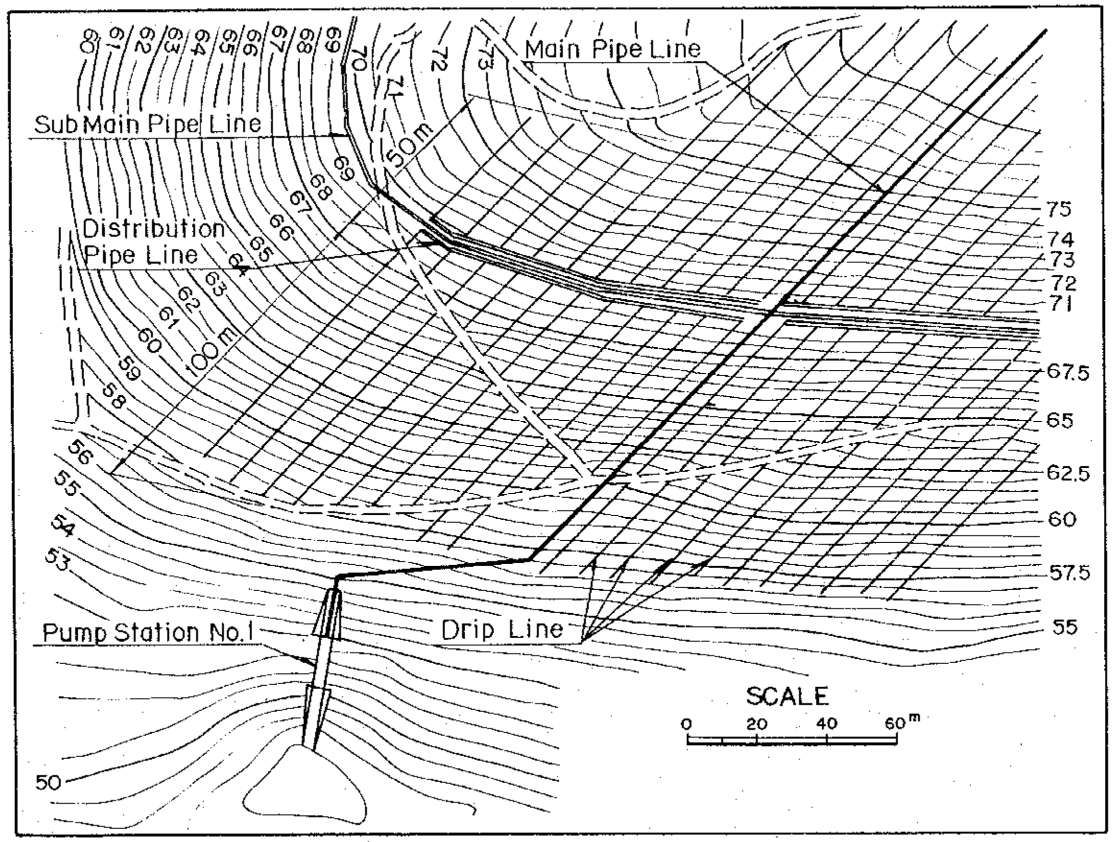
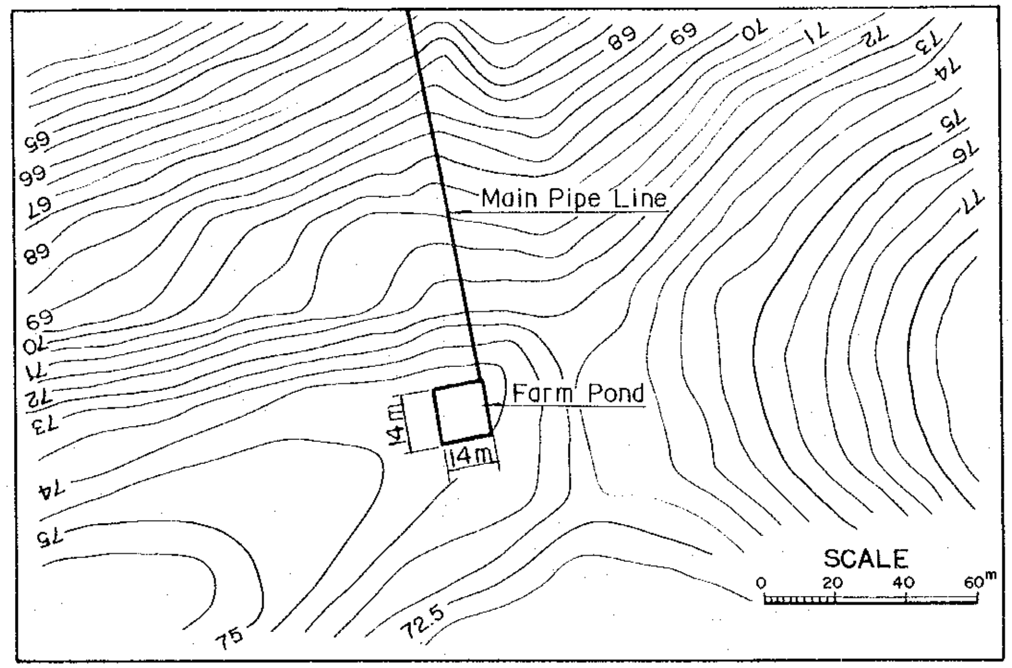
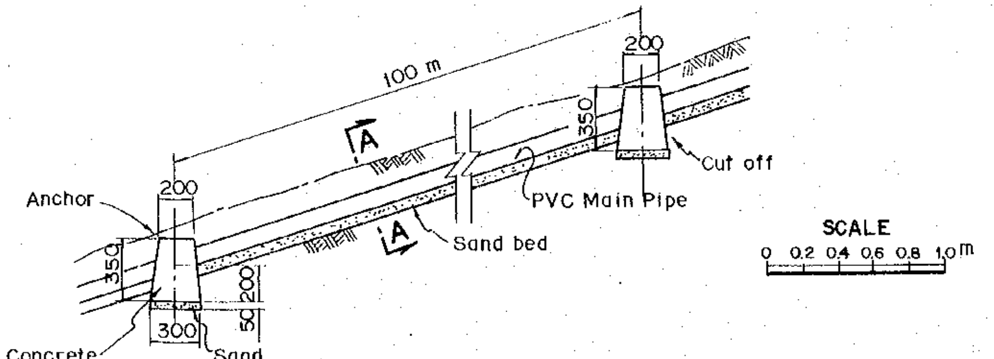
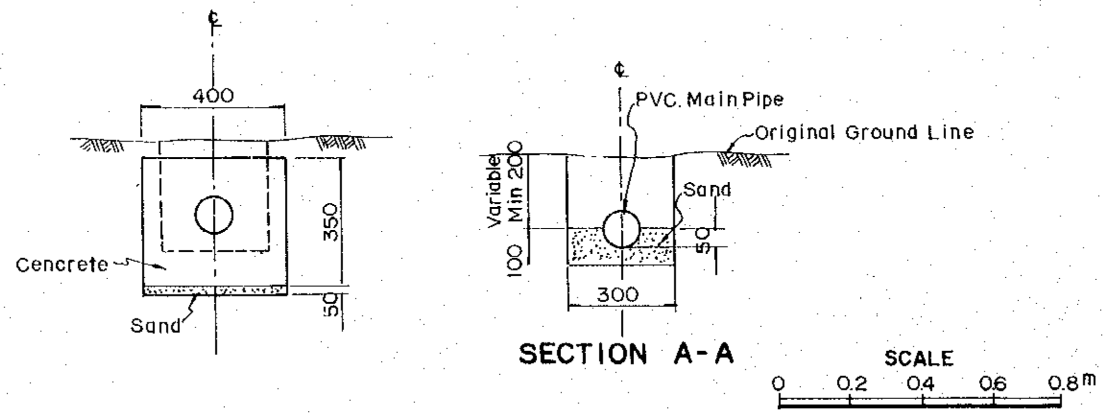


