobilized daily each month (25 working days a month, 300 working days a year after subtracting Sundays and holidays). According to the Table, an average of 35 persons (minimum of 12 persons a day during the November period and a maximum of 72 persons a day during the June period but not including the February and March periods) will work daily.

The workers (trainees) will use small-sized farming equipment, such as hoes, sickles, shovels, rakes, weeders, axes, sprayers, wheelbarrows, etc. on a daily bases.

Table 4.3.14 Number of Workers to be Mobilized to Work at the Training Farm (persons/day)

Village	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
A	6.7	7.8	8.7	5.8	3.9	4.0	4.6	1.3	1.6	1.9	0.4	0
B*	5.1	6.0	6.6	4.4	2.9	3.0	3.5	1.0	1.2	1.4	0.3	0
C	4.2	4.9	5.4	3.6	2.4	2.5	3.0	0.8	1.0	1.2	1.2	0
D	4.8	5.2	5.8	3.8	2.6	2.6	3.0	0.9	1.0	1.3	0.3	0
E*	5.7	6.6	7.4	4.9	3.3	3.4	3.9	1.2	1.3	1.6	0.3	0
F*	4.9	5.7	6.4	4.2	2.8	2.9	3.4	1.0	1.1	1.4	0.3	0
G*	3.6	4.2	4.7	3.2	2.1	2.2	2.5	0.7	0.8	1.0	0.2	0
H	7.4	8.6	9.5	6.3	4.2	4.4	5.0	1,5	1.7	2.1	0.4	0
I	1.0	1.2	1.3	0.8	0.6	0.6	0.7	0.2	0.2	0.3	0	0
J	6.7	7.8	8.7	5.8	3.9	4.0	4.6	1.4	1.6	1.9	0.4	0
K*	5.4	6.3	7.0	4.7	3.1	3.2	3.7	1.9	1.2	1.5	0.3	0
Total	55.5	64.3	71.5	47.5	31.8	32.8	37.9	11.9	12.7	18.8	4.1	0

Note; * Settlers living in this village will use bicycles

The settlers who live far from the training farm will use bicycles for travelling to work. When the bicycles are needed by these settlers, they should rent them in accordance withe established rules.

Necessary bicycle repair costs shall be borne by the Resettlement Management Office.

The number of small-sized farming equipment and bicycles to be provided are shown in Table 4.3.15.

To efficiently carry out a series of work at the training farm, from seeding through harvesting for market, an adequate amount of small-sized farming equipment and bicycles was decided upon.

The management and maintenance of the small-sized farming equipment and bicycles will be undertaken by the Management Centre of the training farm.

Table 4.3.15 The Number of Small-sized Farming Equipment and Bicycles to be Provided.

Equipment Name	Number of units	Use Purpose
Hoe	40	Seed bed preparation, planting, cultivating (application of additional fertilizer), weeding, irrigating
Fork	20	Seed bed preparation, harvesting
Shovel	10	Seed bed preparation, planting, drainage work
Axe	5	Seed bed preparation, planting (cutting supporting wood), general farm management
Weeding Harrow	50	Weeding
Sprayer	10	Insecticide and blight control
Wheelbarrow	10	Weeding, harvesting
Bicycle	30	Settlers' commuting

4) Equipments and Fixtures for Training

Following equipments and fixtures are required for training.

slide projector	1
35 mm camera	1
screen	1
copy machien	1
type writer	1
black board	1
meeting tables	4
chairs	20

5) Equipments for Maintenance

Following for equipments and fixtures are required for maintenance.

wireless machiens	2	
handy talkies	2	
office tables	4	for offecers
	10	for employers

(3) Equipment for Stabilizing Settlers' Living Situations

1) Maize hammer-mill

Maize hammer-mill units necessary for making maize flour (the settlers' basic diet) will be provided.

5,000 people (the estimated population at the time for the durable year of the maize hammer-mill) will benefit from the maize hammer-mill units.

As electricity has yet to be supplied to the Resettlement Area, diesel engines will be used to operate the maize hammer-mills. Mill houses will be arranged at locations with a consideration of population in each village.

1. The Number of Necessary Maize Hammer-mill Units

The necessary number of maize hammer-mill units was calculated based on the following assumptions:

- Population for benefit: 5,000
- Annual maize consumption 225 kg/person
- Maize flour for one week's consumption will be ground at a time (the taste of the flour deteriorates if it is kept more than one week after milling).

- Specifications for the maize hammer-mill:
  Capacity: 500 kg/hr
- Operating capability of the maize hammer-mill:
  500 kg/hr X 0.6 X 4 hr/day = 1,200 kg/day = 1.2 tons/day
  Capability for making flour with one litre of fuel: 130 kg/litre

The annual maize consumption will be

5,000 persons X 225 kg/person/year = 1,125 tons/year

The amount of maize that will be handled at one time (to be ground once a week):

1,125 tons/year X 52 weeks/year = 21.6 tons/time

By assuming that this amount of maize will be ground during a 6 day period (one week, except for Sunday), the required capacity of the maize hammer-mills is

21.6 tons/week ÷ 6 days/week = 3.6 tons/day

As the capacity of one maize hammer-mill unit is 1.2 tons/day, the necessary number of units is

3.6 tons/day ÷ 1.2 tons/day/unit = 3.0

Therefore, 3 maize hammer-mill units will be provided.

2. Installation Locations

By taking into consideration the condition of the settler's residential districts, the present number of settlers and existing facility in "D" village, it was decided upon to build mill houses as follows:

One for "A", "B", "C", "D", "H" and "I" villages (at the Administration Center)

One for "E", "F" and "G" villages

One for "J" and "K" villages

2) Maize Sheller (Threshing Machine)

As maize has been threshed by hand in the Project area, maize sheller will be provided for the improvement of living standard.

1. Precondition for determination of Number of Maize Sheller

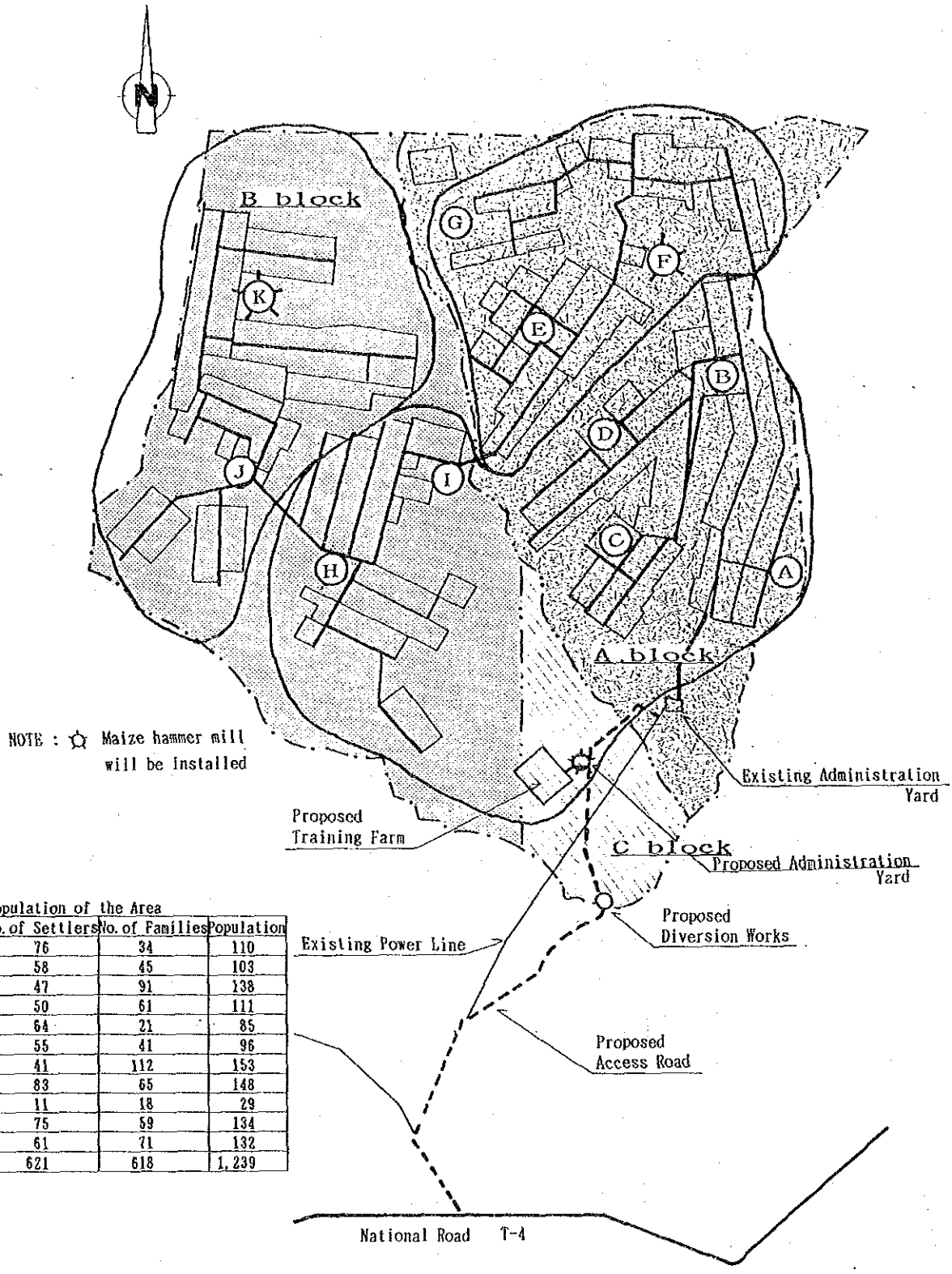
- Cultivation area of maize : 1,100 ha
- Yield of maize : 2.5 ton/ha
- Period of yield : 2 months in dry season
- Working hour of labor : 7 hour/day
- Capacity of maize sheller : 700 kg/hr

2. Required Number of Maize Sheller

Annual yield of maize in the Resettlement Area is 2,750 ton (2.5 ton/ha x 1,100 ha). Required time for threshing of it is 3,928 hr (2,750 ton/0.7 ton/hr). Required total number of days for threshing is 561.2 days (2,928 hr/ 7 hr/day). Required number of maize sheller is 9.35 unit (561.2 days / 60 days). Therefore, 9 of maize shellers is provided.

3. Maintenance

Maize shellers will be maintained at administration center, and will be lend to settlers.



Population of the Area

Village	No. of Settlers	No. of Families	Population
A	76	34	110
B	58	45	103
C	47	91	138
D	50	61	111
E	64	21	85
F	55	41	96
G	41	112	153
H	83	65	148
I	11	18	29
J	75	59	134
K	61	71	132
Total	621	618	1,239

Fig 4.3.2 Instalation of Maize Hammer Mill

(4) Equipments and Tools for Workshop

Following Equipments and Tools will be rady in workshop.

Workshop Facility

1. Diesel Engine Service Equipment & Tools
2. Gasoline Engine Service Equipment & Tools
3. Engine Service Equipment & Tools
4. Chassis Service Equipment & Tools
5. Undercarriage Service Equipment & Tools
6. Electric Component Service Equipment
7. Hand Tools
8. Power Tools
9. Test Inspection Equipment & Tools
10. Material Handling Equipment & Tools
11. Cleaning Equipment & Tools
12. Lubricating Equipment & Tools
13. Fabricating Welding Equipment
14. Machining Equipment & Tools
15. Air Supply

4-3-7 Basic Design Drawings

(1) Access Road

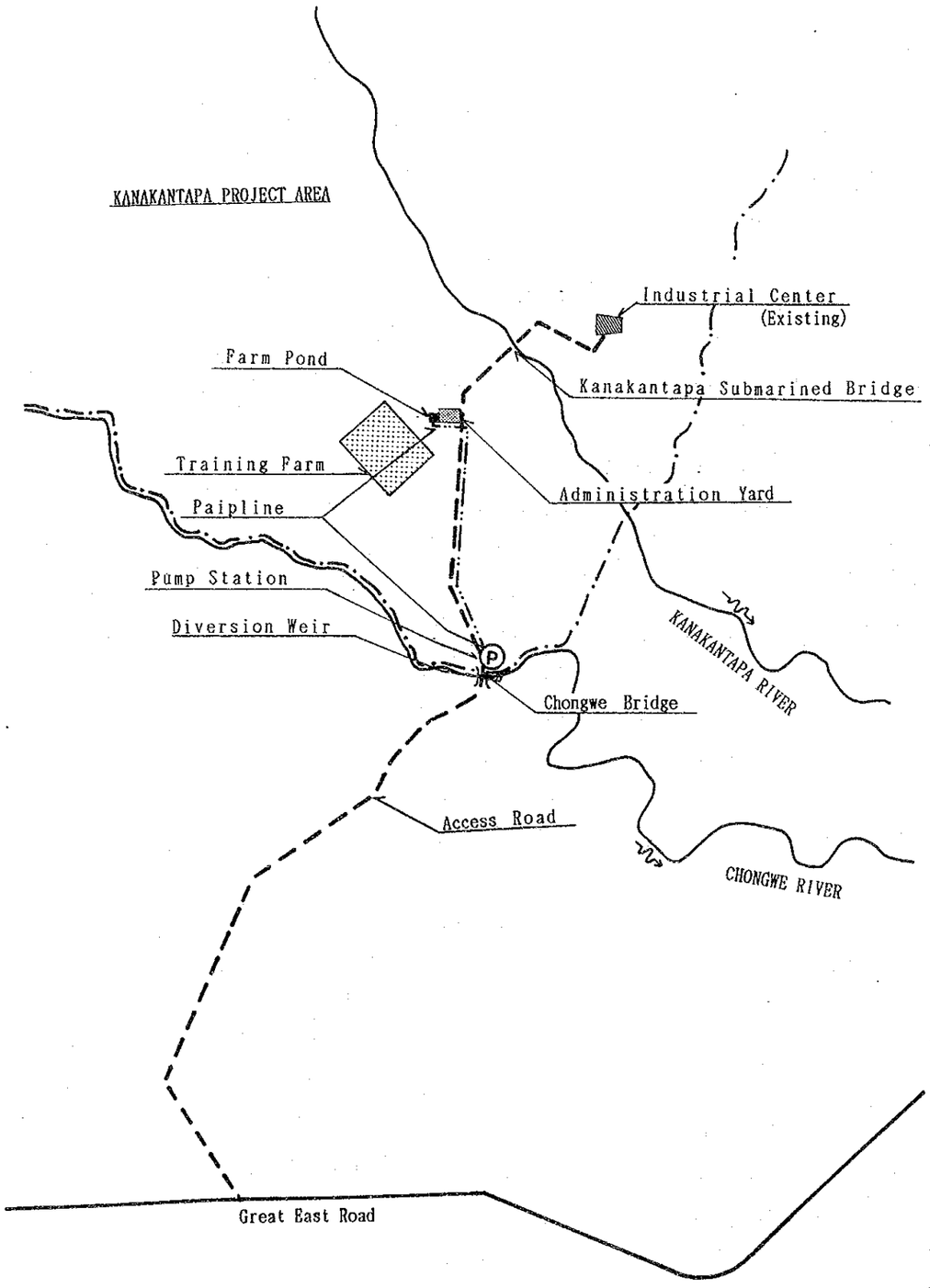
1 The Route of Access Road and Location of Facilities
2 Road Plan (11 sheets)
3 Chongwe River Bridge
4 Kanakantapa River Submergible Bridge

(2) Facilities of Training Farm

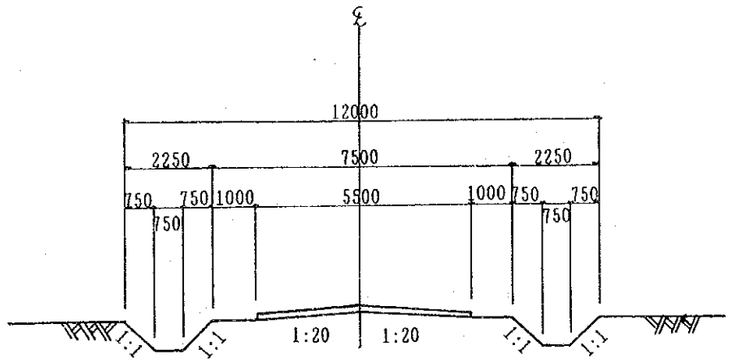
5 Layout of Diversion Works
6 Diversion Weir
7 Settling Basin
8 Pump Stations
9 Layout of Training Farm and Standard Farm Lot
10 Farm Pond
11 Hydrant Riser Arrangement

(3) Facilities of Administration Yard

12 Layout of Administration Yard
13 Administration Bldg.
14 Lodging house
15 Pump house
16 Machinery Bldg.
17 Workshop
18 Warehouse
19 Electric Power Diagram
20 Millhouse