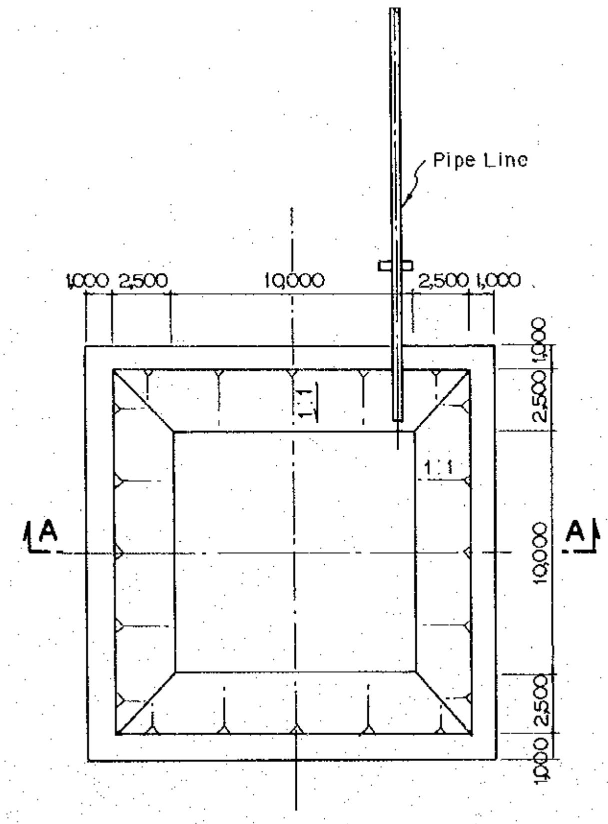


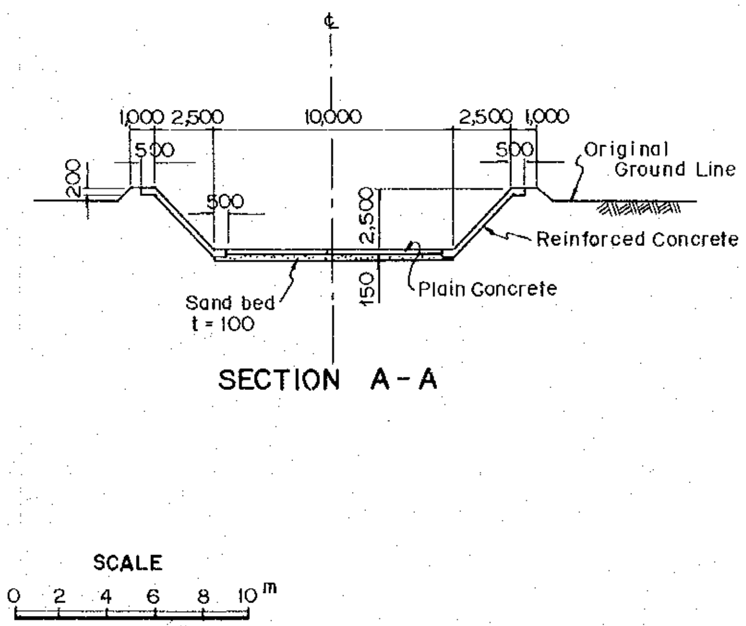


PIPE LINE



SECTION A-A





SECTION A - A

DWG.3008 Plan and Section of Farm Pond and Typical Layout of Pipe line
Bukit Sedanan Project (MA 16)

4 Kelompok Kangkar Merlimau Project (JR-10)

4.1 Present Condition

4.1.1 Project Area

The Project are is located in a hilly area about 5 km East from Parit Sulong town, Batu Pahat District. The present land use is 5 ha of orchard cultivation area, a rubber plantation area, and bush. The area expands in the hill slope. Water resources for the agriculture land are spring water located at the skirts of the hills and water from the Kangar Merlimau stream. The majority of the orchards have water shortages in the off-season.

4.1.2 Irrigation and Drainage Facilities

Small drip irrigation plots of about 0.2 ha are scattered in the hill slope, and their water resources are seepage water from a domestic water tank located on the hill top and/or water pumped up from the Kangar Merlimau stream.

4.1.3 Social Facilities

There are 2 access roads to the Project area, one is a the State road and the other is an access road to the domestic water tank. Both roads are well maintained, but no farm roads are constructed in the Project area.

Kangkar Merlimau village is located around hill skirts, and electric distribution lines are constructed around the Project area. Domestic water in this village area is supplied from domestic water supply company, but one (1) house uses spring water as domestic water. Spring water is retrieved by using an earth canal and one (1) concrete pipe.

4.2 The Project

4.2.1 Background of the Project

The State DOA intends to develop the Project as one of the pilot projects, on durian plantation in regard to the crop diversification program and group farming system in the regional DOA policy.

4.2.2 Proposed Irrigation Area

The proposed irrigation area for the orchard plantation is 36 ha including improvement of the existing irrigation area. The area expands in the hill slope and ranges in elevation from EL 5.00 m to 120 .00 m. The majorty of the slope is steep, nearly 15 ^{o} to 20 ^{o}, and some area,are steeper.

the main crop is durian totalling 36 ha, and the other orchards are duku and dokong. The plantation areas of duku and dokong total each 7 ha.

4.2.3 Irrigation Water Requirement

(1) Seasonal irrigation water requirement of durian and vegetable

Irrigation water requirement for durian, duku and dokong are basically calculated following the procedure of the FAO Irrigation and Drainage Paper No. 24, and durian is also calculated in reference to MARDI's paper "Estimated water requirement of some Malaysian commercial fruit crops" in Prosiding Sinposium Buah-buahan Kebangsaan 1991.

Potential evapo transpiration (ETo) is estimated at 1,120 mm/year by the modified Penman method, using meteorological data from the Johor Baruh International Airport station.

The irrigation water requirement for the Project area is calculated based on the summation of the water requirements for each 3 crops.

The crop coefficient of the 3 crops are adopted as the highest figure during mature growing stage of each crop.

The effective rainfall is estimated by the USDA SCS method, using monthly rainfall. Irrigation methods are designed as drip irrigation, and the overall irrigation efficiency is adopted 85 %.

Seasonal irrigation water requirement is estimated at 215 mm/year for durian and at 117 mm / year for dokong or duku under the drought year with a return period of 5 years. Seasonal irrigation water requirement for the Project area is estimated at 449 mm/year based on the summation of water requirements fot the 3 crops. Detailed calculations of irrigation water requirements are described in Table.3.4.1.

(2) Design irrigation water requirement for facilities

The design irrigation water requirement for durian is calculated to use the peak irrigation water requirement based on the seasonal irrigation water requirement using probable rainfall with a return period of 5 years. The peak irrigation water requirement for the Project is calculated at 0.25 lit / sec / ha.

The design irrigation water requirement for irrigation facilities are calculated as follows, taking into consideration rotation of the irrigation water supply and the design conditions of the facilities.

The irrigation water supply for the area is applied the rotation system. For rotation of water supply, irrigation areas is broadly divided into two (2) sub irrigation areas, (i) the sub irrigation area located between EL 5 m and EL 60 m, and (ii) the other area between EL 60 m and EL 120 m. The sub irrigation areas are further divided into 5 unit irrigation blocks to be served by main pipeline lines, and the hectares of the unit irrigation blocks range from 6.0 ha to 17.0 ha.

Irrigation water is scheduled to be supplied to one (1) sub irrigation area for 12 hours and the other sub irrigation area for the other 12 hours, during the peak requirement of irrigation water.

Using the above irrigation rotation system, the design irrigation water requirement for the facilities is 0.50 lit/sec/ha. The design discharge for the main pipe lines in the sub irrigation area located from EL 5.00 m to EL 60.00 m is about 6.0 lit / sec and those in the other area located above EL 60.00 m is about 3.0 lit / sec.

4.2.4 Reservoir Operation Calculation

The reservoir operations at the proposed pump station site are calculated for half month periods based on the estimated runoff, irrigation requirement, and water loss from the reservoir. Runoff from 1952 to 1990 are applied in the reservoir operation calculation.

As a result of the reservoir operation calculation, it can be clarified that water for irrigation is confirmed to be plainly sufficient and that a reservoir and/or pond for irrigation is not required.

Therefore, reinforcement of the facilities of the existing spring and the integration of water resources such as the spring and the Kangar Merlimau stream shall be required for the Project.

The detailed calculation of the reservoir operation is described in Table 3.4.2..

4.2.5 Drainage Water Requirement

Since the proposed orchards will be planted in the hill slope and the evacuation of excess water will be naturally expected to flow down the slope, drainage facilities in the Project area are not required. Therefore, the drainage water requirement in the Project area will not be estimated.

As for the existing Kangar Merlimau stream, widening of the existing stream is designed in downstream from intake gate structure to flow out the 10-year flood of 3.6 m3/sec.

4.2.6 Water Resources Development Facilities

Water resources development facilities are basically designed using the draft design standard discussed between DID and JICA Study Team during the Feasibility Study and the design standards issued by the Ministry of Agriculture, Forestry and Fishery, Government of Japan.

The general lay out of the water resources development is shown in DWG 4001 and DWG 4002.

To reinforce the existing spring water resources, a bund with a width of 1.5 m and a height of 1.0 m, and an intake structure and canal system to absorb the water resources of the Kangkar Merlimau stream, are designed. Both water resources are integrated at the gate structure designed in front of the pump station No.1.

To compensate the present water supply to each village house, small concrete canals which convey spring water to the house and collect waste water from the house, are also designed.

The design of major structures are illustrated in DWG.4002 to DWG. 4004, and salient features of these facilities are described below.

Bund of spring	H x W x L, 1.0 m x 3.5 m x 90 m
Spillway of bund	H 0.7 m x L 2.0 m x W 2.3 m
Intake gate structure	1 no.
Gate structure	1 no.
Canals	460 m of 2 nos.
Drains	85 m

4.2.7 Irrigation and Drainage Development Facilities

Irrigation development facilities are basically designed using the draft design standard discussed between DID and JICA Study Team during the Feasibility Study, and design standards issued by Ministry of Agriculture, Forestry and Fishery, Government of Japan.

The general lay out of irrigation development is shown in DWG 4002 and DWG 4005 to DWG 4006.

The irrigation system in the Project area is designed to consist of a pump, main pipe line, and farm pond, and irrigation rotation is made 2 times/day during the peak irrigation.

Since the irrigation area is expanded on a hill slope with a wide range of elevation, from EL 5.00 m to EL 120.00 m, and the irrigation rotation involves 2 sub irrigation areas, (1) area from EL 5.00 m to EL 60 .00 m and the other area from EL 60 .00 m to 120 m, the required pump water heads will need to be varied widely.

The design discharge of the pumps and main pipes vary from 0.20 m3/min to 0.40 m3/min, and the suction head of the pump is substantially stable because of the spring water.

Taking into consideration the elevation of the irrigation area and the design discharge of the pumps, a multi stage pump is selected for the Project. The required number of pumps are as follows, including one (1) unit for standby.

Pump Station	D.discharge (m3/min)	Max. Head (m)	Unit of pump (nos.)
Station No.1	0.4	70	2
Station No.2	0.2	70	2
Station No.3	0.2	70	2

Since the water head of the pipe line is about 70 m, and the majority area has a steep topographical slope of about 20 $^{\circ}$, high quality grade PVC pipe is designed. The design velocity of the pipe ranges from 0.7 m/sec to 0.9 m/sec, and the diameter of the pipe is selected from 60 mm to 90 mm.

The occurrence of water hammers in the pipe line, during a stop in water supply, will be studied, using longitudinal sections of the pipe line and the energy line of water in pipe line, and one (1) pressure control facility with a pressure regulation valve is designed for the main pipe line.

In regard to the operation and maintenance work of the pumps and the main pipe lines and the convenient transportation of agriculture input and output, 4 access roads and 5 farm roads are designed to connect with the existing road system.

Both types of roads are designed to be 5 m wide with 3 m of laterite pavement.

Design of the typical structures are illustrated in DWG.4002 and DWG.4005 to DWG.4006, and the salient features of these facilities are described below.

Irrigation area	50 ha
Pump station	3 sites
Pump(multi stage pump)	
7.5 kw (h=70 m)	4 units.
11.0 kw (H=70 m)	2 units.
Pipeline	1,840 m
Pressure regulation valve box	1 no.
Farm road	1,780 m
On farm facilities	Drip irrigation facilities 36 ha

4.2.8 Construction Plan

Mechanical construction methods will be applied to the construction of the Project. Major structures are the pump station, pipe line, and access & farm roads.

Main construction volume such as embankment of access and farm road, and concrete work of the pump station etc., are roughly estimated at about 11,600 m3 of embankment, about 3,000 m3 of excavation and about 150 m3 of concrete works.

Taking into consideration the above construction volume, the construction schedule is assumed at 6 months, consisting of 1 month for mobilisation, preparatory work, and demobilisation periods and 5 months for the construction period.