S=1/50000



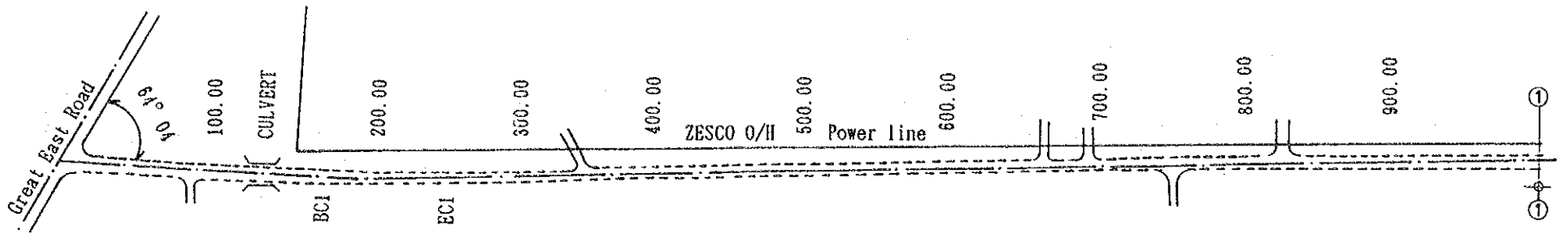
STANDARD SECTION OF ACCESS ROAD

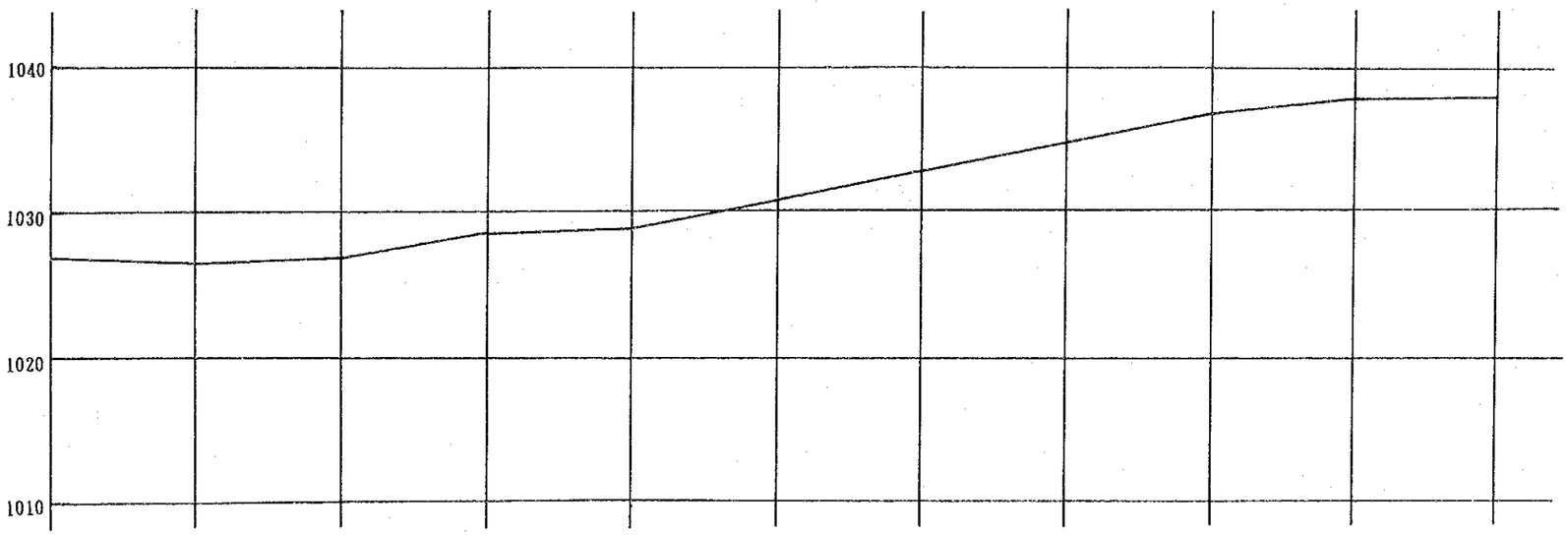
S = 1/150

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

The Route of Access Road and Location of Facilities

1



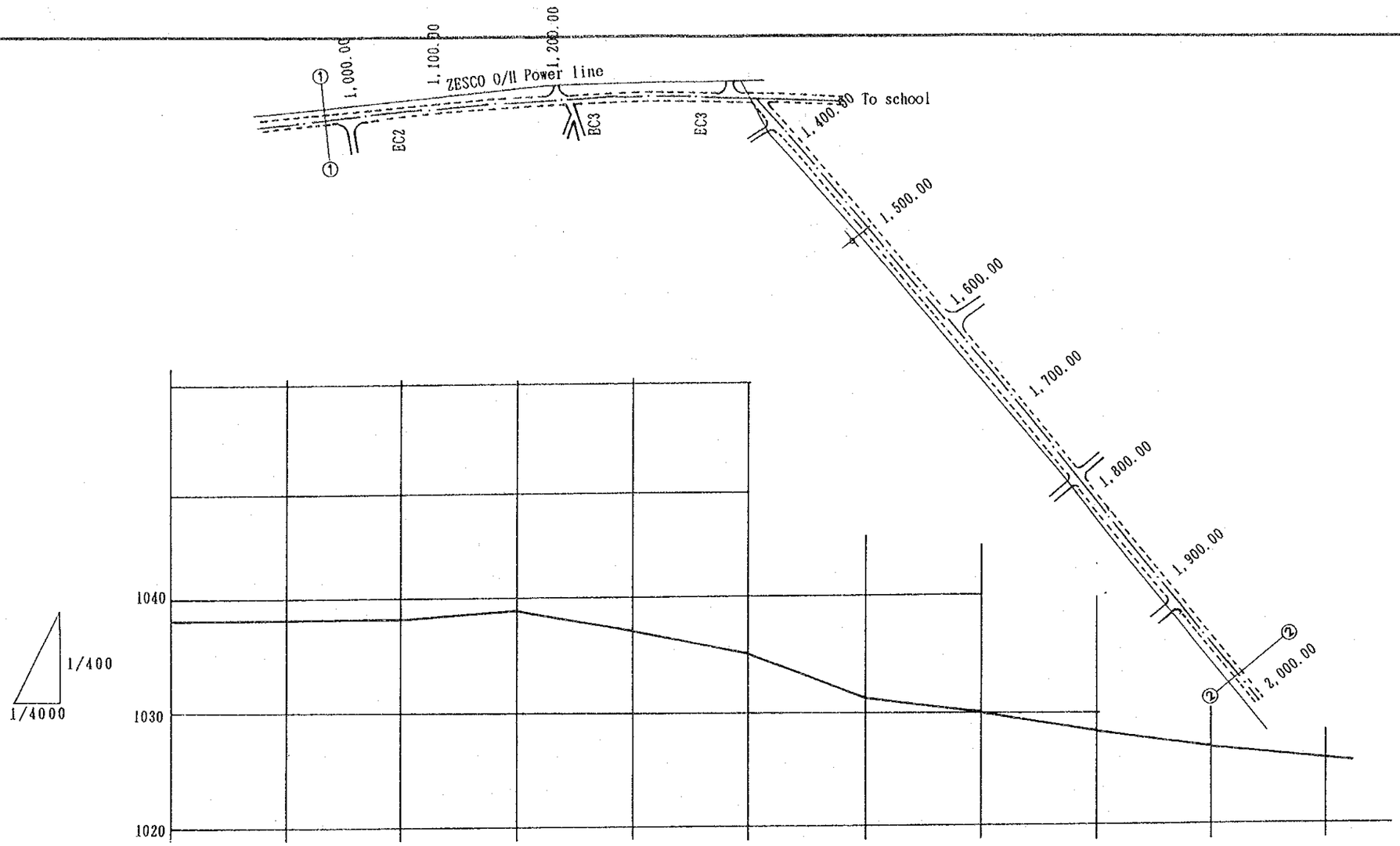


Slope	LEVEL		1/100		2/100			1/100		LEVEL
Design El. (m)	1027.05	1027.05	1029.05	1028.00	1029.00	1031.00	1032.00	1035.00	1037.00	1038.00	1038.00
Ground El. (m)	1027.03	1026.53	1026.89	1028.46	1029.22	1031.36	1033.22	1035.26	1037.18	1037.96	1038.22
Accumu. Distance	0	100	200	300	400	500	600	700	800	900	1,000
Distance (m)	0	100	100	100	100	100	100	100	100	100	100

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

ROAD PLAN

2-1



Slope	LEVEL		1/100	15/1000	2/100	4/100	2/100	15/1000		
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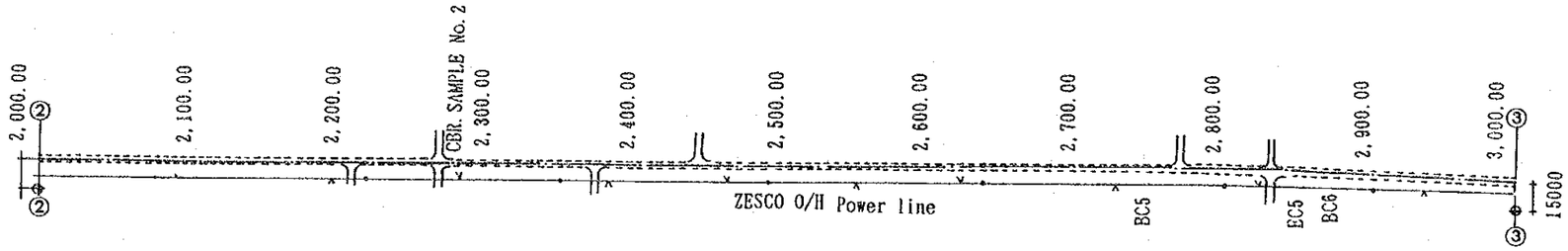
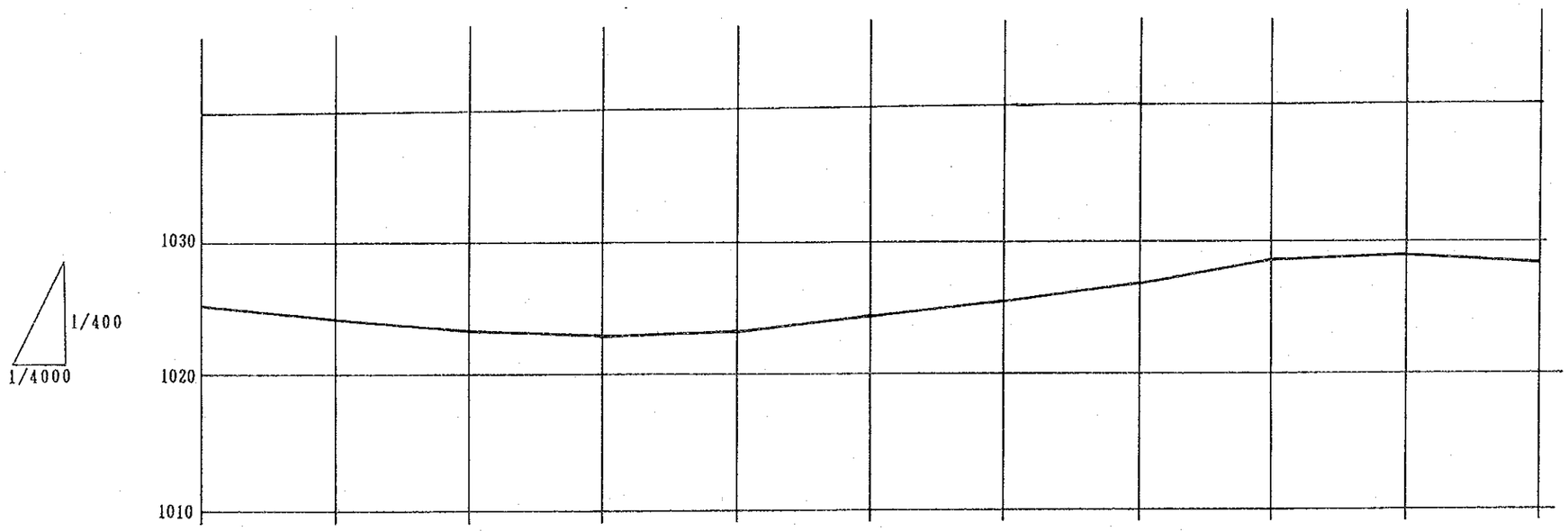
Ground El. (m)	1038.22	1037.48	1037.82	1039.09	1037.50	1034.82	1031.30	1029.46	1027.98	1026.59	1025.23
Accumu. Distance	1,000	1,100	1,200	1,300	1,400	1,500	1,600	1,700	1,800	1,900	2,000
Distance (m)	0	100	100	100	100	100	100	100	100	100	100

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

ROAD PLAN

2-2





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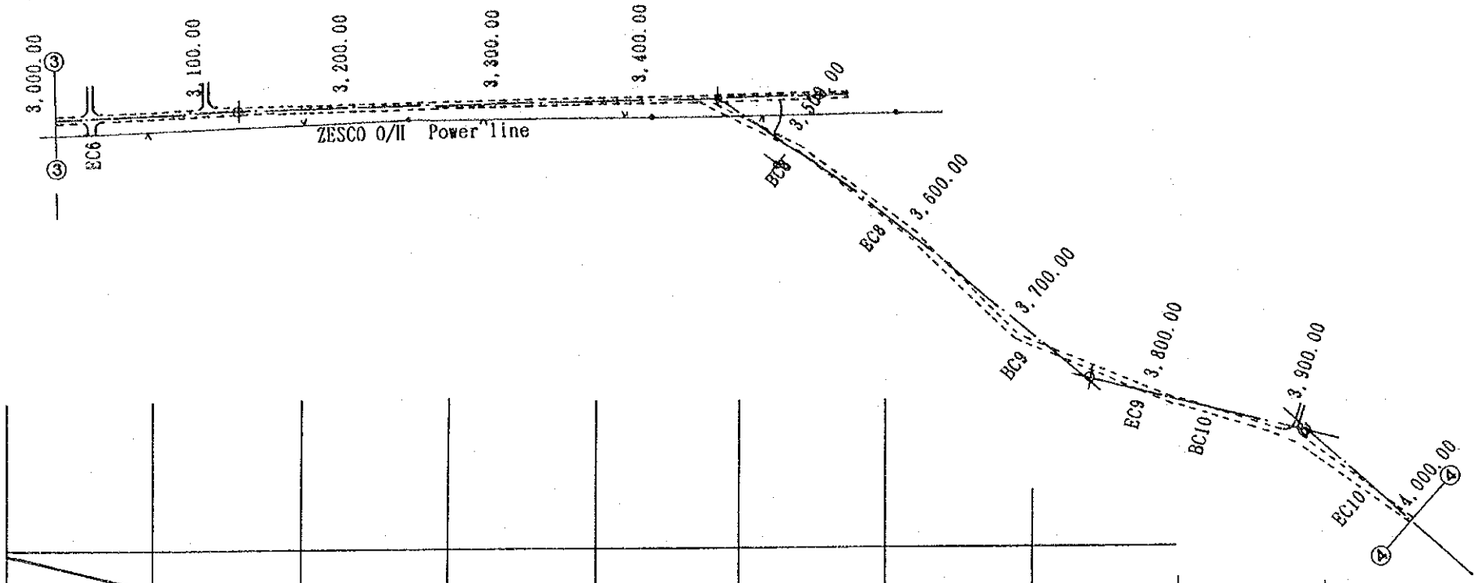
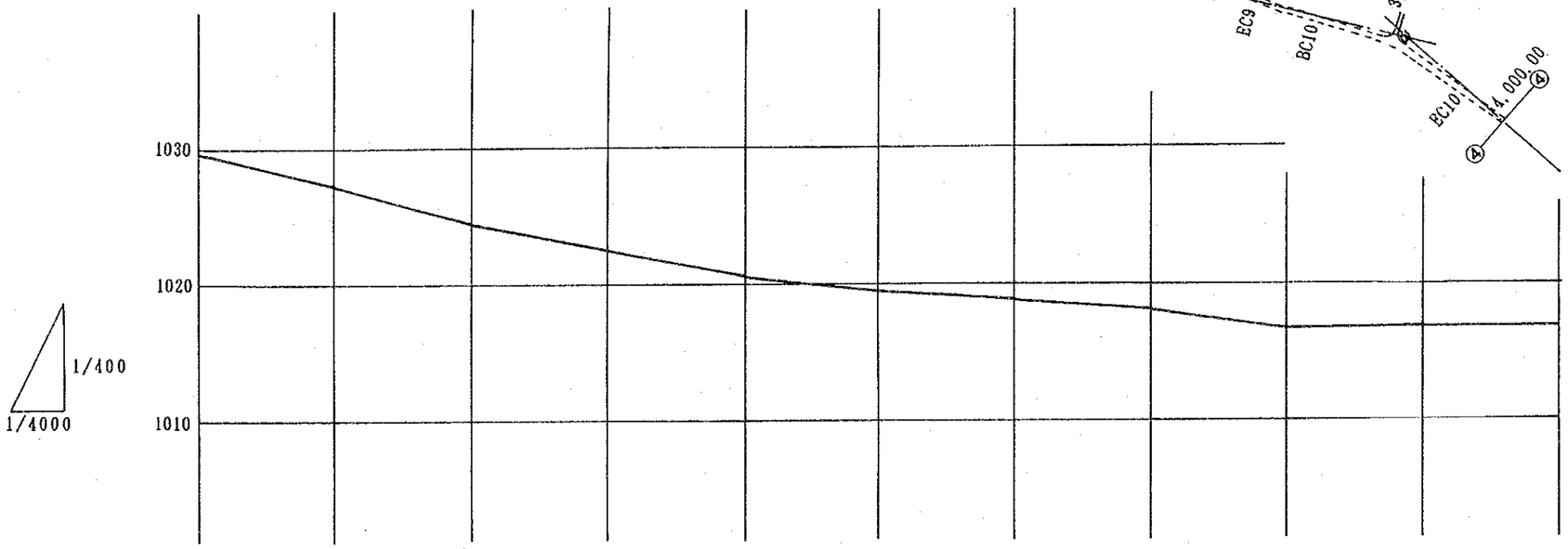
	1025.00	1024.00	1023.50	1023.00	1023.40	1024.20	1025.20	1025.70	1028.20	1028.80	1028.00
	1025.23	1024.21	1023.43	1022.90	1023.40	1024.16	1025.19	1026.69	1028.15	1028.87	1028.09
	2,000	2,100	2,200	2,300	2,400	2,500	2,600	2,700	2,800	2,900	3,000
	0	100	100	100	100	100	100	100	100	100	100

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

ROAD PLAN

2-3



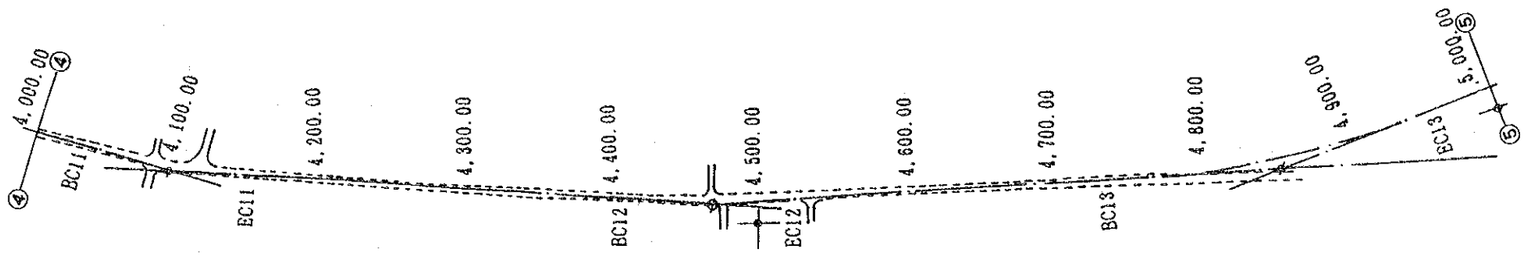


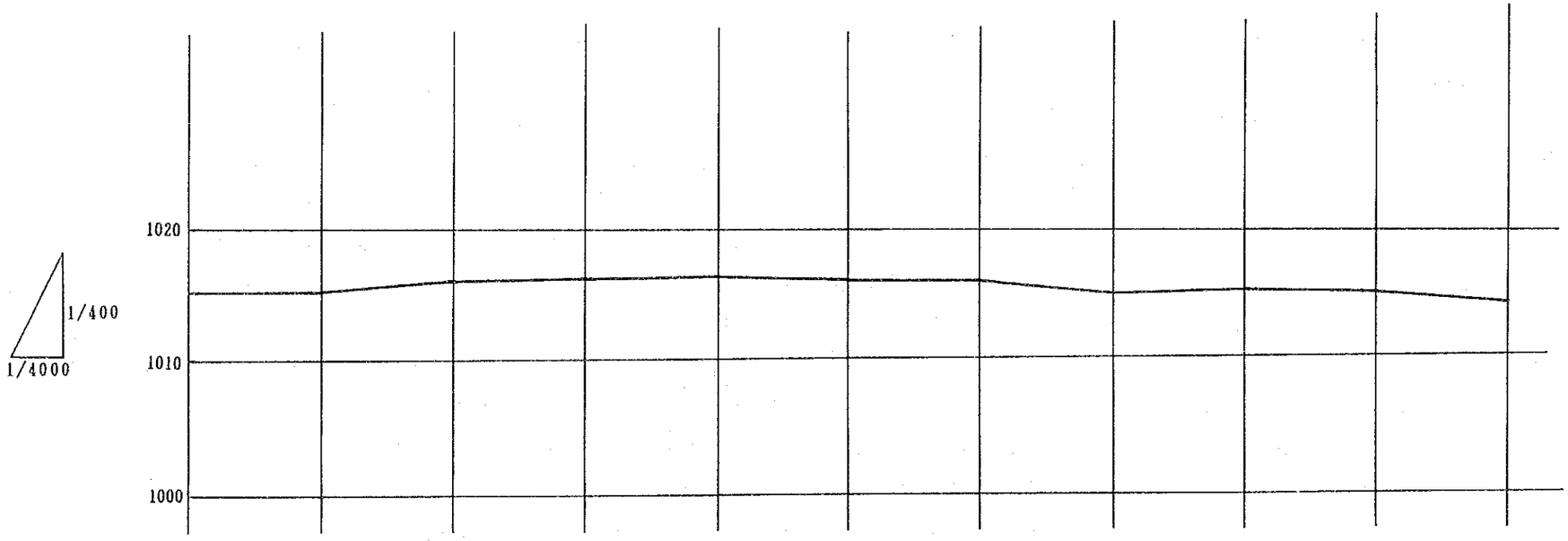
Slope	22/1000	3/100	23/1000	15/1000	1/100	1/1000	13/1000	LEVEL		
Design El. (m)	1028.00	1025.80	1022.80	1020.60	1019.00	1018.00	1017.00	1016.30	1015.50	1015.50	1015.50
Ground El. (m)	1028.09	1025.76	1022.77	1020.67	1019.12	1017.82	1017.03	1016.29	1015.64	1015.37	1015.40
Accumu. Distance	3,000	3,100	3,200	3,300	3,400	3,500	3,600	3,700	3,800	3,900	4,000
Distance (m)	0	100	100	100	100	100	100	100	100	100	100

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

ROAD PLAN

2-4



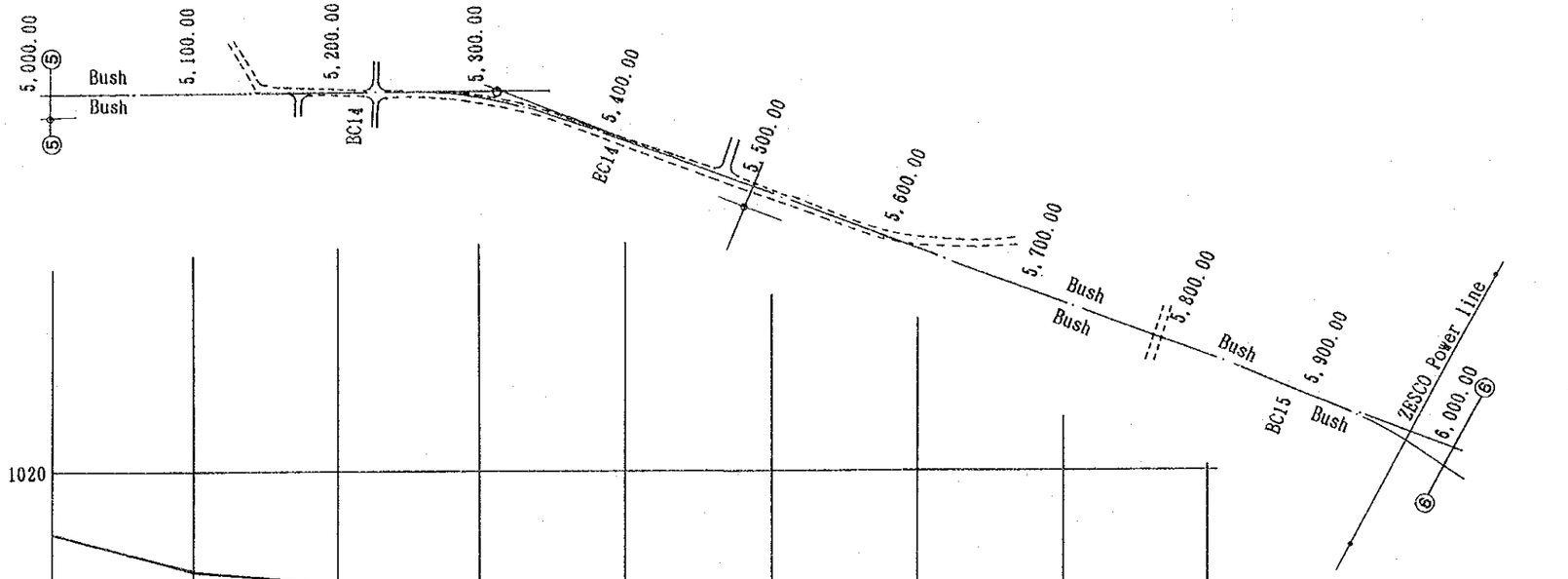


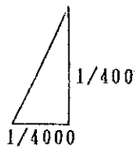
Slope	35/1000		2/1000	LEVEL		3/1000	5/1000	3/1000	LEVEL	5/1000	
Design El. (m)	1015.50	1015.85	1016.20	1016.40	1016.40	1016.40	1016.10	1015.60	1015.30	1015.30	1014.80
Ground El. (m)	1015.40	1015.71	1016.18	1016.46	1016.43	1016.35	1016.13	1015.60	1015.27	1015.25	1014.77
Accumu. Distance	4,000	4,100	4,200	4,300	4,400	4,500	4,600	4,700	4,800	4,900	5,000
Distance (m)	0	100	100	100	100	100	100	100	100	100	100