4.3 Estimate of Project Cost

4.3.1 Unit Price Analysis

Unit prices of the respective works of the project are estimated to up-dating the bidding prices for the similar works in Johor State, and the Government price schedule issued in 1993, using the annual inflation rate of commodity issued by the Central Bank of Malaysia. The unit prices of these works are estimated at 1994 price levels.

Reference data of bidding prices for similar works are as follows:

1) Western Johor IADP Phase II 1993,
2) Sng. Melaka Flood Alleviation project 1992,

The updated unit prices of the respective works are shown in Table 3.4.3..

4.3.2 Estimate of Quantity

All quantities are estimated, based on designed mentioned above. The quantities estimated are shown in Table 3.4.4.

4.3.3 Estimate of Construction Cost

Total construction cost consisting of direct construction cost, land acquisition cost and physical contingency is estimated at about RM 1,242,300 at 1994 price levels, as shown below.

Physical contingency is assumed as 15 % of direct construction costs.

Description	Cost (RM)
	K. Kangar Melimau
1 Direct construction cost	944,100
2 Land Acquisition	15,000
3 Physical Contingency	141,600
4 Engineering cost	94,400
5 Administration cost	47,200
Total	1,242,300

The detailed costs are shown in Table 3.4.4.

Table 3.4.1 Irrigation Water Requirement (JR-10)
Durian Dokong Duku

JR-10	Jan(1)	Jan(2)	Feb(1)	Feb(2)	Mar(1)	Mar(2)	Apr(1)	Apr(2)	May(1)	May(2)	Jun(1)	Jun(2)	Jul(1)	Jul(2)	Aug(1)	Aug(2)	Sep(1)	Sep(2)	Oct(1)	Oct(2)	Nov(1)	Nov(2)	Dec(1)	Dec(2)	Total
Durian																									
Dokong																									
Duku/Langsat																									
Rainfall	31	0.0	49.0	84.5	42.0	86.0	252.0	152.0	137.0	59.5	27.0	43.0	119.0	166.0	0.0	32.0	191.5	15.5	164.5	18.0	149.5	50.5	105.5	46.0	2,021
Potential Evapotranspiration	46.5	49.6	50.4	43.7	49.5	52.8	47.7	47.7	48.3	51.5	48.2	48.2	45.9	49.0	45.3	48.3	42.2	42.2	43.5	46.4	41.4	41.4	43.7	46.6	1,120
Durian																									
Crop coefficient (Kc)	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	Average Kc=0.85
Crop Evapotranspiration (ETc)	39.5	42.2	42.8	37.1	42.1	44.9	40.5	40.5	41.1	43.8	40.9	40.9	39.0	41.6	38.5	41.1	35.8	35.8	37.0	39.4	35.2	35.2	37.1	39.6	952
Effective Rainfall	16.4	0.0	29.9	51.5	22.7	46.4	93.2	56.2	67.1	29.2	15.4	24.5	54.7	76.4	0.0	15.4	84.3	6.8	67.4	7.4	59.8	20.2	41.1	17.9	904
Net Irrigation Requirement	23	42	13	0	19	0	0	0	0	15	26	16	0	0	39	26	0	29	0	32	0	15	0	22	316
Irrigation Efficiency	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	
Conveyance efficiency																									
Application Efficiency																									
Gross Irrigation Requirement (mm)	27.17	49.6	15.24	0	22.82	0	0	0	0	17.22	30.04	19.31	0	0	45.3	30.25	0	34.13	0	37.72	0	17.64	0	25.45	372
Dokong																									
Crop coefficient (Kc)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	Average Kc=0.6
Crop Evapotranspiration (ETc)	27.9	29.76	30.24	26.21	29.7	31.68	28.62	28.62	28.98	30.91	28.89	28.89	27.54	29.38	27.18	28.99	25.29	25.29	26.1	27.84	24.84	24.84	26.19	27.94	672
Effective Rainfall	13.0	0.0	26.0	44.8	18.5	37.8	75.6	45.6	52.1	22.6	12.7	20.2	45.2	63.1	0.0	11.2	68.9	5.6	64.2	7.0	31.4	10.6	39.0	17.0	732
Net Irrigation Requirement	14.9	29.8	4.3	0.0	11.2	0.0	0.0	0.0	0.0	8.3	16.2	8.7	0.0	0.0	27.2	17.8	0.0	19.7	0.0	20.8	0.0	14.2	0.0	10.9	204
Irrigation Efficiency	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	
Conveyance efficiency																									
Application Efficiency																									
Gross Irrigation Requirement (mm)	17.5	35.0	5.0	0.0	13.2	0.0	0.0	0.0	0.0	9.8	19.1	10.2	0.0	0.0	32.0	20.9	0.0	23.2	0.0	24.5	0.0	16.7	0.0	12.8	240
Duku/Langsat																									
Crop coefficient (Kc)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	Average Kc=0.6
Crop Evapotranspiration (ETc)	27.9	29.8	30.2	26.2	29.7	31.7	28.6	28.6	29.0	30.9	28.9	28.9	27.5	29.4	27.2	29.0	25.3	25.3	26.1	27.8	24.8	24.8	26.2	27.9	672
Effective Rainfall	13.0	0.0	26.0	44.8	18.5	37.8	75.6	45.6	52.1	22.6	12.7	20.2	45.2	63.1	0.0	11.2	68.9	5.6	64.2	7.0	31.4	10.6	39.0	17.0	732
Net Irrigation Requirement	15	30	4	0	11	0	0	0	0	8	16	9	0	0	27	18	0	20	0	21	0	14	0	11	204
Irrigation Efficiency	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	
Conveyance efficiency																									
Application Efficiency																									
Gross Irrigation Requirement (mm)	17.5	35.0	5.0	0.0	13.2	0.0	0.0	0.0	0.0	9.8	19.1	10.2	0.0	0.0	32.0	20.9	0.0	23.2	0.0	24.5	0.0	16.7	0.0	12.8	240

Table 3.4.2 Water Balance at Proposed Pump Station (JR-10)

												SUMMARY OF RESERVOIR OPERATION												Unit 1,000 m3	
		Jan.		Feb.		Mar.		Apri.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.	
1	1952	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
2	1953	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
3	1954	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
4	1955	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
5	1956	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
6	1957	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
7	1958	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
8	1959	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
9	1960	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
10	1961	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
11	1962	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
12	1963	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
13	1964	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.00	0.00
14	1965	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
15	1966	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
16	1967	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
17	1968	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
18	1969	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
19	1970	0.10	0.10	0.10	0.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
20	1971	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
21	1972	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
22	1973	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
23	1974	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
24	1975	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
25	1976	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
26	1977	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
27	1978	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
28	1979	0.10	0.10	0.10	0.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
29	1980	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
30	1981	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
31	1982	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
32	1983	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
33	1984	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
34	1985	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
35	1986	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
36	1987	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
37	1988	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
38	1989	0.10	0.10	0.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
39	1990	0.10	0.10	0.10	0.10	0.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

Table 3.4.3 Unit Price Analysis (JR-10)

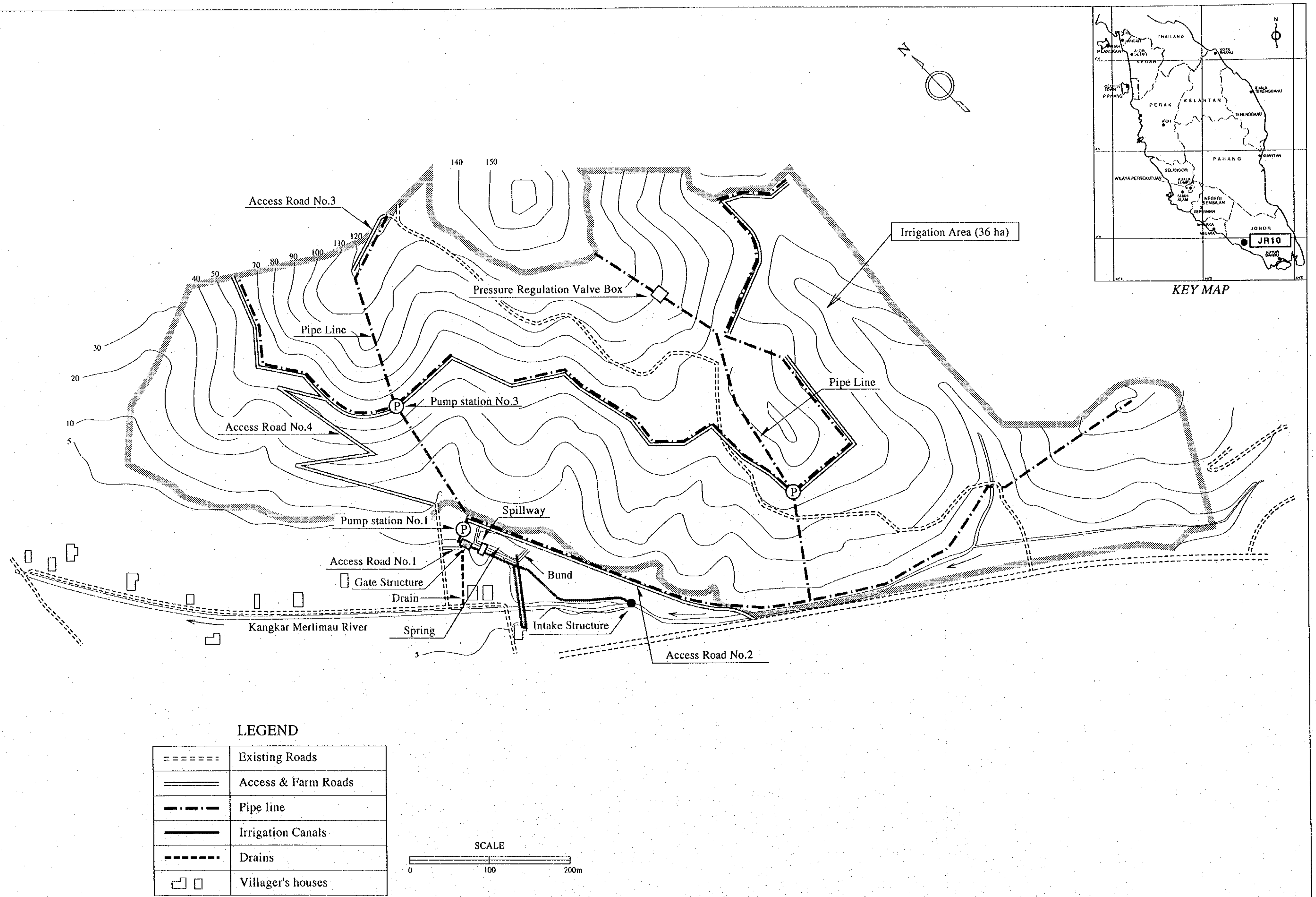
Description	Unit	Tender Price	Tender Year	Infration Rate (%)	Up-dated Price (RM)	Adopted Price (RM)	Remarks Data sources
Access Road							
Stripping	m3	2.7	1991	1.131	3.1	3.1	JPS Price List 1993 Average price
Excavation	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Embankment	m3	10.0	1993	1.035	10.4	10.4	Western Johor I.A.D.P. Phase II
Laterite pavement	m3	14.4	1993	1.035	14.9		JPS Price List 1993 Average price
		11	1993	1.035	11.4	13.1	Western Johor I.A.D.P. Phase II
Pump Station							
Excavation	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Stripping	m3	2.7	1991	1.131	3.1	3.1	JPS Price List 1993 Average price
Embankment	m3	10.0	1993	1.035	10.4	10.4	Western Johor I.A.D.P. Phase II
Backfill	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Reinforced Concrete	m3	512.0	1993	1.035	529.9		JPS Schedule of Rate 1993
		470.0	1991	1.131	531.6		JPS Price Schedule 1993
		431.0	1993	1.035	446.1	502.5	Western Johor I.A.D.P. Phase II
Plain Concrete	m3	240.0	1991	1.131	271.4	271.4	JPS Price List 1993
Foundation Concrete	m3	80.0	1991	1.131	90.5		JPS Price List 1993
		124.0	1993	1.035	128.3	109.4	Western Johor I.A.D.P. Phase II
Trash screen	m2	444.4	1991	1.131	502.7	502.7	JPS Price List 1993
Pumps							
Type 7.5 kw H 70 m	nos.	20,000.0	1994	1	20,000.0	20,000.0	Supplyers' estimate
Type 11.0 kw H 70 m	nos.	20,500.0	1994	1	20,500.0	20,500.0	Supplyers' estimate
Pump house	m2						
Pipe line							
Excavation for pipe	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Excavation for anchor block	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Backfill	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Sand bed	m3	20.0	1992	1.084	21.7	21.7	Sg.Melaka Flood Alleviation Project
Reinforced Concrete of anchor	m3	478.0	1993	1.035	494.7		JPS Schedule of Rate 1993
		436.0	1991	1.131	493.1		JPS Price Schedule 1993
		397.0	1993	1.035	410.9	466.2	Western Johor I.A.D.P. Phase II
PVC Pipe							
dia. less than 75 mm	m	17.0	1991	1.131	19.2	26.9	JPS Price List 1993
dia. 100 mm	m	17.0	1991	1.131	19.2	26.9	JPS Price List 1993