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

ROAD PLAN

2-5



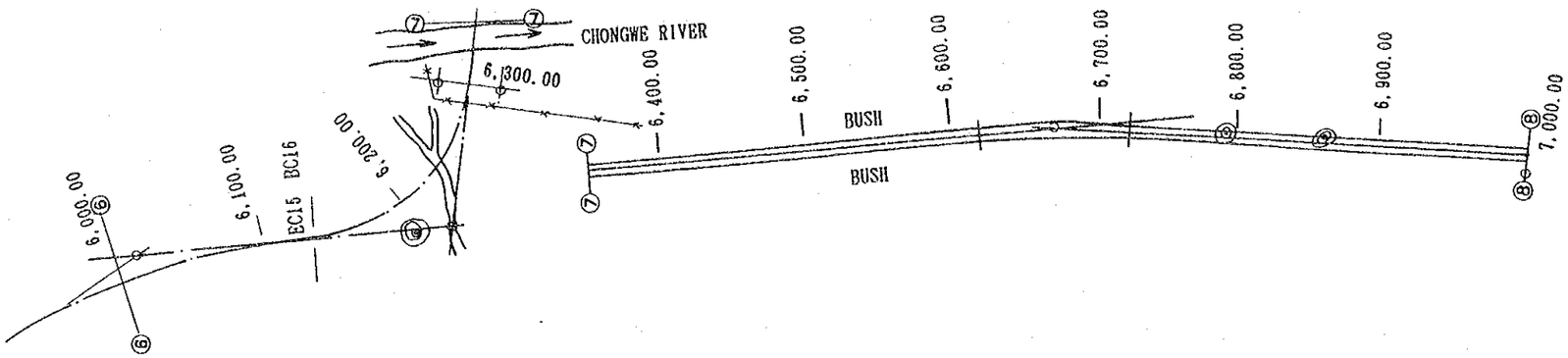


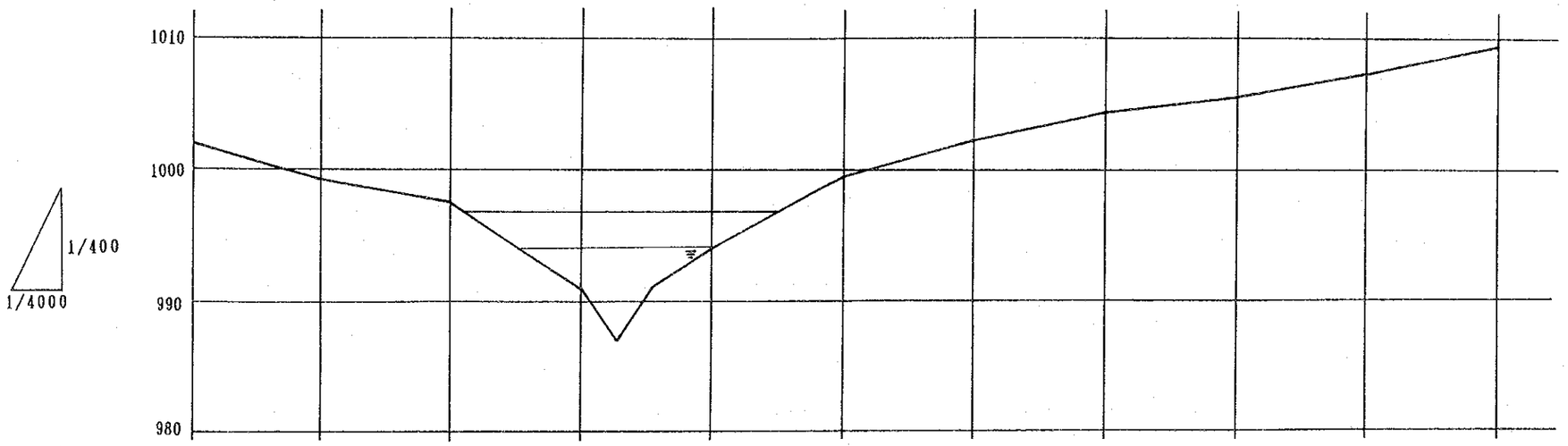
Slope	7/1000	9/1000	4/1000	6/1000	LEVEL	1/1000	8/1000	19/1000	3/100	34/1000	
Design El. (m)	1014.80	1013.10	1012.20	1011.80	1011.20	1011.20	1011.10	1010.30	1008.40	1005.40	1002.00
Ground El. (m)	1014.77	1013.10	1012.18	1011.83	1011.23	1011.26	1011.07	1010.29	1008.37	1005.39	1001.83
Accumu. Distance	5,000	5,100	5,200	5,300	5,400	5,500	5,600	5,700	5,800	5,900	6,000
Distance (m)	0	100	100	100	100	100	100	100	100	100	100

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

ROAD PLAN

2-6



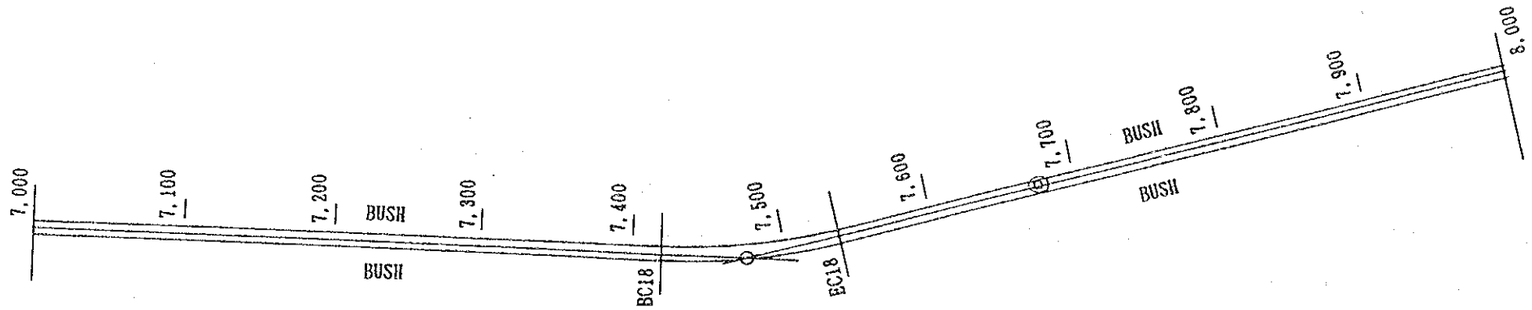


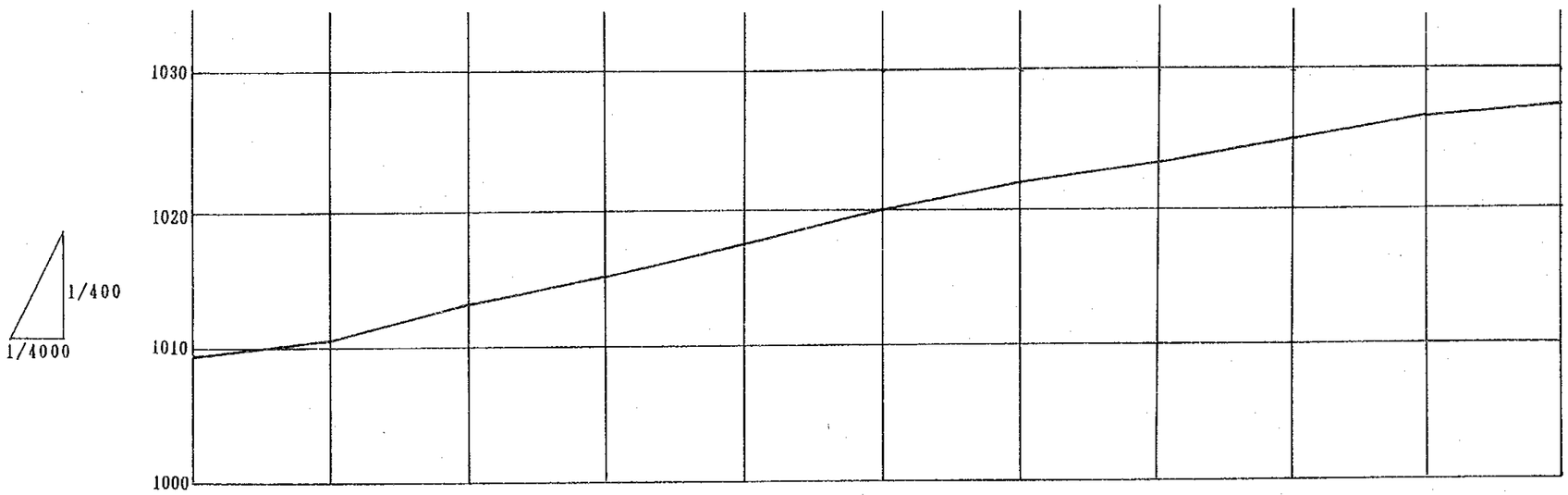
Slope	3/100	15/1000	1/70	LEVEL			48/1000	3/100	2/100	1/100	2/100	
Design El. (m)	1002.00	999.00	997.50	996.40	Bridge	996.40	999.00	1002.00	1004.00	1005.00	1007.00	1009.00
Ground El. (m)	1001.83	999.18	997.92	991.05	986.75	991.00	994.44	999.70	1002.56	1004.41	1005.62	1007.38	1009.30
Accumu. Distance	6,000	6,100	6,200	6,300	6,325	6,350	6,400	6,500	6,600	6,700	6,800	6,900	7,000
Distance (m)	0	100	100	100	25	50	100	100	100	100	100	100	100

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

ROAD PLAN

2-7



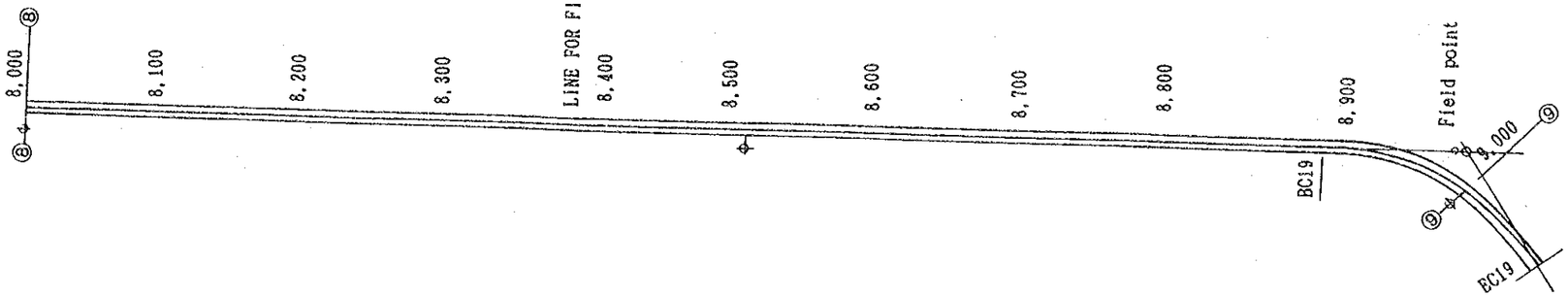


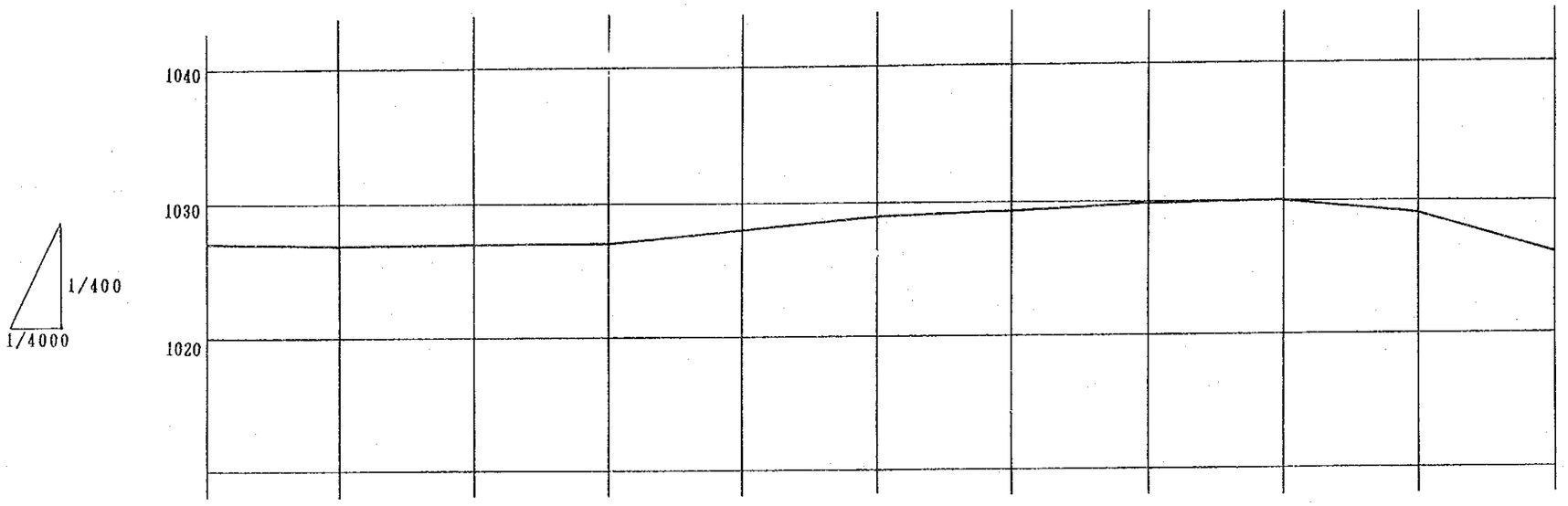
Slope	1/100	3/100	2/100	25/1000	2/100	15/1000	15/1000	5/1000			
Design El. (m)	1009.00	1010.00	1013.00	1015.00	1017.00	1019.50	1021.50	1023.50	1025.00	1026.50	1027.00
Ground El. (m)	1009.30	1010.51	1013.19	1015.06	1017.57	1019.88	1021.87	1023.34	1024.96	1026.75	1027.31
Accumu. Distance	7,000	7,100	7,200	7,300	7,400	7,500	7,600	7,700	7,800	7,900	8,000
Distance (m)	0	100	100	100	100	100	100	100	100	100	100

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

ROAD PLAN

2-8



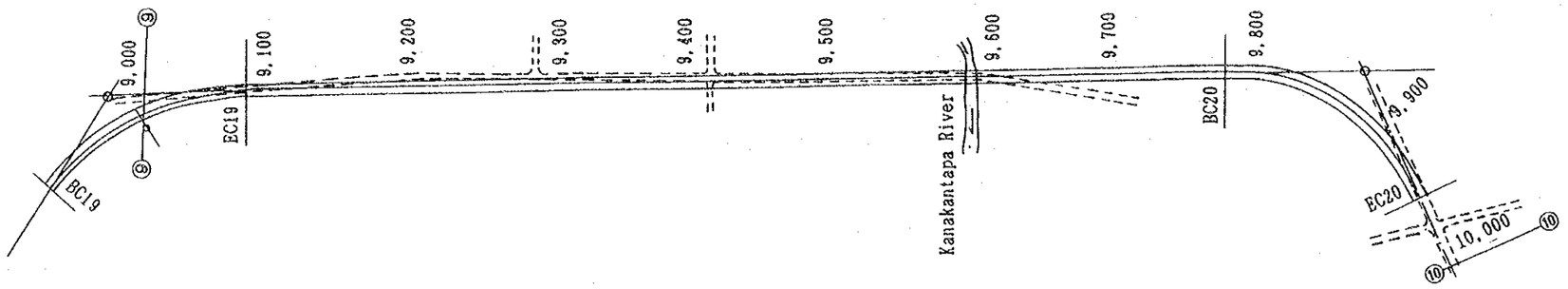


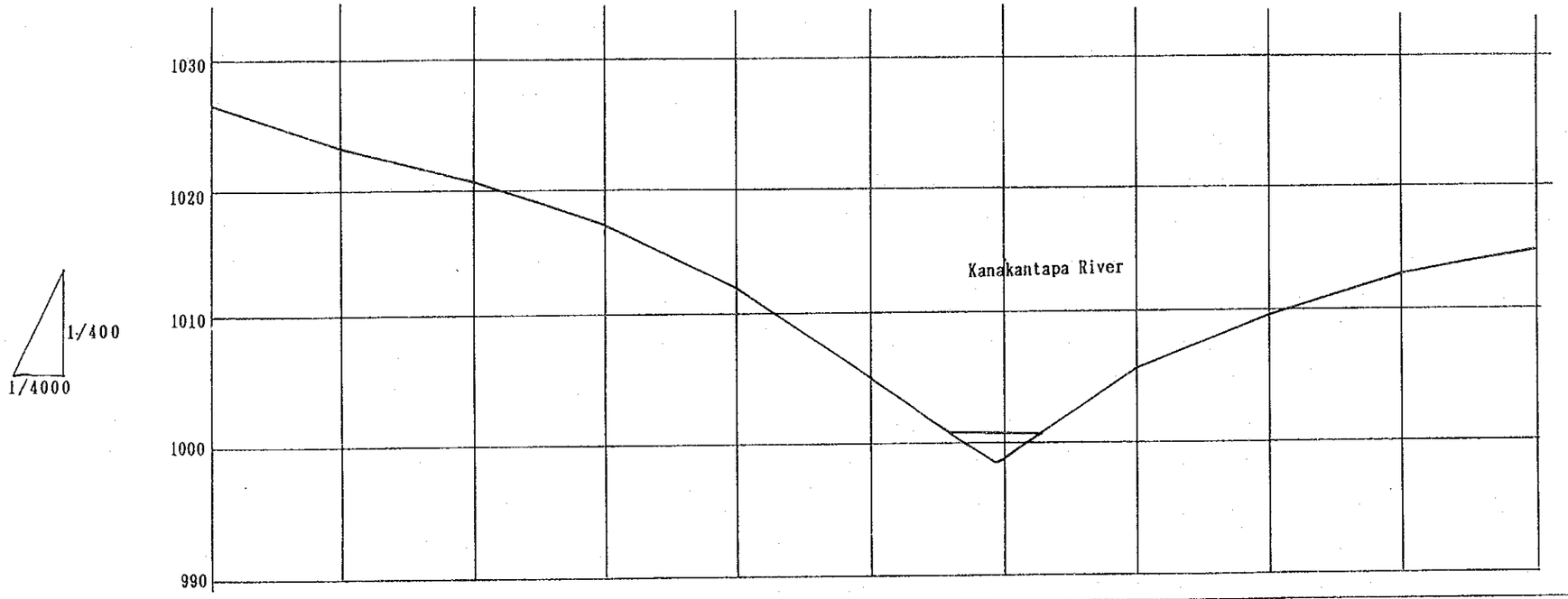
Slope	LEVEL			1/100	5/1000	1/100	LEVEL		3/100	
Design El. (m)	1027.00	1027.00	1027.00	1027.00	1028.00	1029.00	1029.50	1030.00	1030.00	1029.00	1026.00
Ground El. (m)	1027.31	1027.12	1027.04	1026.95	1027.99	1029.19	1029.76	1029.95	1030.06	1029.08	1026.42
Accumu. Distance	8,000	8,100	8,200	8,300	8,400	8,500	8,600	8,700	8,800	8,900	9,000
Distance (m)	0	100	100	100	100	100	100	100	100	100	100

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

ROAD PLAN

2-9



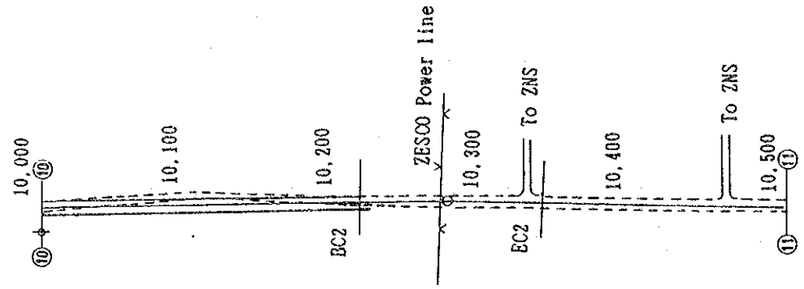


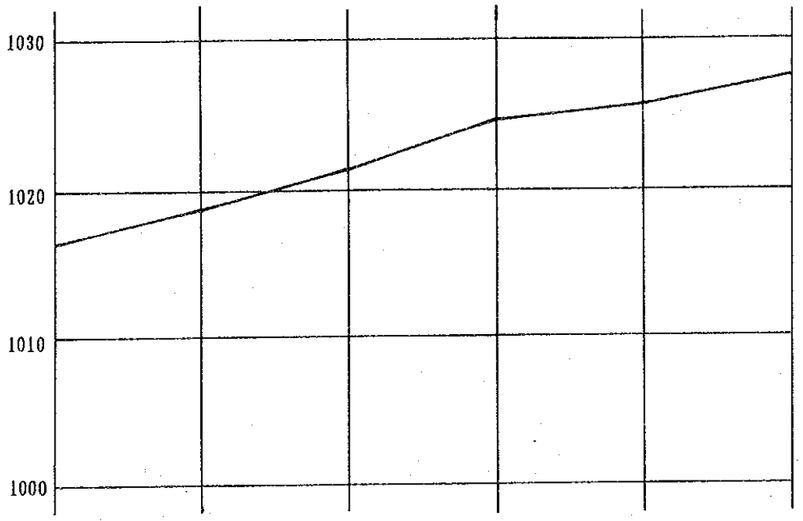
Slope	25/1000		3/100	5/100	7/100	67/1000	LEVEL	32/1000	4/100	3/100	18/1000		
Design El. (m)	1026.00	1023.50	1021.00	1018.00	1013.00	1006.00	1002.00	1002.00	1002.00	1007.40	1011.40	1014.40	1016.20
Ground El. (m)	1026.42	1023.52	1021.14	1017.99	1013.12	1006.02	1002.00	1000.48	1002.00	1007.40	1011.43	1014.42	1016.19
Accumu. Distance	9,000	9,100	9,200	9,300	9,400	9,500	9,560	9,600	9,625	9,700	9,800	9,900	10,000
Distance (m)	0	100	100	100	100	100	60	100	25	100	100	100	100

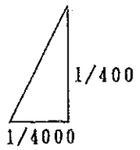
NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

ROAD PLAN

2-10





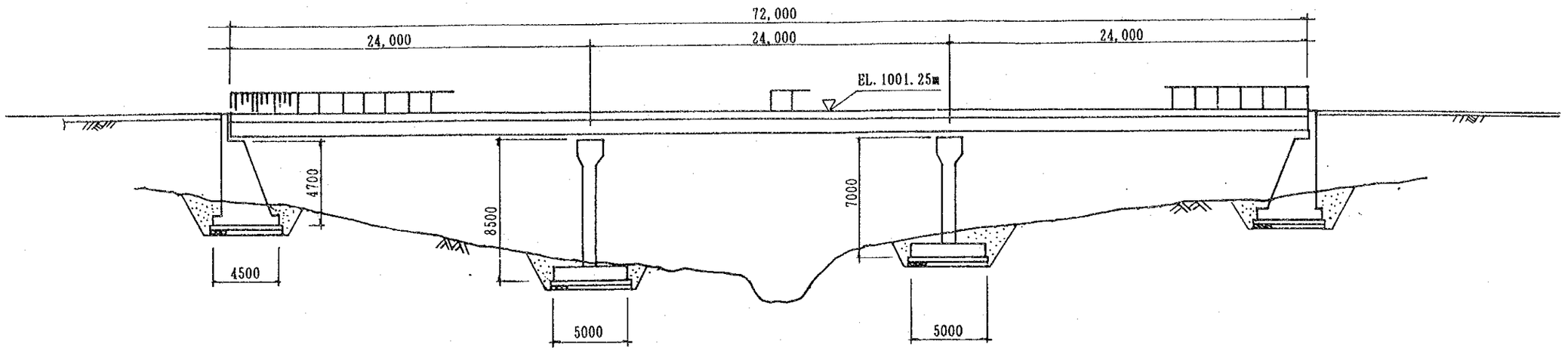


Slope	23/1000	25/1000	35/1000	3/100	17/1000	
Design El. (m)	1016.20	1018.50	1021.00	1024.50	1025.50	1027.20
Ground El. (m)	1016.19	1018.62	1021.17	1024.52	1025.45	1027.18
Accumu. Distance	10,000	10,100	10,200	10,300	10,400	10,500
Distance (m)	0	100	100	100	100	100

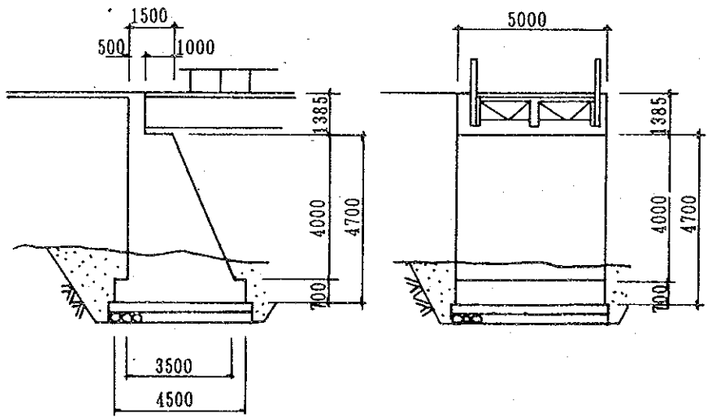
NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

ROAD PLAN

2-11



P L O F I L S = 1/300



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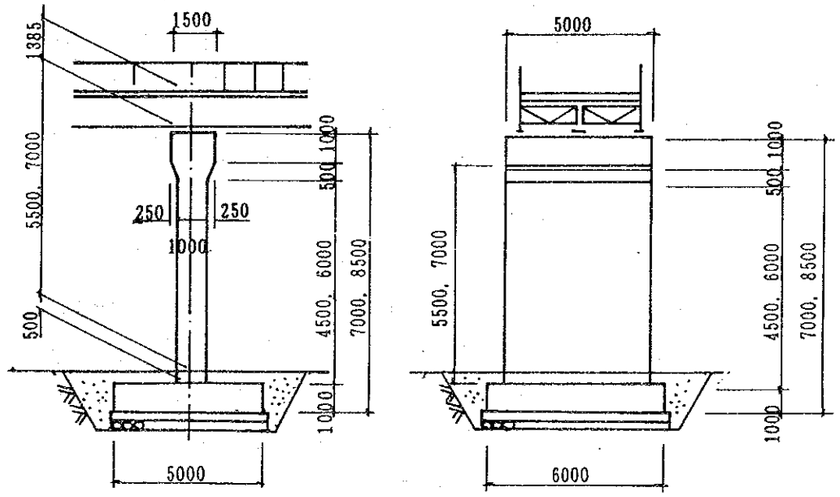

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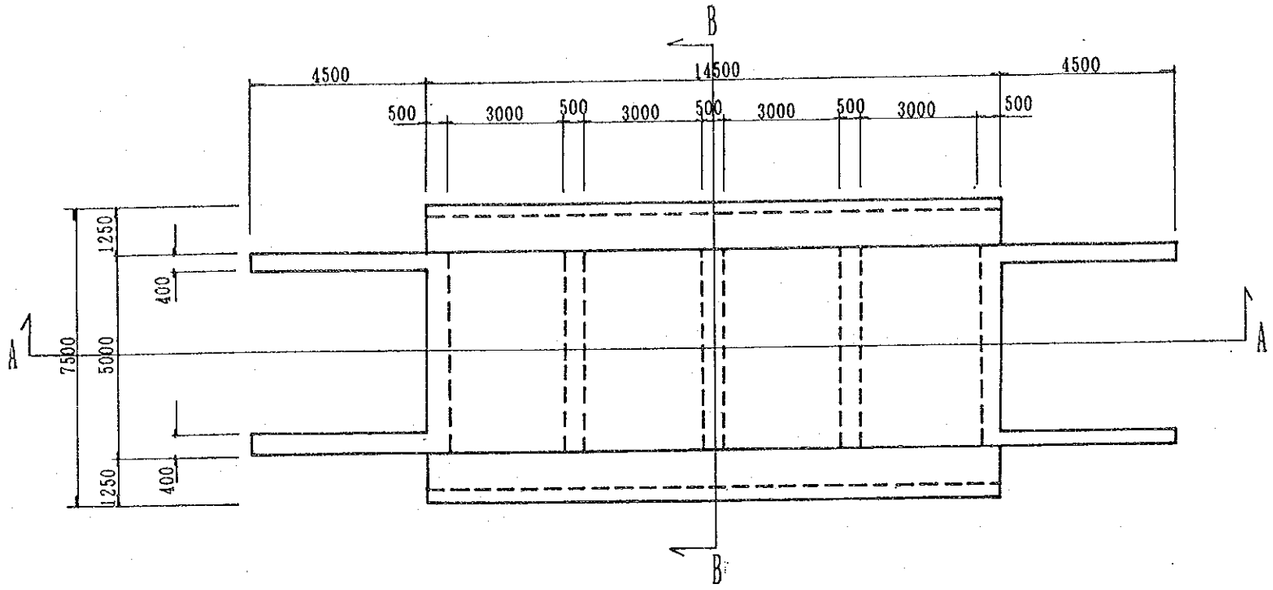
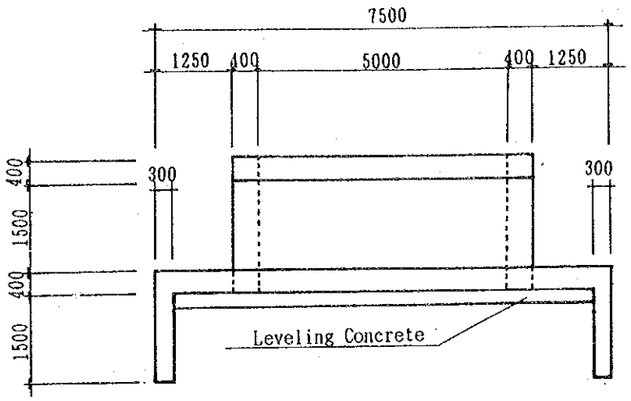
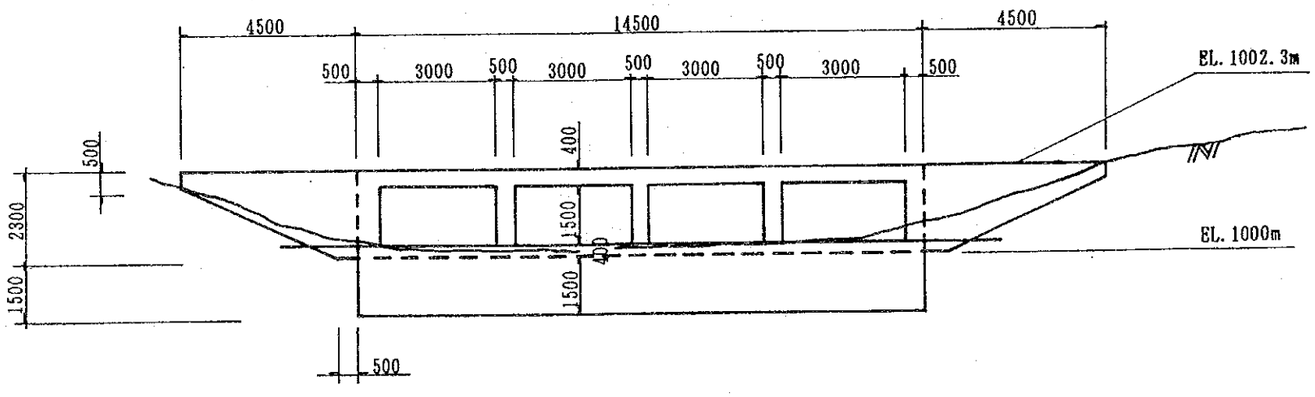


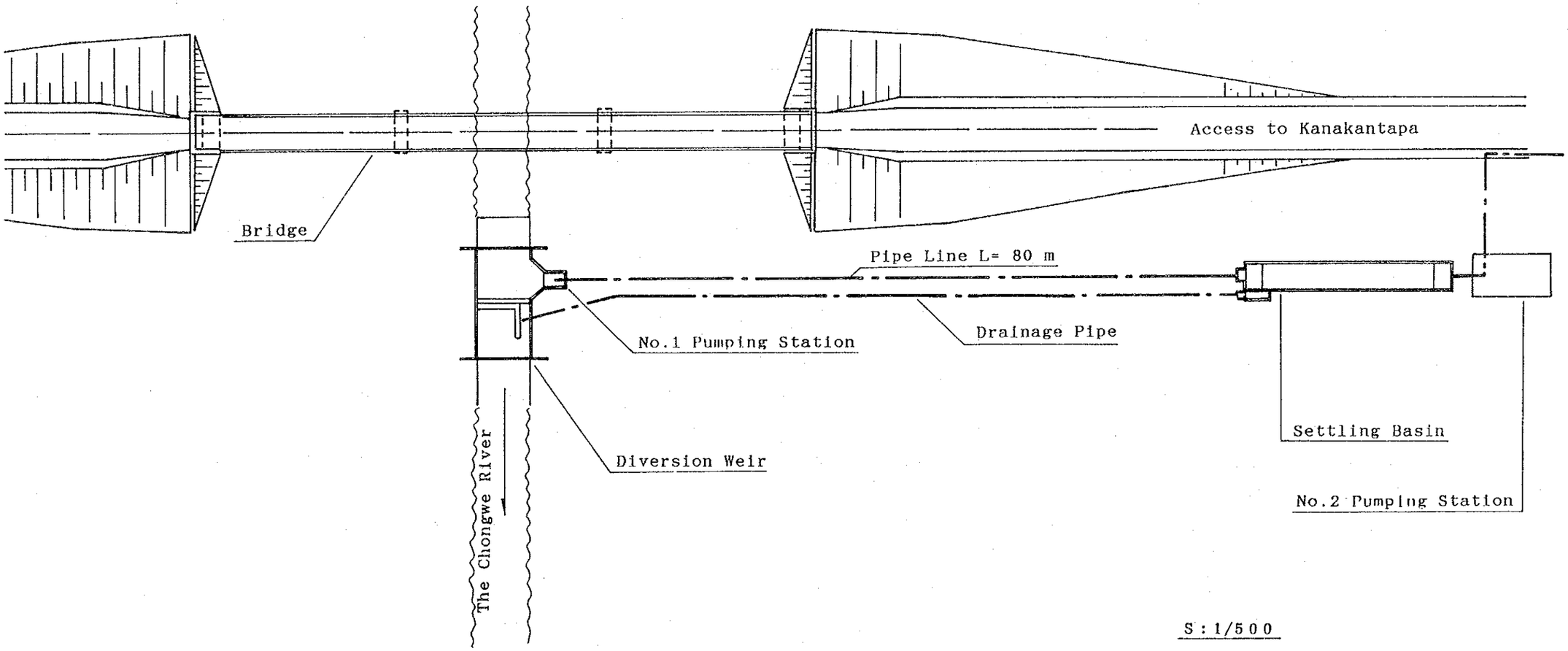
P L A N S = 1/150



B - B S e c t i o n S = 1/100



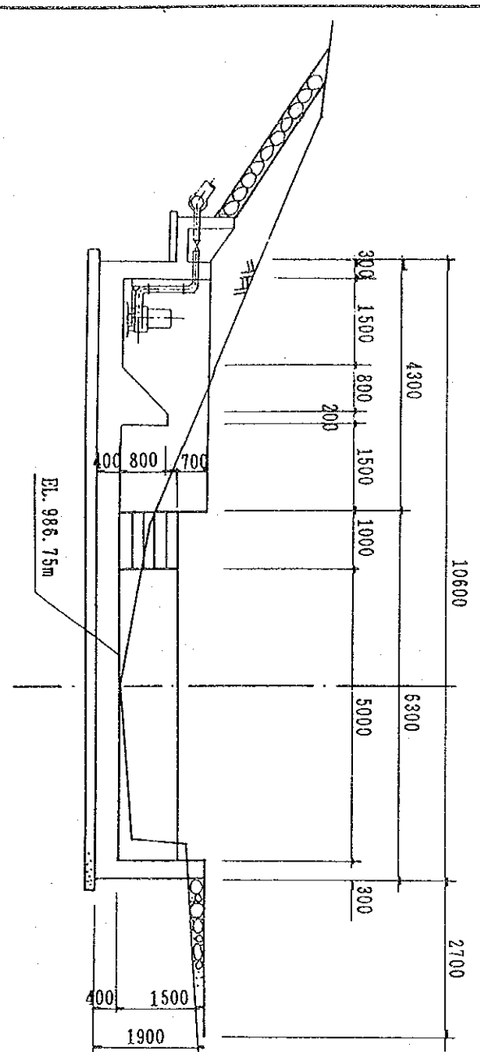
A - A S e c t i o n S = 1/150



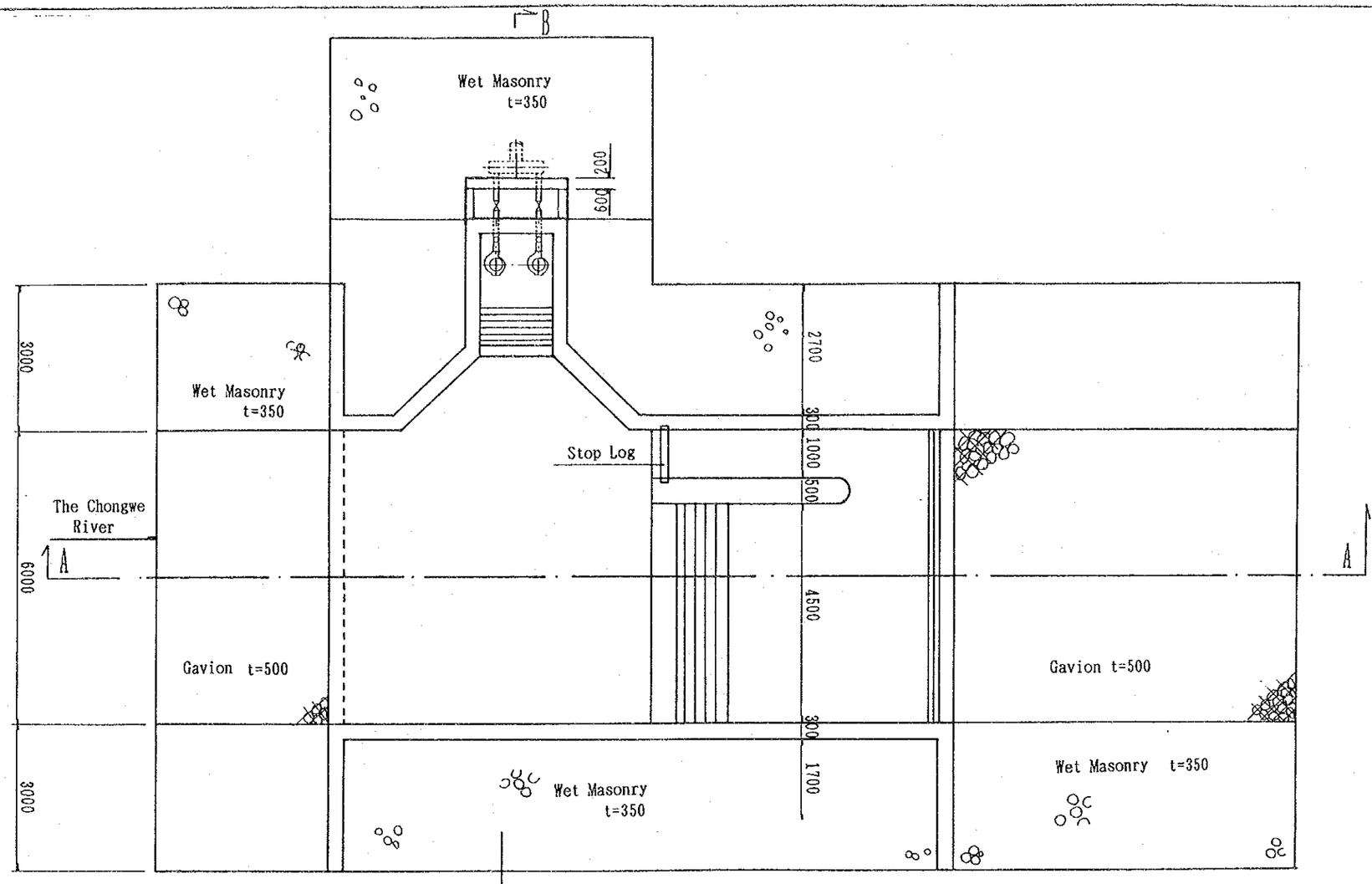
NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Layout of Diversion Works