Sluice Valve	nos.						
Flange & valve	nos.						
Steel Plate	m2	100.0	1991	1.131	113.1	115.0	JPS Price List 1993
Canal & Related Structures							
Reinforced Concrete	m3	495.0	1993	1.035	512.3		JPS Schedule of Rate 1993
		453.0	1991	1.131	512.3		JPS Price Schedule 1993
		414.0	1993	1.035	428.5	484.4	Western Johor I.A.D.P. Phase II
Plain Concrete	m3	240.0	1991	1.131	271.4	271.4	JPS Price List 1993
Excavation	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Embankment	m3	10.0	1993	1.035	10.4	10.4	Western Johor I.A.D.P. Phase II
Backfill	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Gate							
0.8m x 1.6m	nos.	1,050.0	1991	1.131	1,187.6	1,190.0	JPS Price List 1993
0.4m x 0.3m	nos.	90.0	1991	1.131	101.8	110.0	JPS Price List 1993
0.5m x 1.2m	nos.	500.0	1991	1.131	565.5	570.0	JPS Price List 1993
0.4m x 0.4m	nos.	110.0	1991	1.131	124.4	130.0	JPS Price List 1993
Farm Road							
Excavation	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Stripping	m3	2.7	1991	1.131	3.1	3.1	JPS Price List 1993 Average price
Embankment	m3	13.3	1993	1.035	13.8	13.8	Western Johor I.A.D.P. Phase II
Laterite pavement	m3	14.4	1993	1.035	14.9		JPS Price List 1993 Average price
		11	1993	1.035	11.4	13.2	Western Johor I.A.D.P. Phase II
Drainage & River Treatment							
Excavation	m3	1.8	1993	1.035	1.9	1.9	Western Johor I.A.D.P Phase II
On-farm development							
Drip irrigation facilities	ha	4,300.0	1994	1	4,300.0	4,300.0 *	Supplyer's price
Land Acquisition	ha	100,000.0	1994	1	100,000.0	100,000.0	

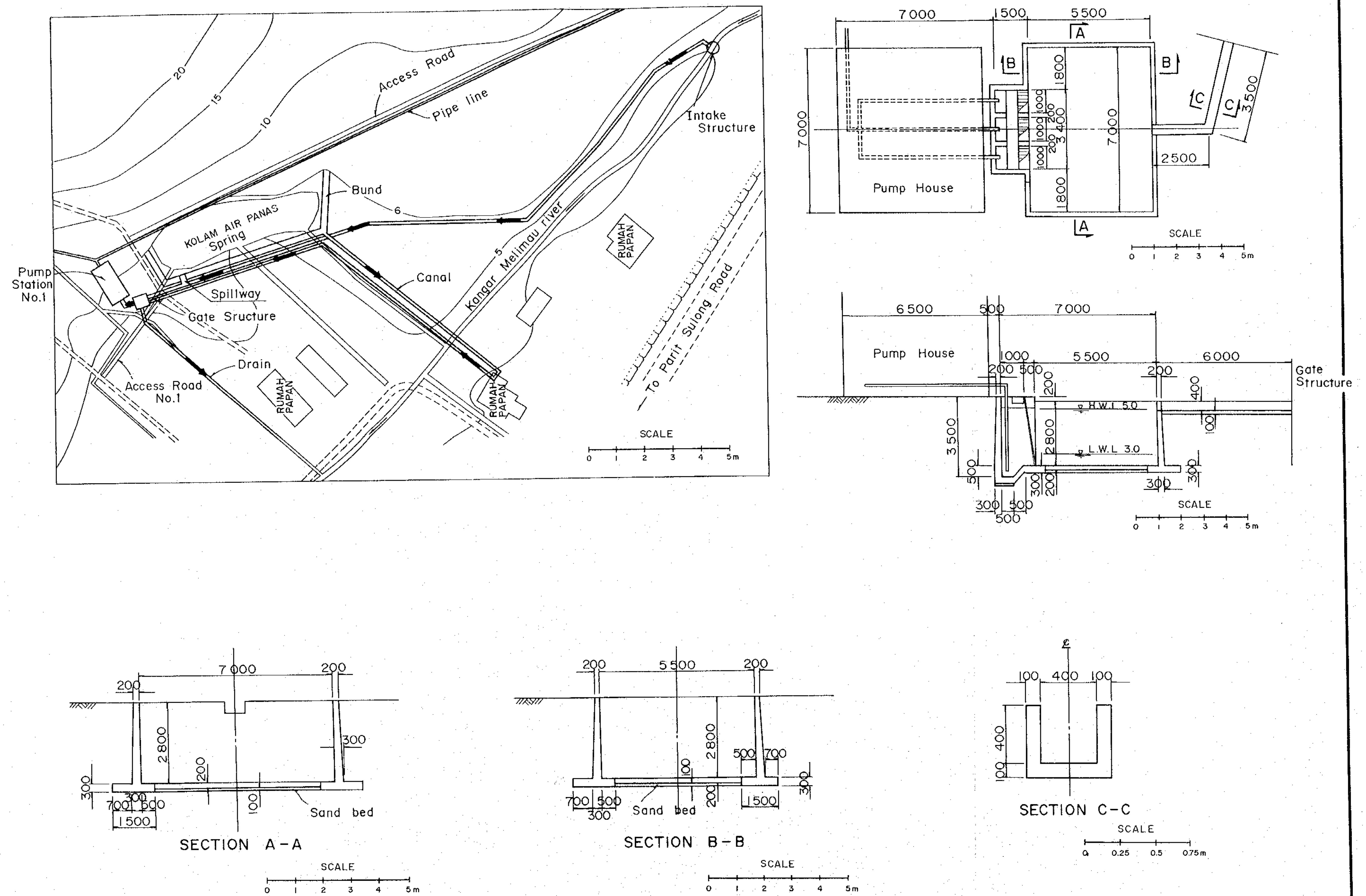
Table 3.4.4. Estimate of Construction Cost (JR-10)

Work Item	Unit	Quantity	Unit Price(RM)	Amount(RM)
Access Road				
Excavation	m3	200.0	9.6	1,920.0
Embankment	m3	1,500.0	10.4	15,600.0
Laterite pavement	m2	1,800.0	13.1	23,580.0
Subtotal				41,100.0
Pump Station, Farm Pond & Embankment for Spring				
Excavation	m3	1,370.0	9.6	13,152.0
Stripping	m3	35.0	3.1	108.5
Embankment	m3	435.0	10.4	4,524.0
Backfill	m3	520.0	17.0	8,840.0
Reinforced Concrete	m3	185.0	502.5	92,962.5
Plain Concrete	m3	17.0	271.4	4,613.8
Foundation Concrete	m3	12.0	109.4	1,312.8
Trash screen	m2	21.0	502.7	10,556.7
Pumps				
Type 7.5 kw H 70 m	nos.	4.0	20,000.0	80,000.0
Type 11.0 kw H 70 m	nos.	3.0	20,500.0	61,500.0
Pump House	m3	85.0	1,000.0	85,000.0
Subtotal				362,570.3
Pipe line				
Excavation for pipe	m3	460.0	9.6	4,416.0
Excavation for anchor block	m3	4.0	9.6	38.4
Backfill	m3	370.0	17.0	6,290.0
Sand bed	m3	54.0	21.7	1,171.8
Reinforced Concrete of anchor	m3	1.0	466.2	466.2
PVC Pipe				0.0
dia. less than 75 mm	m	1,200.0	26.9	32,280.0
dia. 100 mm	m	640.0	26.9	17,216.0
Sluice Valve	nos.			0.0
Flange & valve	nos.			0.0
Steel Plate	m2	3.9	115.0	448.5
Subtotal				62,326.9
Canal & Related Structures				
Reinforced Concrete	m3	84.0	484.4	40,689.6
Plain Concrete	m3	14.0	271.4	3,799.6
Excavation	m3	214.0	9.6	2,054.4
Embankment	m3	11.0	10.4	114.4
Backfill	m3	53.0	17.0	901.0
Gate				
0.8m x 1.6m	nos.	2.0	1,190.0	2,380.0
0.4m x 0.3m	nos.	1.0	110.0	110.0
0.5m x 1.2m	nos.	1.0	570.0	570.0
0.4m x 0.4m	nos.	1.0	130.0	130.0
Subtotal				50,749.0
Farm Road				
Excavation	m3	1,500.0	9.6	14,400.0
Embankment	m3	12,770.0	13.8	176,226.0
Laterite pavement	m2	6,200.0	13.2	81,840.0
Subtotal				272,466.0
Drainage & River Treatment				
Excavation	m3	60.0	1.9	114.0
On-farm development				