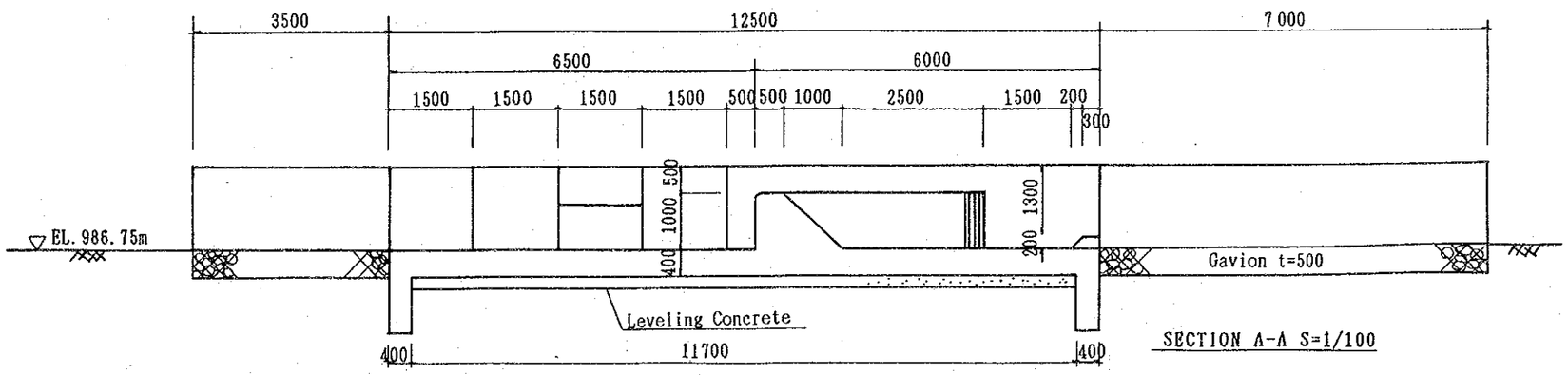
5



SECTION B-B S=1/100



PLAN S=1/100

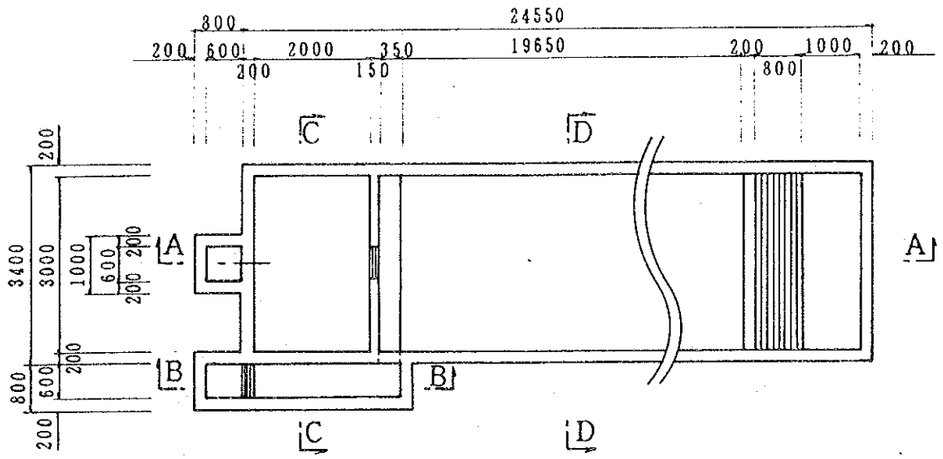


SECTION A-A S=1/100

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Diversion Weir

6



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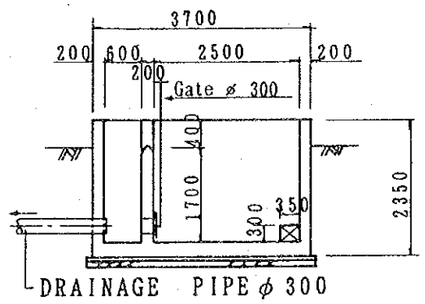

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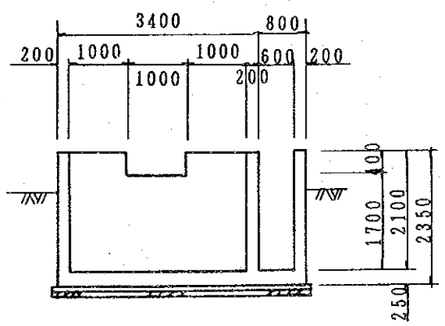

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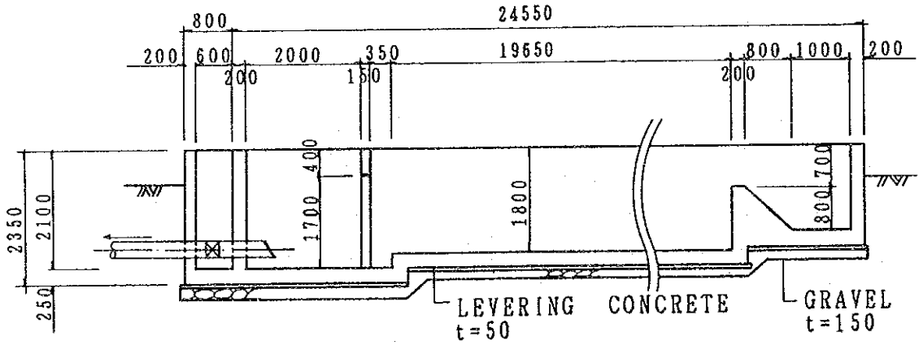

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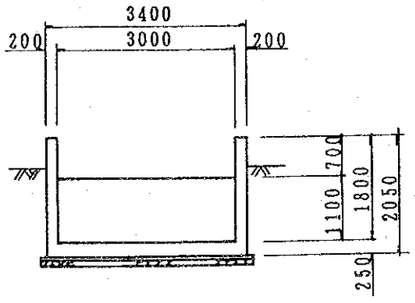

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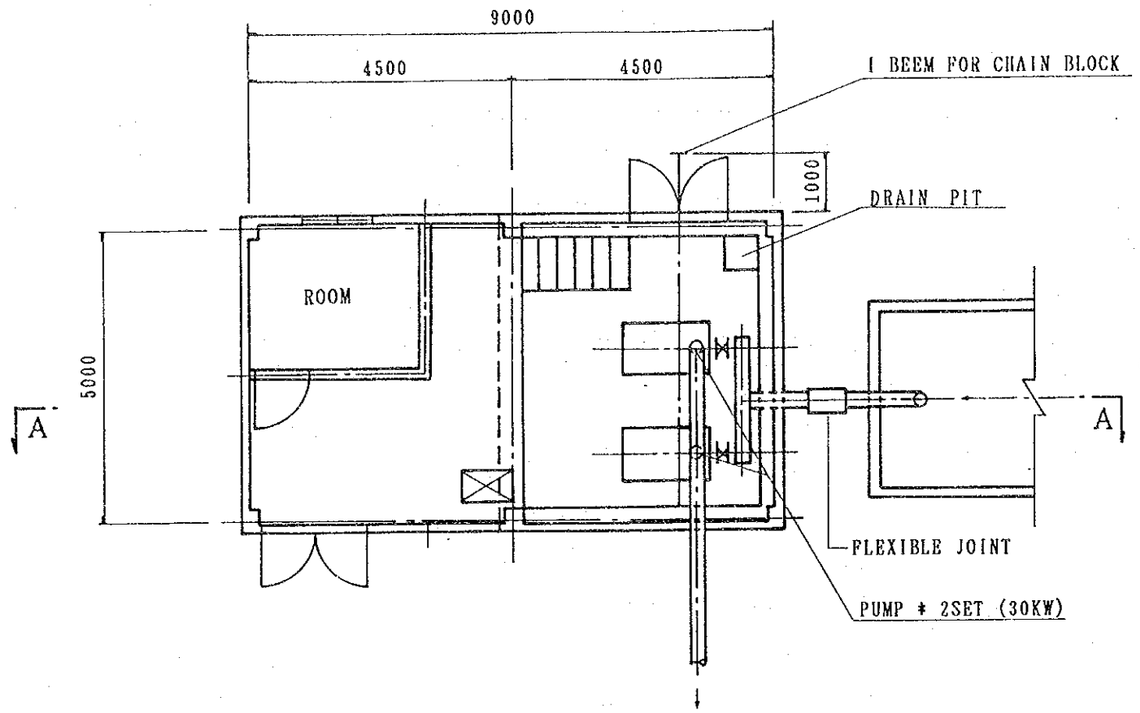

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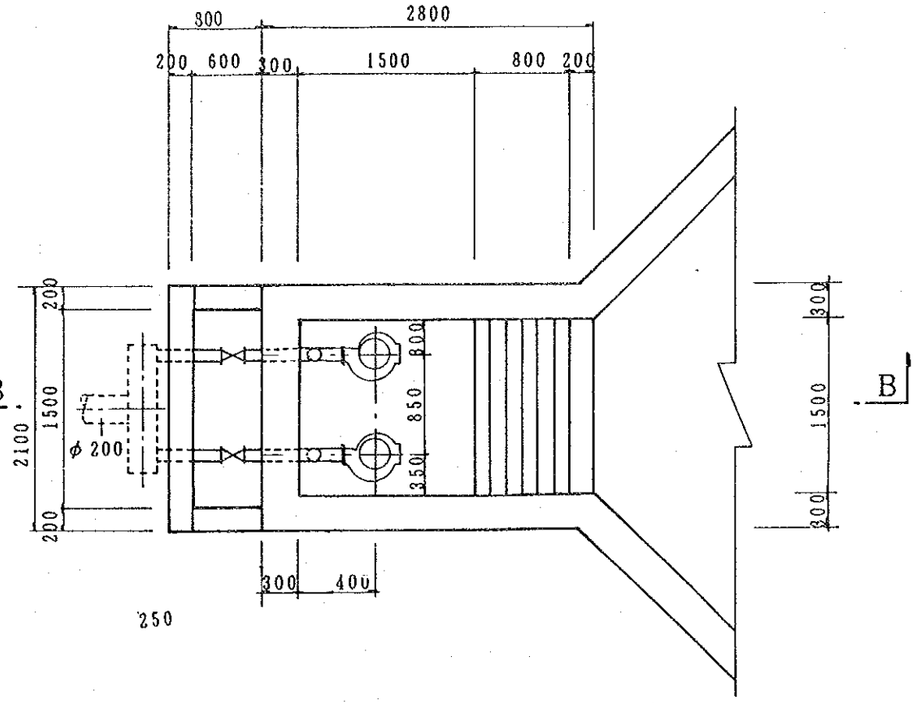

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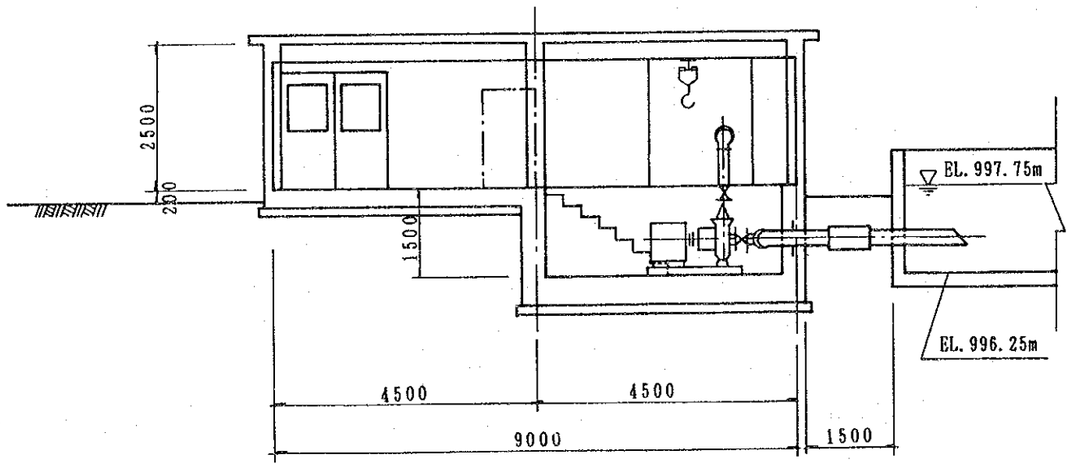
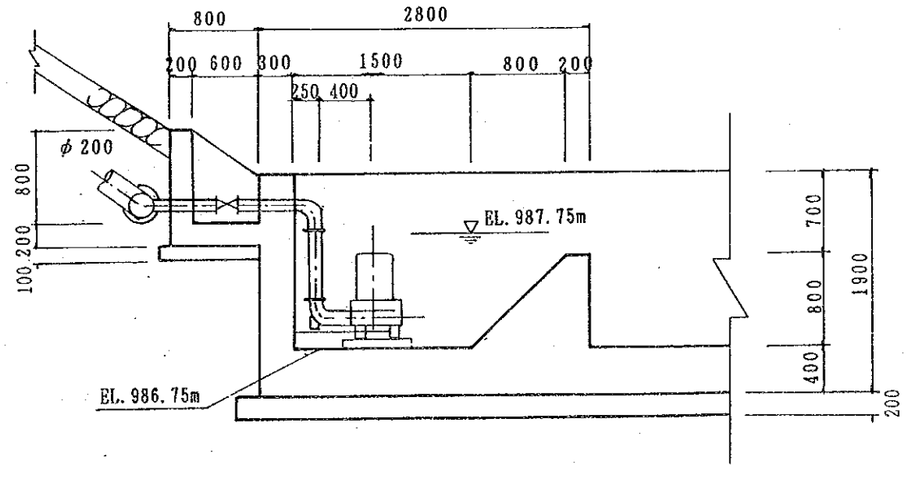


SECTION A－A S=1/100

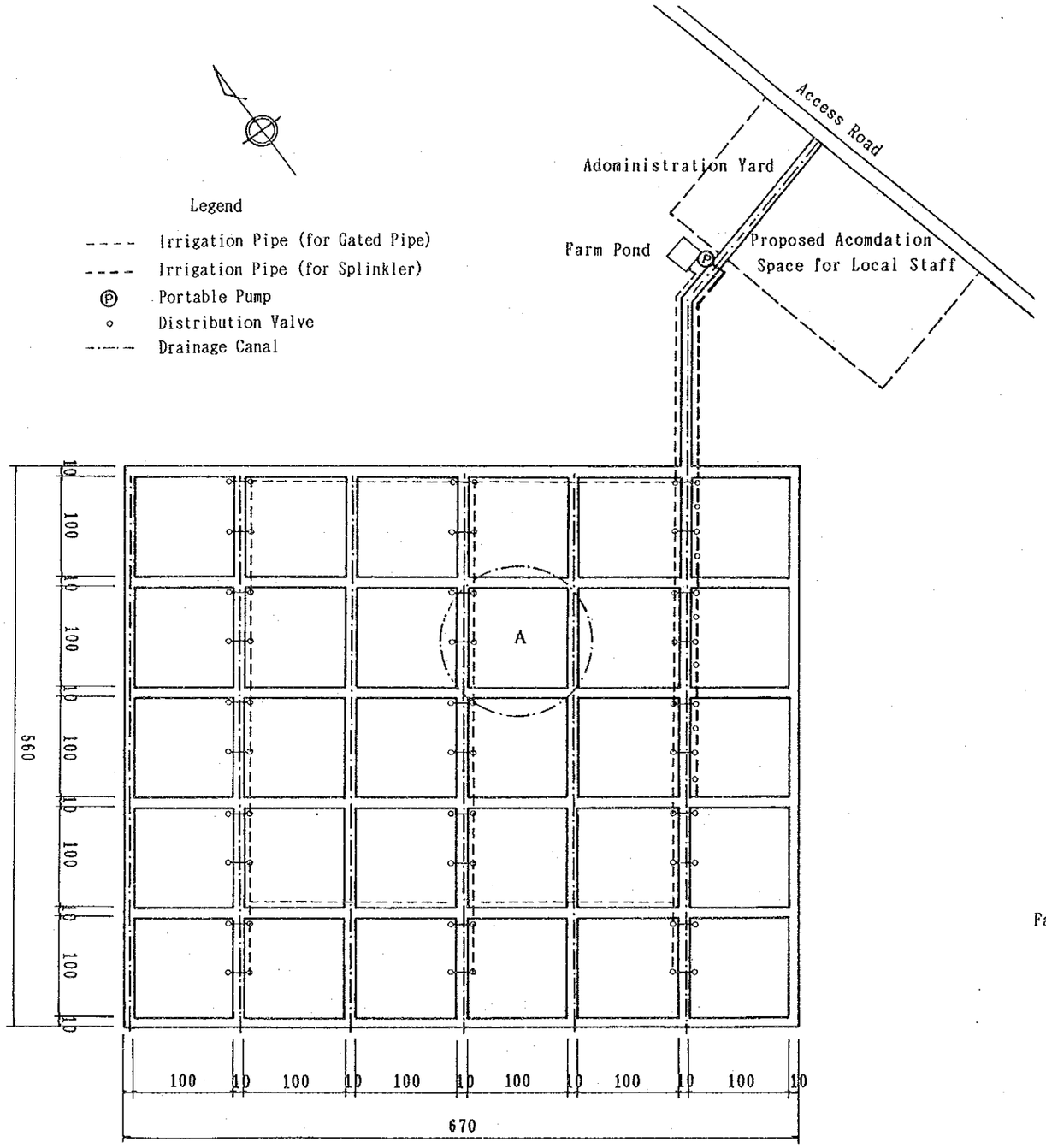


SECTION B－B S=1/50

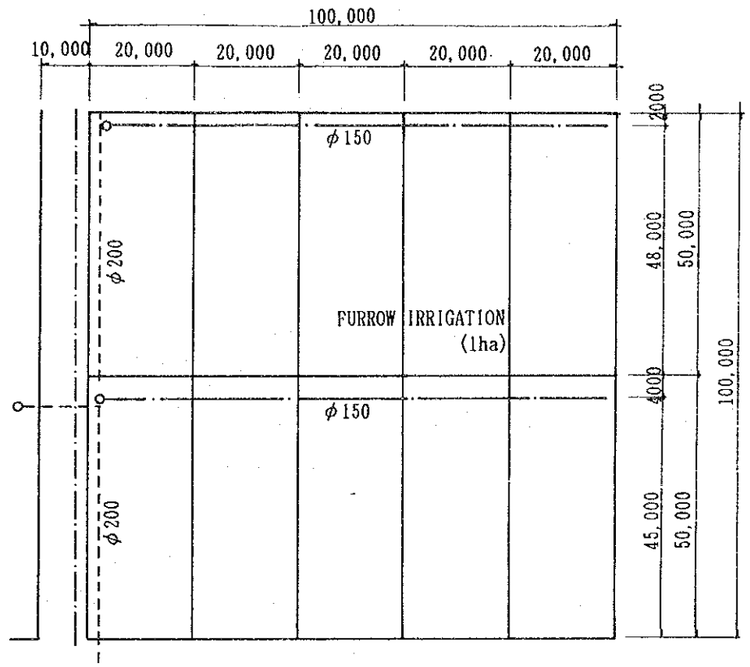
NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Pump Stations

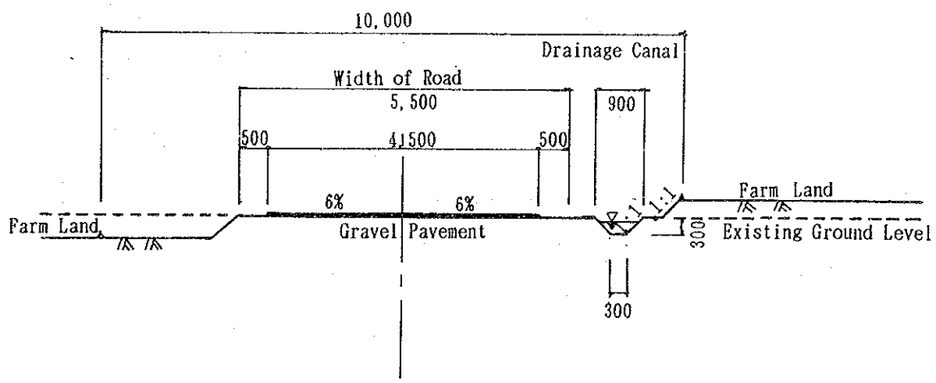
8



Layout of Trainning Farm s=1/500



Detail of A Legend

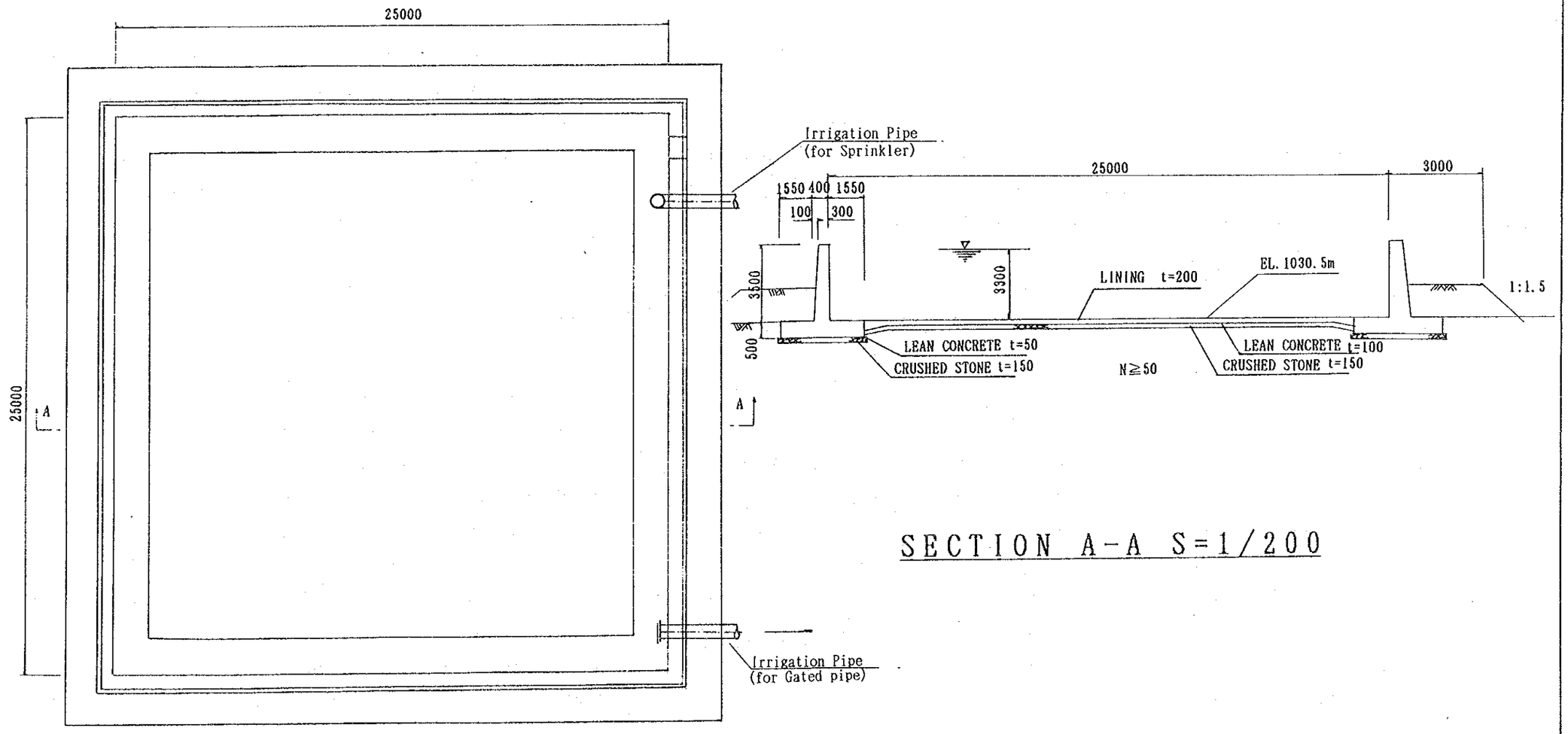


Standard Section of Farm Road S = 1/100

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Layout of Training Farm and Standard Farm Lot

9



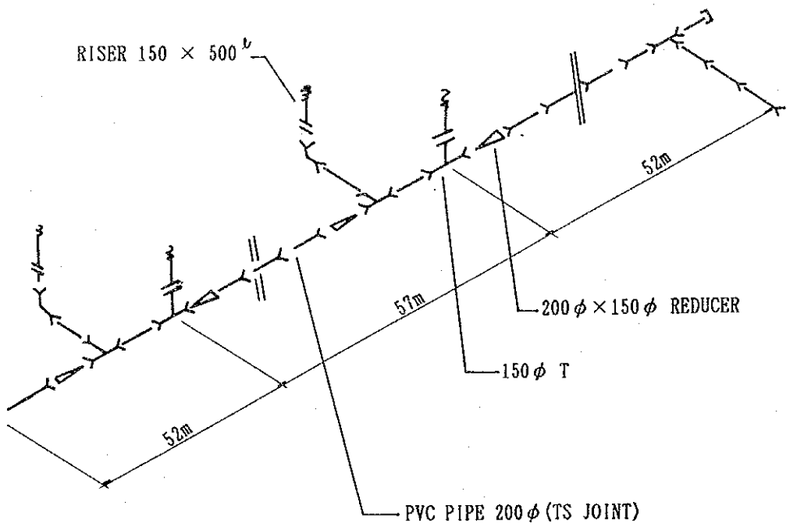
PLAN S=1/200

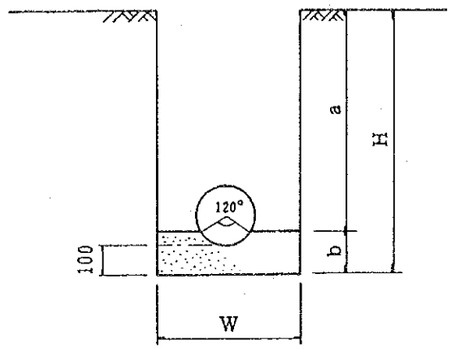
SECTION A-A S=1/200

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Farm Pond

10

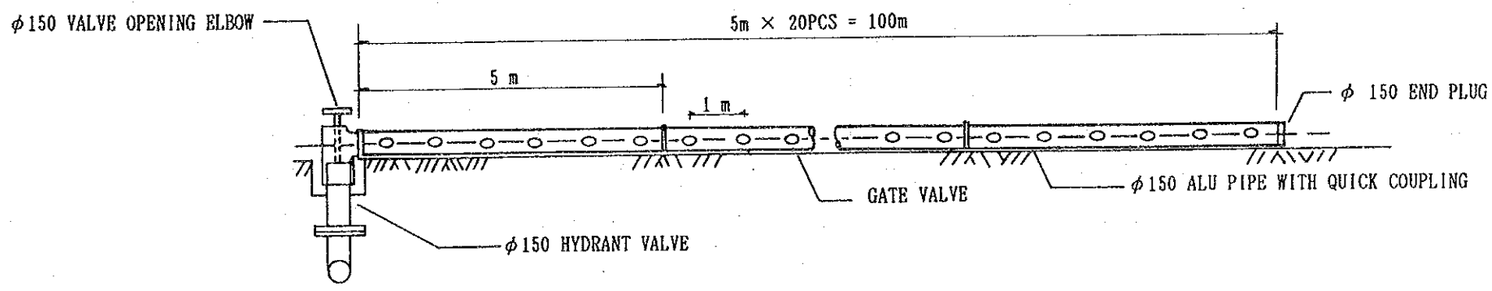




Dimensions(mm)

Material	W	H	a	b
Ductile Pipe				
φ250	700	1,100	850	250
Polyvinyl Pipe				
φ250	700	1,000	750	250
φ200	500	900	700	200
φ150	500	900	700	200

SECTION OF IRRIGATION PIPE



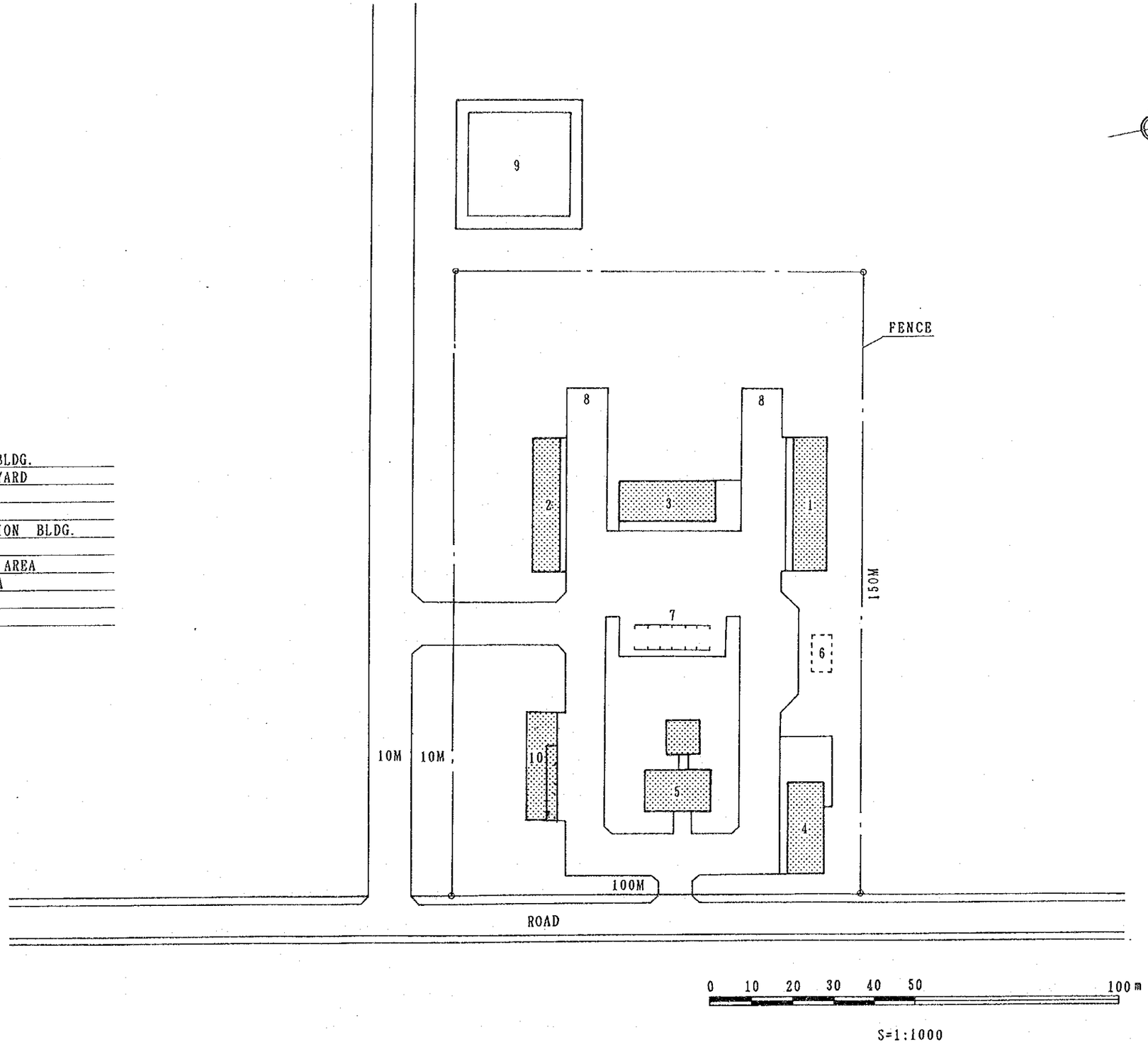
Gated Pipe

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Hydrant Riser Arrangement

11

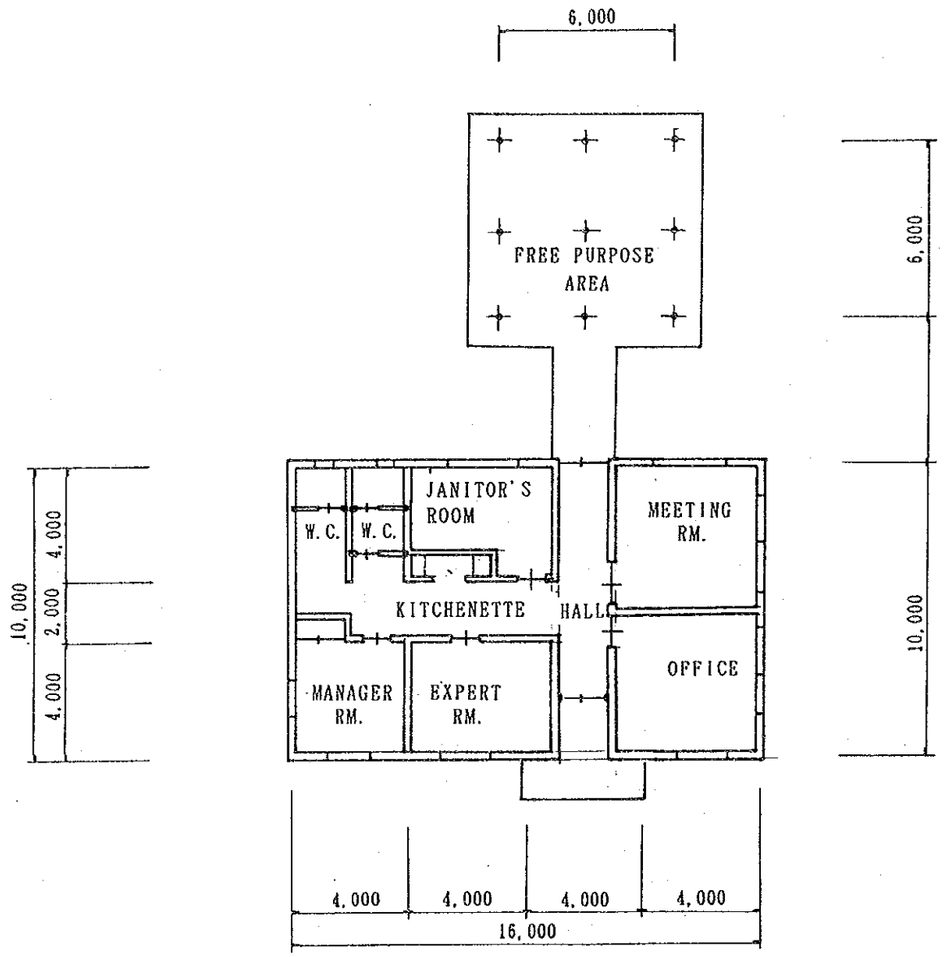
1	MACHINERY BLDG.
2	MACHINERY YARD
3	WORKSHOP
4	WAREHOUSE
5	ADMINISTRATION BLDG.
6	FUEL TANK
7	CAR PARKING AREA
8	MACHINE AREA
9	FARM POND
10	LODGING HOUSE



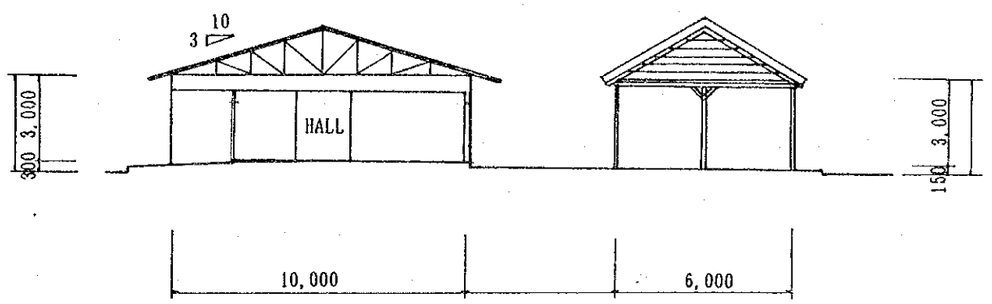
NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Layout of Administration Yard

12



ADMINISTRATION BLDG. PLAN S=1:200



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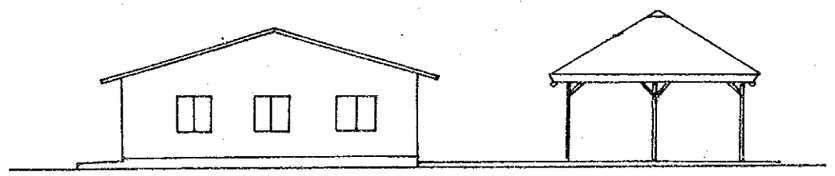
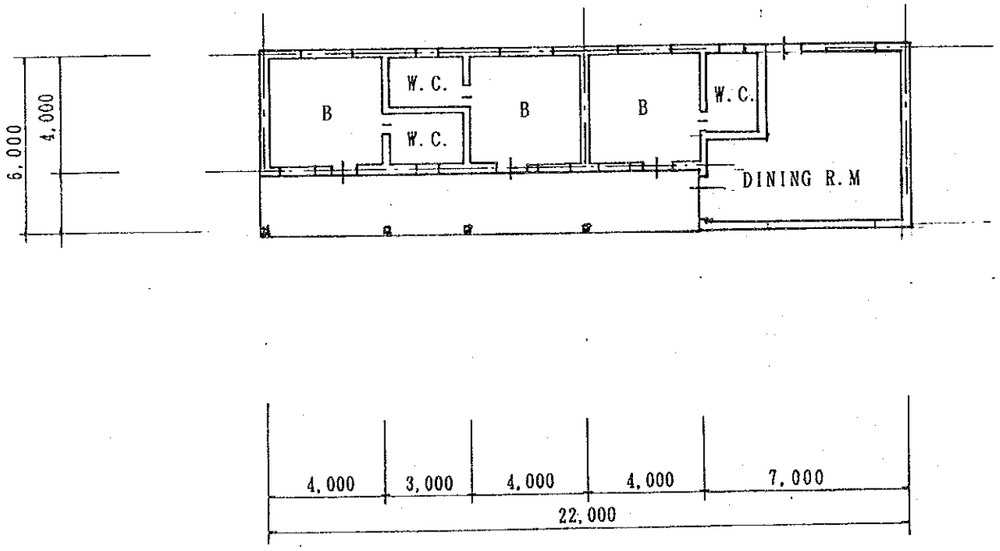


ELEVATION S=1:200

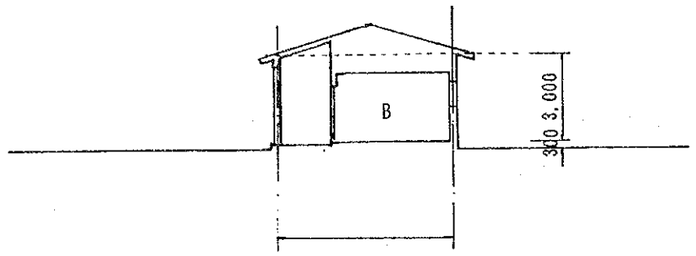
NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Administration Bldg

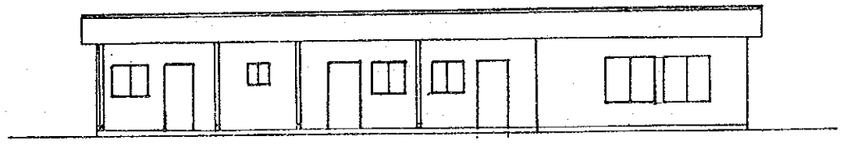
13



LODGING HOUSE FOR EXPERTS S=1:200



SECTION S=1:200

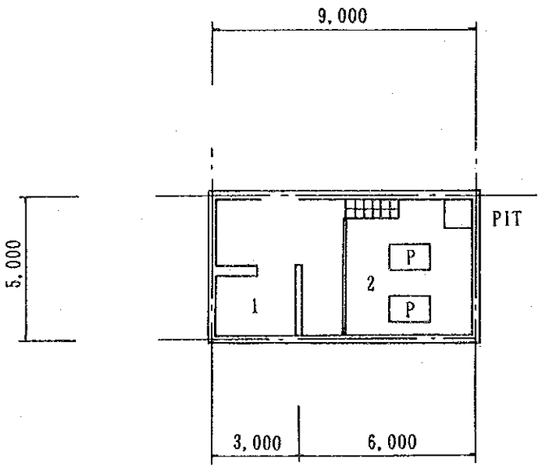


ELEVATION S=1:200

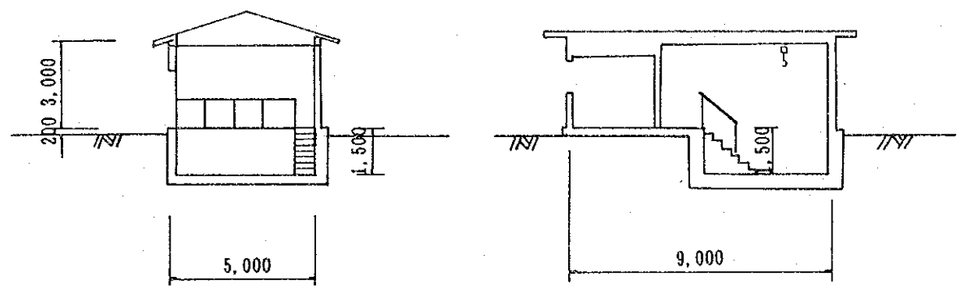
NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Lodging House for Experts

14



PUMP HOUSE PLAN S=1:200



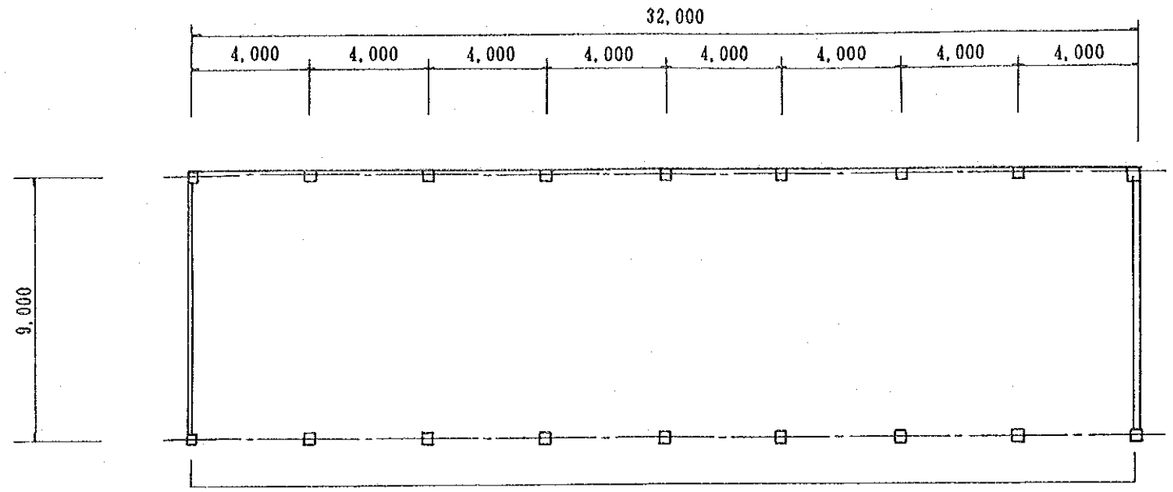
SECTION S=1:200

1. TOOL STORE
2. PUMP ROOM

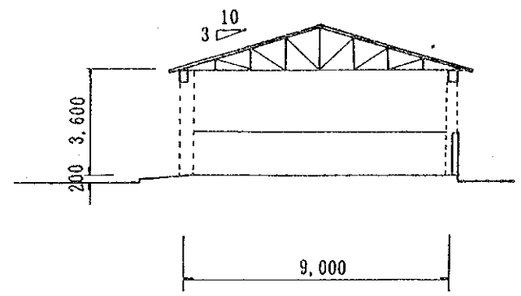
NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Pump house