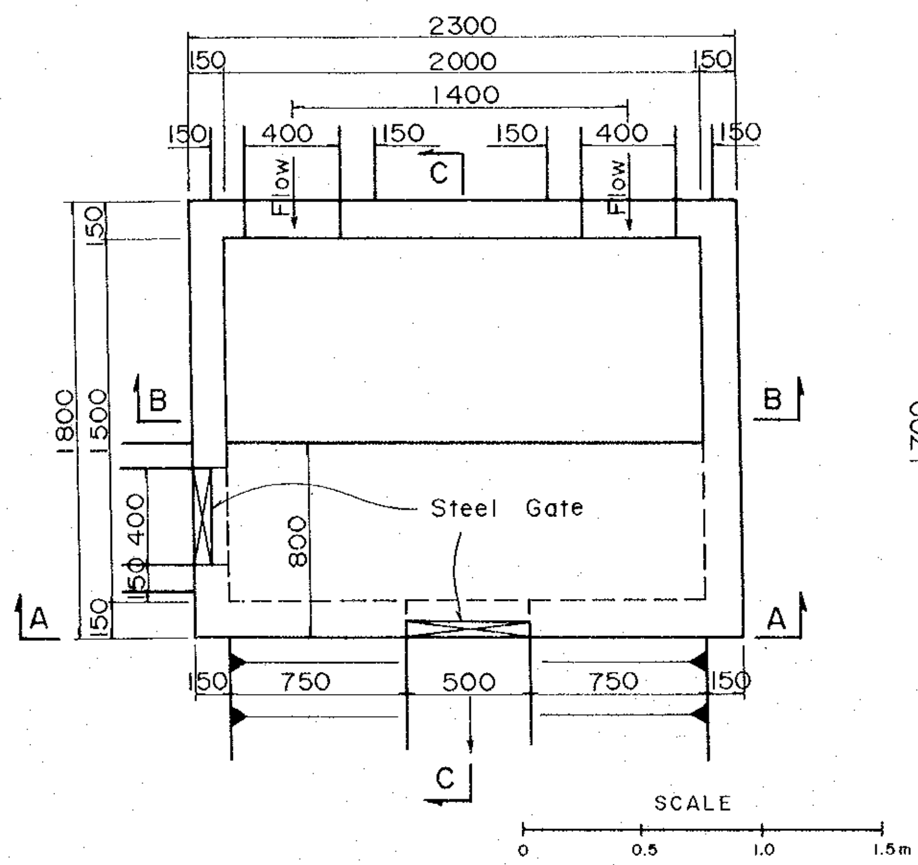
Drip irrigation facilities	ha	36.0	4,300.0	154,800.0
SUBTOTAL				944,126.2
Land Acquisition	ha	0.2	100,000.0	15,000.0
Physical Contingency (15 % of Subtotal)				141,618.9
Engineering Cost (10 % of Subtotal)				94,412.6
Administration cost (5 % of Subtotal)				47,206.3
TOTAL				1,242,364.1



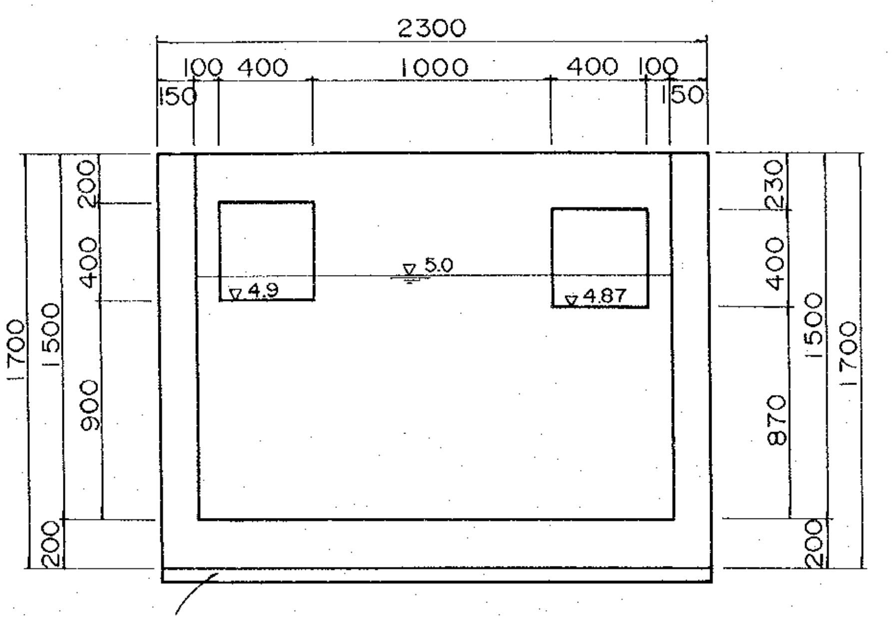
DWG4001 General Layout of Kelompok Kangkar Merlimau Project



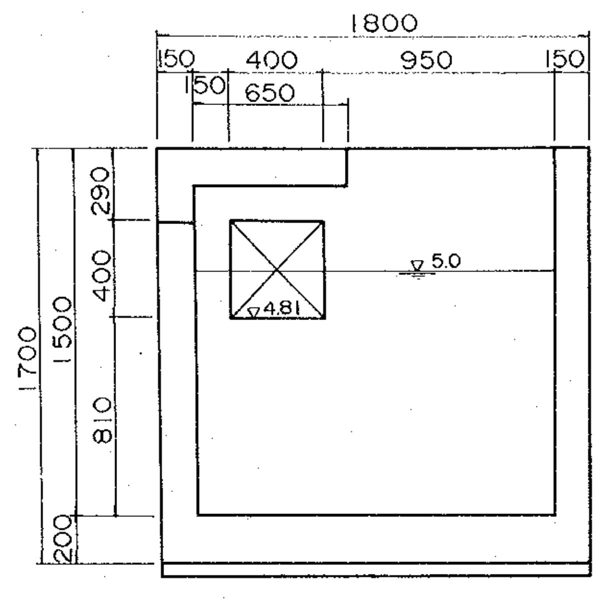
DWG4002 General Layout of Pump Station No.1
K. Kangkar Merlimau Project (JR.10)