15



MACHINERY BLDG. 1 PLAN S=1:200



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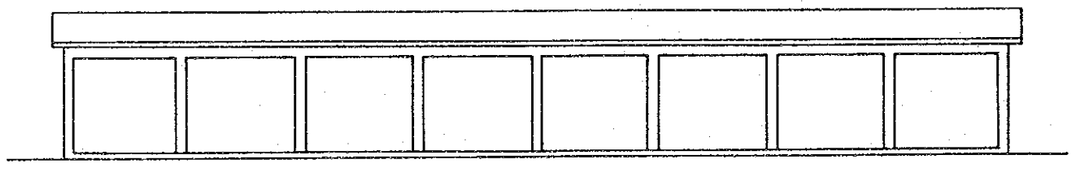
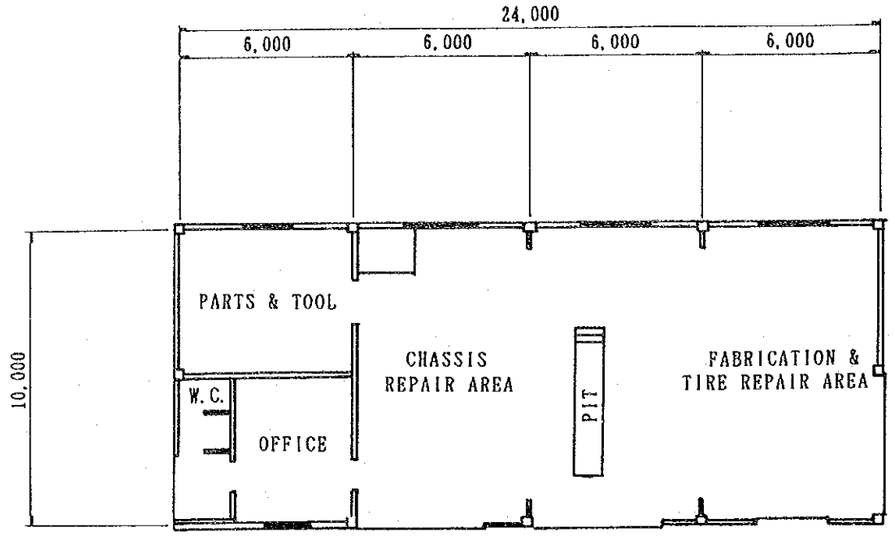
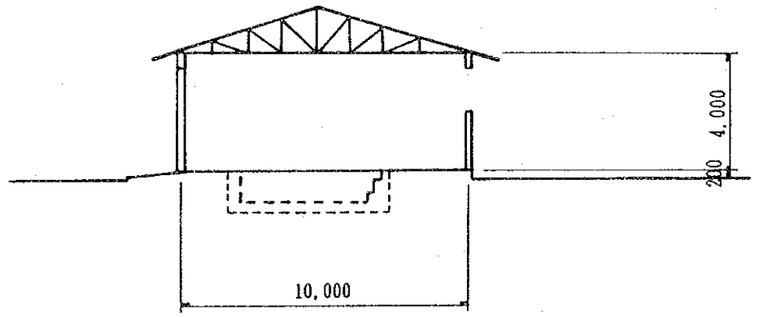


ELEVATION S=1:200



WORKSHOP PLAN S=1:200



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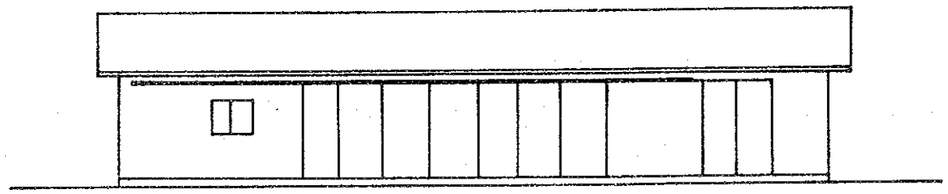
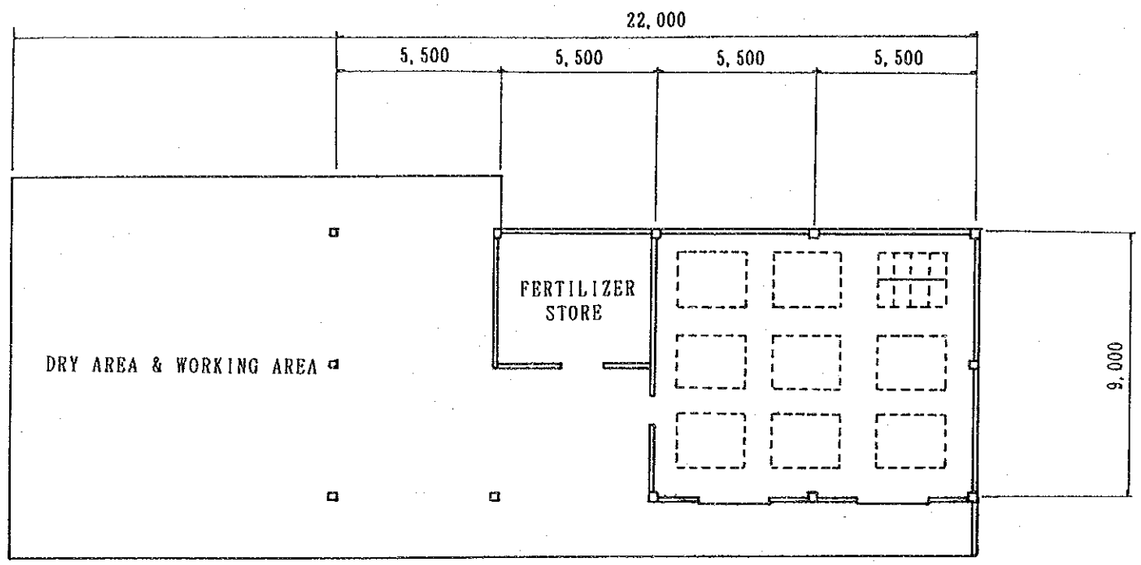
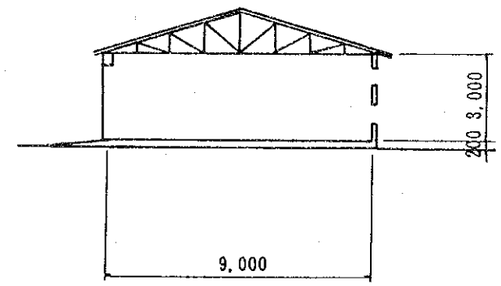
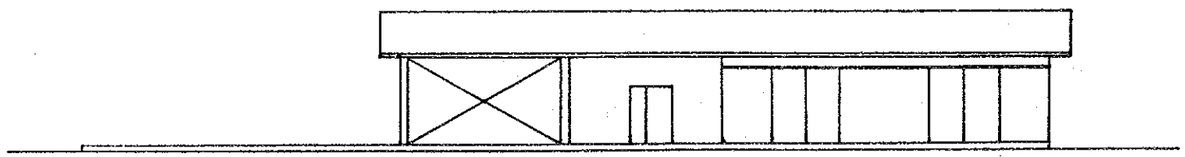


ELEVATION S=1:200





WAREHOUSE PLAN S=1:200



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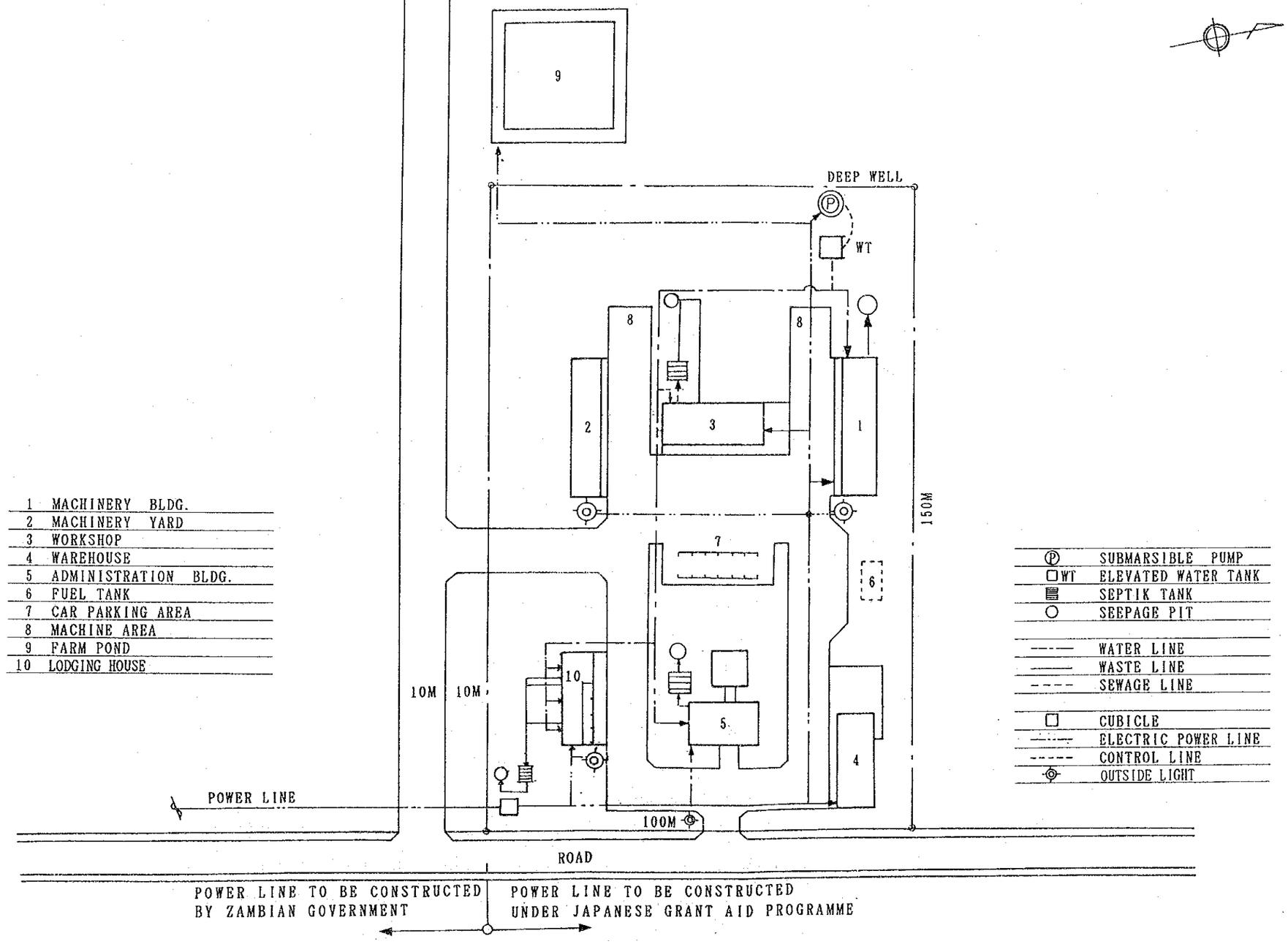


1	MACHINERY BLDG.
2	MACHINERY YARD
3	WORKSHOP
4	WAREHOUSE
5	ADMINISTRATION BLDG.
6	FUEL TANK
7	CAR PARKING AREA
8	MACHINE AREA
9	FARM POND
10	LODGING HOUSE

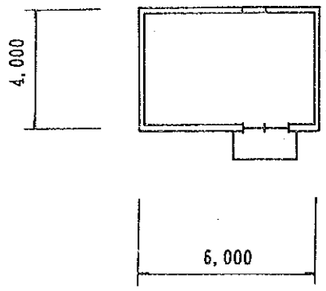
P	SUBMARSIBLE PUMP
WT	ELEVATED WATER TANK
	SEPTIK TANK
	SEEPAGE PIT
----	WATER LINE
——	WASTE LINE
- - - -	SEWAGE LINE
	CUBICLE
—·—·—	ELECTRIC POWER LINE
-----	CONTROL LINE
	OUTSIDE LIGHT

S=1:1000

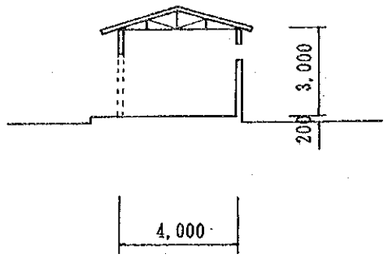
NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Electric Power Diagram

19



MILL HOUSE PLAN S=1:200



SECTION S=1:200

NEW AGRICULTURAL VILLAGE DEVELOPMENT PROJECT

Millhouse

20

4-4 Project Implementation Plan

4-4-1 Project Construction Condition

The executing organization of the Project is the Department of Resettlement of the Prime Minister's Office which is proceeding with the resettlement programme nationwide in Zambia in accordance with advice received from the National Steering Committee (NSC). Therefore, application must be made through the Department of Resettlement prior to proceeding with any of the Project,s electrical, building, or river work.

The project implementation organization will be composed of the Department of Resettlement, a consultant firm which will undertake he Project's detailed design preparation and construction supervision, and a construction contractor.

After making a consultant contract agreement with the Department of Resettlement, the consultant will conduct field surveys, and conduct detailed design preparation and its related work, tendering, and construction supervision, such as engineering management, schedule control, and safety management.

A construction contractor will be selected by tendering. The contractor will establish an area office and assign a chief engineer to the office to manage construction work for the entire Project.

For the construction of bridges and pumping stations, a specialist for each job will be needed.

4-4-2 Project Implementation Method

① In Zambia, construction work is not mechanized to any great extent. Most of the construction contractors who may be used as subcontractors for Project construction have no large construction equipment. During the field survey period, the study team did not come across any contractor having a crane for use in bridge construction, nor did they find any that employed a bridge engineer.

For the construction of the access road bridges, it will be necessary to bring in a 15-ton capacity truck crane and bridge engineers.

Also, as there are no pump installation engineers available in Zambia, a specialist shall be dispatched from Japan.

② Zambia is a landlocked country. Project use equipment and materials must be put ashore at a foreign port and then transported a great distance through foreign port and then transported a great distance through foreign country (ies). Thus, the equipment and materials will be out of the direct control of the Government of Zambia during the shipping period. Furthermore, during the transporting period, the equipment and materials might fall into the hands of thieves or robbers. Therefore, small-sized equipment and material units must be securely packed and placed in containers.

③ If technical cooperation from the Government of Japan, such as the expert dispatchment programme, is to be provided continuously prior to completing Project construction for the management and operation of the provided equipment, it would be desirable to dispatch and equipment specialist who will actually take part in the management of the equipment units.

4-4-3 Construction and Construction Supervision Plan

For the implementation of the Project, the Government of Zambia will undertake the following work by using a consultant firm (hereinafter referred to as the consultant).

(1) Detailed Design

Based on the Basic design Study of the Project, the consultant will conduct field surveys and prepare the detailed design and tender documents. During this detailed design period, the consultant will confirm the Project implementation organization and the amount of budgetary funds of the Government of Zambia. The consultant will also confirm the progress of the undertakings that will be borne by the Government of Zambia in accordance with the previous agreement and

will reflect such progress in the tender documents so that smooth Project implementation will result.

(2) Tendering and Signing of the Contract

For tendering, the consultant will conduct tender announcement, pre-qualification evaluation, tender document delivery, and tender evaluation. The consultant will then assist the Government of Zambia in preparing a construction contract agreement with a Japanese contractor.

(3) Construction Supervision

1) Work to be Conducted on Japan

After the construction contract is signed, the consultant will examine the various drawings and documents that will be submitted by the contractor and will inspect the equipment and materials that will be purchased by the contractor.

2) Construction Supervision at the Project Site

The consultant will take various proceedings required for starting Project construction, witness the local procurement of equipment and materials, inspect work progress, advise and supervise the contractor for examining, making trial operations, and testing locally procured equipment, and conduct schedule control, quality control, and cost control in order to complete Project construction within the schedule specified in the Exchange of Notes for the Project.

3) Construction Supervision System

Civil engineering work for the Project is diversified into the construction of roads and irrigation system, and farmland development. Construction items include bridges, irrigation facilities, pumping stations, and pipeline. On the other hand, the total amount of building facility construction is relatively small (the management building is only one-storyed and all of the Project buildings are not of high grade).

For these remains, to conduct construction supervision, one civil engineer will remain at the site continuously and one architect will visit the site several times depending on the work progress.

4-4-4 Procurement Plan

As a rule, construction equipment and materials shall be procured in Zambia. Only items unobtainable in Zambia will be procured in Japan or other countries. Table 4.4.1 lists the major construction equipment and materials and the names of the countries from which they will be procured.

As a general principle, the equipment to be provided for the Project shall be procured in Japan. This equipment is listed in Table 4.4.2.

Table 4.4.1 Construction Equipment and Materials and the Procurement Countries

Zambia	Japan	Third Country
Materials and Equipment		
Sand	Valves	Gated pipes
Gravel	Air relief valves	
Cement	Mosaic tile	
Concrete	Steel doors	
Reinforcing bars	Shaped steel	
Wood	Sanitary earthenware	
Blocks	PVC pipes (for water supply)	
Slate	Generator	
Paint	Power distribution panels	
Tile	Power cables	
Fuel	Lighting fixtures,	
	Centrifugal pumps,	
	Submersible pumps Fuel tank, 3 m^3	
Construction Equipment		
Concrete mixer	Backhoe	
	Truck crane	
	21 - ton class bulldozer	

Table 4.4.2 Project Use Equipment to be Provide

to be procured in Zambia	to be procured in Japan
(For Land Reclamation & Farm Road Construction)	
	Bulldozers : D8 Class 2 Motor grader : 155HP 1 Backhoe : 0.4 m^3 1 Vibrating roller (self moving) : 10-ton Class 1 Sprinkler truck : 7 m^3 1
(For Training Farm)	
Bicycle : 30	Wheel tractors : 65HP 2 Disc harrow : 2 Disc plough : 2 Planter : 2 Ridger : 2 Rotary plough : 2 Trailer : 2 Small-sized farming equipments Pickup truck : 4WD 1 Truck : 6-ton 1 Wireless set : 2 Equipments for training Fixtures
(Equipement for Stabilizing Settlers Living Situation)	
Maize hammer mills : 3 Maize sheller : 9	
(Workshop Equipment)	
	A set of repair shop equipment and tools
(Spare Parts)	
	Amount equivalent to 10% of the above equipment values

4-4-5 Project Implementation Schedule

(1) Work Procedure and Contents

Project implementation starts when the Exchange of Notes concerning the grant aid cooperation for the Project is signed by the governments of Japan and Zambia.

After the Exchange of Notes is signed, the Government of Zambia's Department of Resettlement will make a consultant agreement with a Japanese consultant to undertake the Project.
The consultant will prepare the detailed design and tender documents, conduct a series of construction agreement related work, and carry out Project construction supervision.

① Work to be Conducted Prior to the Start of construction Work
- Preparation of detailed design
- Preparation of tender documents
- Conducting tendering for the Government of Zambia
- Assisting the Government of Zambia in making the construction contract agreement

② Work to be Conducted During and After Project Construction
- Construction work supervision
- Inspection and confirmation of constructed Project facilities and provided equipment.

Before Project construction starts, the consultant will prepare the detailed design, including field surveys, and determine the specifications of the equipment to be provided and for the Project construction work, and will them prepare the tender documents.

For the tender document preparation, the consultant will hold meetings with agencies concerned, prepare the tendering schedule, and execute tendering as the proxy for the Government of Zambia. Further, the consultant will evaluate tender documents submitted by contractors and will assist the Government of Zambia in making a contract agreement with a successful bidder.

During and after the Project construction period, the consultant will conduct supervision work as follows:

① Work to be Performed in Japan

After the construction contract agreement is made, the consultant will examine and confirm the various drawings and documents submitted by the construction contractor, and will inspect the equipment and materials procured by the contractor.

② Construction Supervision Work in Zambia

The consultant will undertake the various proceedings required for starting Project construction, witness and inspect locally procured construction equipment and materials, inspect work progress, and advise and supervise the contractor in making inspections, making trial operations, and testing installed equipment, and conduct schedule control, quality control, and cost control in order to complete the work within the period specified in the Exchange of Noters for the Project.

(2) Project Implementation Schedule

The Project cinsists of 1) the construction of access road, 2) the land reclamation works, 3) the construction of administration facilities and 4) the provision of equipment. Considering to following reason, the Project implementation schedule may be divided into two phases, phase I is for the construction of road and administration facilities and phase II is for the land reclamation works and the provision of equipment.

- The main works of road construction and land reclamation works is the earth works including structure of river (Bridge and Diversion works). Therefore, it is necessary to carry out the construction in dry season. Considering to effective use of the common construction machie for the reduce of construction costs, it is beter the implemetation schedule is divided into two phase.

- The road constructed will be useful for the people not only in the Project Area but also in neighboring area, therefore, the road construction must be given the first priority.

- considering the price escalation in Zambia, in phase I, it is more safety to construct the administration facilities which use a lot of local materials.

The imprlemetation period of phase I may be fourteen months with four months of detail design and ten months of construction. And it of phase II may be nine months with three months of detail design and six months of construcion and procurement.

The implemetation schecules are shon in Fig. 4.4.1 and 4.4.2.

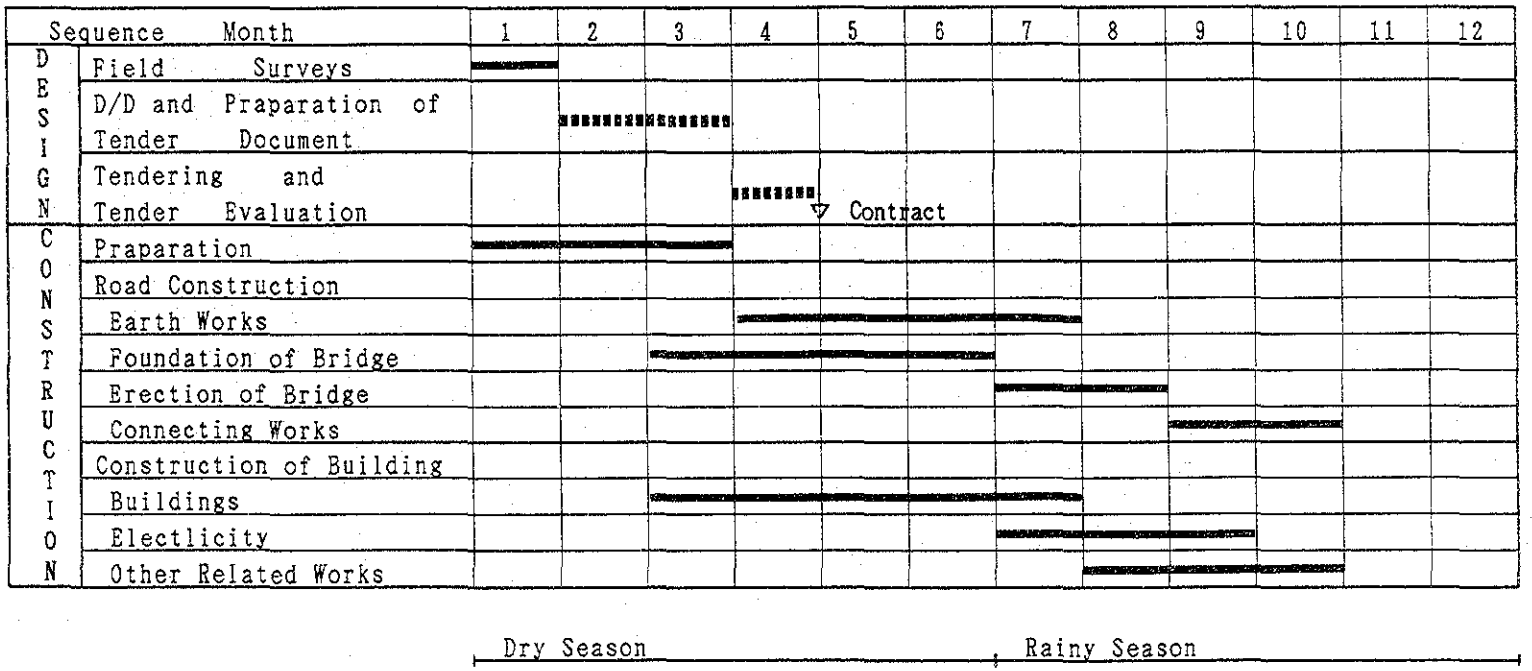


Fig 4.4.1 Project Implementation Schedule (Phase I)

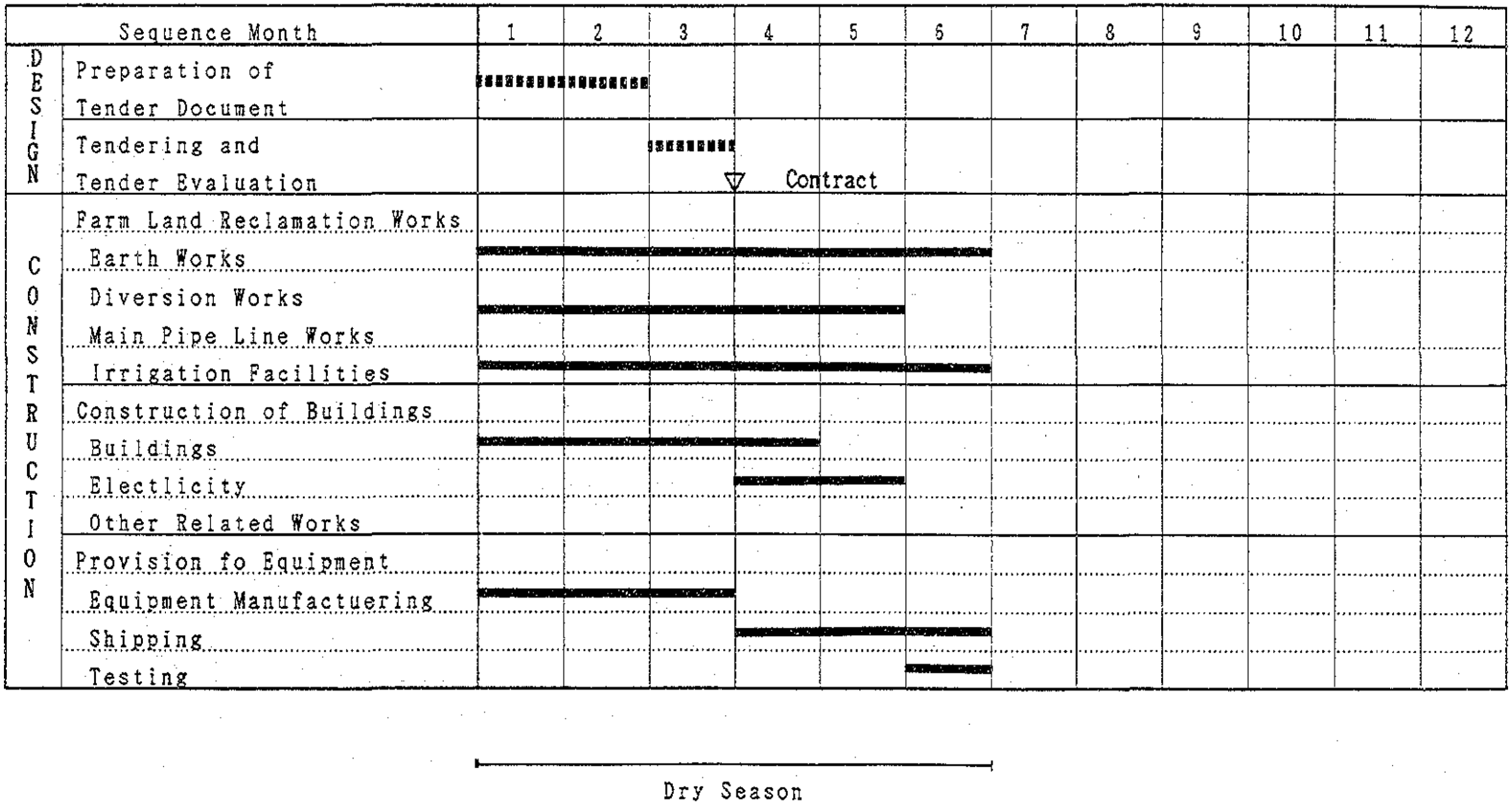


Fig. 4.4.2 Project Impremention Schedule (Phase II)

4-4-6 Scope of Work

The scope of Project construction work and the boundaries of the work to be undertaken by the Japanese and Zambian sides are as follows:

1) Work to be Undertaken by the Japanese Side

- Construction of Road:

  Improvement and construction of a 10.5 km long access road which includes the construction of one steel bridge and one submersible bridge.

- Construction of a Training Farm and a Small-scale Irrigation System:

  Diversion works and one pumping station (intake pump: lift-type submersible sewage pump; delivery pump: centrifugal pump).

  Pipeline: 2.5 km

  Training farmland development: 30 ha
  (including one farm pond having a capacity of 2,000 m^3 and a total of 2.6 km irrigation pipeline)

- Construction of Buildings:

Management Building:	196 m^2
Garage for Agricultural Machinery and Vehicles:	288 m^2
Workshop:	240 m^2
Warehouse:	198 m^2
Mill Houses:	48 m^2

- Facility Work:

  The electrical work for the administration centre
  The electrical work for the irrigation pumps
  The construction of one water supply well for the administration centre.

- Provision of Equipment :

  Land Reclamation Equipment:

Bulldozer	D8 Class	2 units
Motor Grader	155 hp	1 unit
Backhoe	0.43	1 unit
Vibrating Roller	10-ton Class	1 unit
Sprinkler truck	6.8 kiloliter	1 unit

Training Farm Use Equipment:

Wheel tractor	65 hp	2 units
Disc Harrow	Accessory for 65 hp tractor	2 units
Disc plough	"	2 units
Planter	"	2 units
Ridger	"	2 units
Trailer	"	2 units

Small-sized farming Equipment:

40 hoes, 10 shoves,20 slashers, 5 axes, 20 forks,
10 sprayers, 10 wheelbarrows

Training Farm Management and Training Use Equipment

Pickup Truck:	4 Wheel Drive; 5 passengers	1 units
Truck:	Cargo Truck	1 unit
Bicycles:		30 units
Fuel Tank:	3 kiloliters X 2	1 unit

2) Work to be Undertaken by the Zambian Side

- To secure the sites and water rights for constructing the proposed Project facilities
- To exempt taxes and take necessary measures for obtaining custom clearances for the Project materials and equipment upon its arrival at the port of disembarkent
- To accord Japanese nationals, whose services may be required in connection with the supply of products and the services under the verified contract, such facilities as may be necessary for their entry and stay in Zambia for the performance of their work.
- To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Zambia with respect to the supply of products and services for the Project.
- To organize the responsible agencies needed for Project implementation and for Project facilities management and

operation after Project construction and to assign counterpart personnel to the agencies.

- To ensure the necessary budget and personnel for the proper operation and maintenance of constructed Project facilities and provided equipment.
- To provide facilities for the distribution of electricity to the Project site.
- To bear all expenses, other than those to borne by the grant aid cooperation programme of the Government of Japan, necessary for the construction of Project facilities as well as for the transportation and installation of the equipment.

CHAPTER 5

Project Evaluation and Conclusion

CHAPTER 5 PROJECT EVALUATION AND CONCLUSION

5.1 Project Benefits

Objective of the New Agricultural Village Development Project is to execute reconstruction of national economy by improving agricultural productivity and increasing employment opportunities through the resettlement projects. The Kanakantapa resettlement project has been carried out as one of national resettlement projects, being regarded as the leading development model for the New Agricultural Village Development Project.

This project envisages an improvement of living standard and settlement of farmers through carrying out the following project under the grant aid program of the Government of Japan.

(1) Construction and improvement of a 10.5 km long access road from National Road T-4 to the Resettlement Area

(2) Development of a 30 ha training farm with a small-scale irrigation system and construction of administration facilities

(3) Provision of facilities and equipment required for land reclamation, operation of training farm and improvement of settlers' living standard

Benefits to be expected with execution of this Project will be as follous.

(1) Benefit by Improvement of Access Road

Transportation from the project area to Lusaka city will be improved and time and distance will be saved in comparison with the actual condition. It is also expected that on-farm roads in the project area will be improved using construction equipment to be provided by the Government of Japan. Consequently, the time for collection, shipping and transportation of agricultural production in the project area will be saved and their damage during transportation will also be decreased. Therefore, this improvement of access road will make a great contribution to the agricultural economy in the area.

As cultural exchange between Lusaka city and the project area will also be facilitated, enhancement of social economic condition of the area can be expected accordingly.

(2) Benefit by Construction of Training Farm

Training farm aims to establish and improve the cropping system in the Kanakantapa area and to demonstrate how to cultivate cash crops using the irrigation system throughout the year. A total of 9,600 man-days of settlers will take part in the operation of training farm.

Proposed settlers in the Kanakantapa have less experience in farming thus they are required to be trained on basic techniques of farm management and cropping. Following effects can be expected if settlers take part in the operation of training farm.

- Settlers will have chance to study farm management and cropping technique and to get necessary information on optimum and new cash crops. These techniques and information will contribute to increasing the agricultural production and to getting more income.

- Getting employment opportunity in the dry season will help to increase settlers income.

- It is possible to get the basic information and technique on irrigation farming in the future.

- Social consciousness concerned with cooperativeness and co-working will be raised.

(3) Benefit by Provision of Machinery and Equipment

Land reclamation and construction equipment:

Land reclamation works which has been entrusted to local contractors may be carried out by the Department of Resettlement within the context of the development plan and the Project in this area can be completed earlier. It makes a great contribution for promotion of the Resettlement Project in Zambia. Construction, maintenance and repairing of on-farm roads in the area, can be done with these equipment and agricultural activity, marketing and living standards will be improved.

Machinery and Equipment for Training Farm:

An appropriate and effective operation of training farm, will make it possible to render settlers with adequate services. It will be possible to get high quality of shima (maize flour), which is staple food in Zambia, with low price by provision of maize mill. As a result, an improvement of diet and stabilization of living condition can be achieved

5.2 Conclusion

By the execution of this Project, agricultural activity will be activated and economic development will be promoted in the Kanakantapa Area and this Project contributes much toward settlement of farmers and enhancement of their living standards. Furthermore, this Project area is located near to Lusaka and once the settlers' living standards is enhanced, the Project implementation under the grant aid Programme of the Government of Japan will be justified and the Resettlement Area will become a model area of resettlement programme. These effects, when made know to other resettlement area, will be highly appreciated. In view of the contents and scope of the effects of the project, implementation of the Project with grant aid cooperation from the Government of Japan is considered to be appropriate.

5.3 Recommendation

In order to ensure a smooth and effective implementation of the Project and to operate and manage the facilities and equipment to be constructed or provided by the Project, the following recommendations are made.

(1) Operation of training farm is essential for the success of the Project. Therefore, it is necessary to get an adequate technical assistance from agricultural machinery and cropping and farm management experts who are dispatched from Japan.

(2) It is basic condition for the Project to get the irrigation water for training farm and the Project may not achieve its targets, if water from the Chongwe river is not be obtained. It is prerequisite to make sure of water

intake from the Chongwe river and to supply electric power to the Project area which must be carried out by the Government of Zambia.

(3) Judging from meteorological condition, it is not advisable to leave land without any plantation from viewpoints of land conservation, preservation of land fertility and environment . In conducting land reclamation works, it is necessary to consider the method of land reclamation paying attention to environmental affect. Also in the farm management, it is necessary to instruct the farming with consideration to land conservation by introducing green manure crop, etc.

(4) For further development of this area, an organization of settlers is recommended. Apart from the technical assistance in training farm management, enlightment of settler to direct their organization by the Department of Resettlement and other related institutions is necessary.

APPENDIX

APPENDIX 1

Members List of The Study Team

Members List of the Study Team

Duty	Name	Belonging to
Team Leader/ Agricultural Development	Mr. Yasuo SAKAGUCHI	Deputy Director, Chikugo-gawa Karyu Irrigation Office, Kyushu Agricultural Administration Bureau, M.A.F.F.
Grand Aid Planner	Mr. Toru MAEDA	Staff,Grant Aid Division, Economic Cooperation Bureau, Ministry Of Foreign Affairs
Resettlement Planner/ Project Coordinator	Mr. Hideo ARUGA	Deputy Director, Planning and Survey DIV., Emigration Department, JICA
Chief Engineer/ Agricultural infrastructure Development	Mr. Gunjiro OZAWA	Pacific Consultants International (PCI)
Agricultural Facilities	Mr. Tadaharu AKESAKA	ditto
Material & Equipment	Mr. Yasuro HAGIHARA	ditto
Agricultural Management	Mr. Atsushi BABA	Taiyo Consultants
Cost Estimation	Mr. Atsusi KISHI	Pacific Consultants International (in home office work)

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MEMBERS LIST OF DRAFT EXPLANATION TEAM

Duty	Name	Belonging to
Team Leader/	Mr. Yutaka HOSONO	Managing Director, Grant Aid Study and Design Department, JICA
Agricultural Development	Mr. Tsuneo MATSUTOMI	Deputy Director, Overseas Land Improvement Cooperation Office, Design Division, Agricultural Structure Improvement Bureau, MAFF
Immigration Planner/ Project Coordinator	Mr. Hideo ARUGA	Planning and Survey Division, Emigration Department, JICA
Chief Engineer/ Rural Infrastructure Planner	Mr. Gunjiro OZAWA	Pacific Consultants International (PCI)
Equipment Planner	Mr. Yasuro HAGIHARA	- ditto -
Supporting Staff	Mr. Koichi SHIMOMURA	- ditto - (Kenia Nairobi office)

APPENDIX 2

The Schedule of The Field Study

(1) Basic Design Study

DATE	ACTIVITY
13 / Feb. Wed.	LV. Tokyo 20:55 ～ Removal
14 / Feb. Thu.	Removal ～ AR. Perth 06:20 (QF-070)
	LV. Perth 14:15 ～ AR. Harae 18:40 (QF-023)
15 / Feb. Fri.	LV. Harae 18:40 ～ AR. Lusaka 19:30 (QF-605)
16 / Feb. Sat.	Meeting with Japaneese Expert Mr. Toklya
17 / Feb. Sun.	Survey of Study Area
18 / Feb. Mon.	Meeting with JICA Office
	Courtesy Call Ministry of Agriculuture(Permenent Secretary)
	Courtesy Call Department of Resettlement(Permenent Secretary)
	Courtesy Call Prime Minister Office
19 / Feb. Tu.	Courtesy Call Japan Embassy
	Explanation of Inception Report to Department of Resettlement
20 / Feb. Wed.	Survey of Study Area (A Block)
21 / Feb. Thu.	Meeting about Department of Resettlement
22 / Feb. Fri.	Meeting about Survey , Data Collection(Meteological Office , Geography Office , e.t.c.)
23 / Feb. Sat.	Meeting within Study Team , Meeting with Japaneese Expert Mr. Morita
24 / Feb. Sun.	Horiday
25 / Feb. Mon.	Data Collection(Road Office , Public Enterprise Office)
26 / Feb. Tu.	Survey of Study Area
27 / Feb. Wed.	Data Collection(Water Resources Office)
28 / Feb. Thu.	Instruction to Survey
1 / Mar. Fri.	Inspection of Commercial Farm , Survey of Study Area (Model Farm)
2 / Mar. Sat.	Meeting of Study Team
3 / Mar. Sun.	Survey of Study Area(Survey for Administration Buildg. Area)
4 / Mar. Mon.	Data Collection(Hydrogical Data , e.t.c.)
5 / Mar. Tu.	Survey of Study Area(Soil Survey of Model Farm)
6 / Mar. Wed.	Meeting with Department of Resettlement, Data Collection
7 / Mar. Thu.	Inspection of Illigation Pilot Area(MAZABUKA)
8 / Mar. Fri.	Survey of Study Area
9 / Mar. Sat.	Team Leader and other two members arrived at Lusaka
10 / Mar. Sun.	Meeting at JICA Office
11 / Mar. Mon.	Courtesy Call Japan Embassy(Onisi secretary)
	Meeting with Department Resettlement Cabinet Office
	Courtesy Call Department of Resettlement(Permenent Secretary)
	Courtesy Call Permenent Secretary to Cabinet
	Meeting with Department Resettlement Cabinet Office
	(Including Two Members of Ministry of Agriculture , Forestry and Fisheries)
12 / Mar. Tu.	Survey of Study Area
13 / Mar. Wed.	Courtesy Call Ministry of Agriculuture(Permenent Secretary)
	Meeting about Minutes , Courtesy CallPrime Minister
14 / Mar. Thu.	Signature of Minutes
	Imform to JICA Office , Embassy
15 / Mar. Fri.	LV. Lusaka 09:30 (QZ-610) ～ AR. Nairobi 13:10
	LV. Nairobi 23:25 (LH-585) Removal
16 / Mar. Sat.	Removal ～ AR. Frankfurt 05:50
17 / Mar. Sun.	LV. Frankfurt 16:50 (LH-710) Removal
18 / Mar. Mon.	Removal ～ AR. Tokyo 12:00

(2) Drafit Final Report Explanation

DATE	ACTIVITY
5 /Jun. Wed.	LV. Tokyo 13:30 ~ AR. London 18:05 (BA-008)
	LV. London 22:25
6 /Jun. Thu.	AR. Lusaka 11:20 (BA-053)
7 /Jun. Fri.	Courtesy Call Department of Resettlement P/S
	Courtesy Call Ministry of Agriculuture
	Meeting with Department of Resettlement
	QZ611 Mr. Hosono and Mr. Simomura arrived
	Meeting with JICA Office(Pamoji)
8 /Jun. Sat.	Survey of Site
9 /Jun. Sun.	Filling Data
10 /Jun. Mon.	Courtesy Call Japan Embassy (Mr. Eda)
	Courtesy Call Department of Resettlement and Ministry of Agriculuture
	Courtesy Call Director of Water Affairs
11 /Jun. Tue.	Meeting with Department of Resettlement and Ministry of Agriculuture
12 /Jun. Wed.	Courtesy Call NCDP
13 /Jun. Thu.	Signature of Minutes
	Imform to JICA Office of
	LV. Lusaka 20:15
14 /Jun. Fri.	AR. London 07:30 (BA-052)
15 /Jun. Sat.	LV. London 15:30
	AR. Tokyo 11:20 (BA-007)