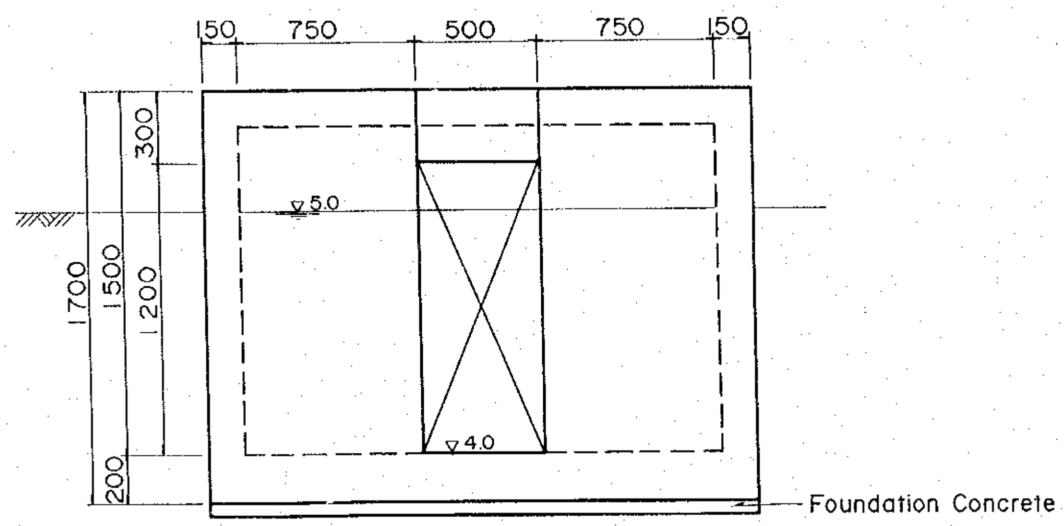
Gate Structure



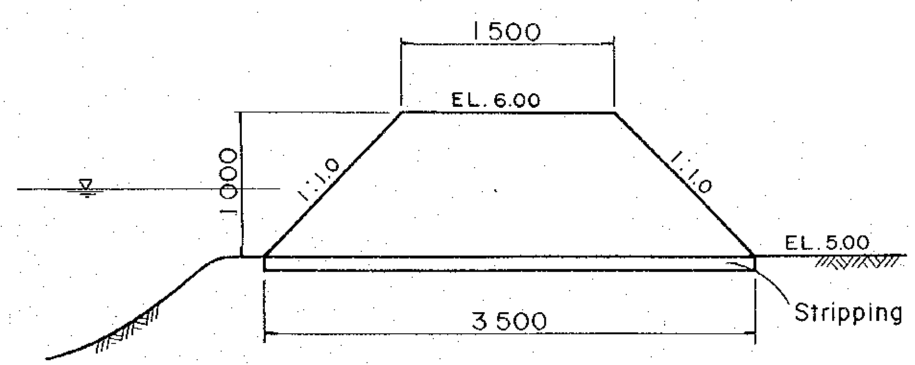
SECTION B-B



SECTION C-C

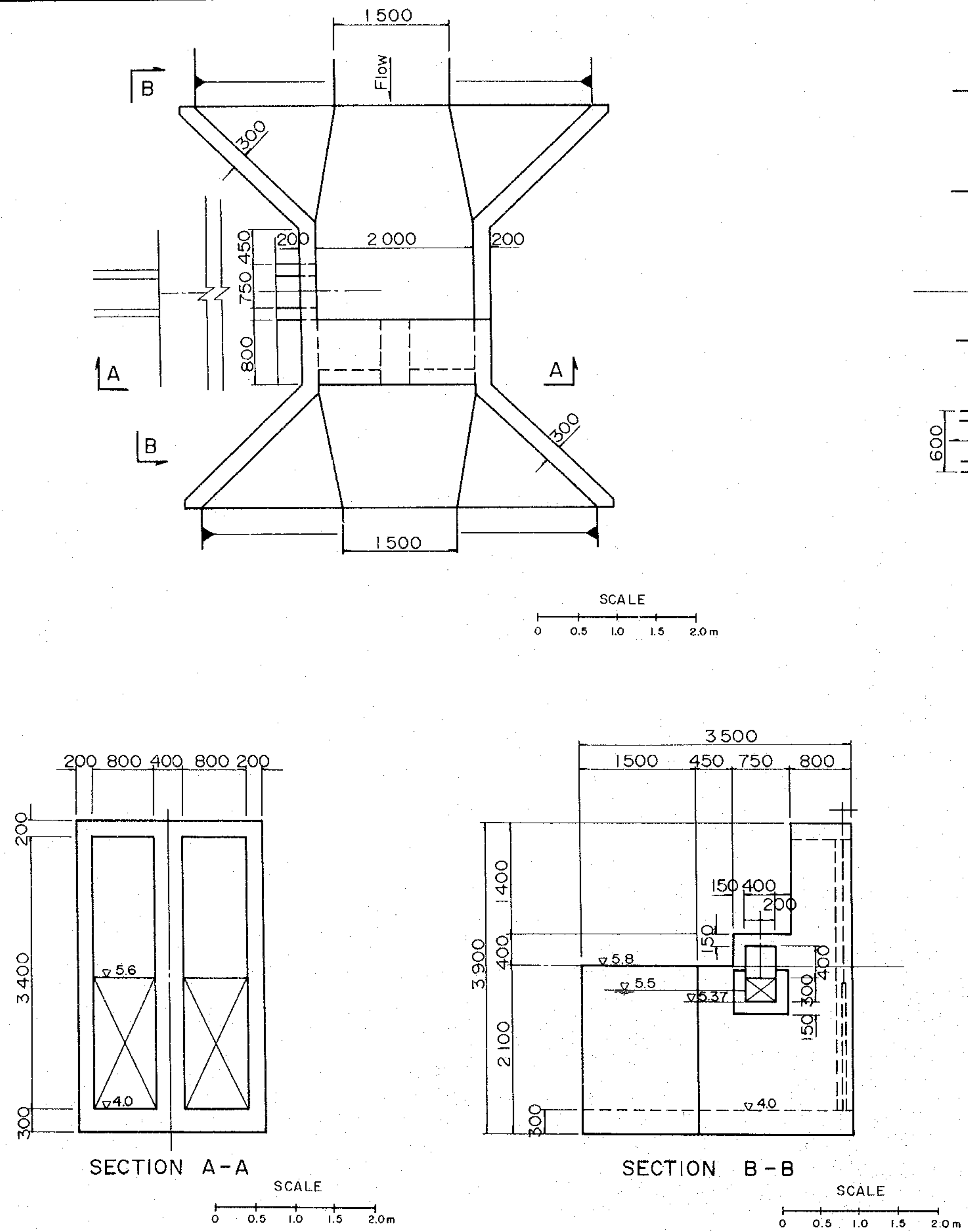


SECTION A-A

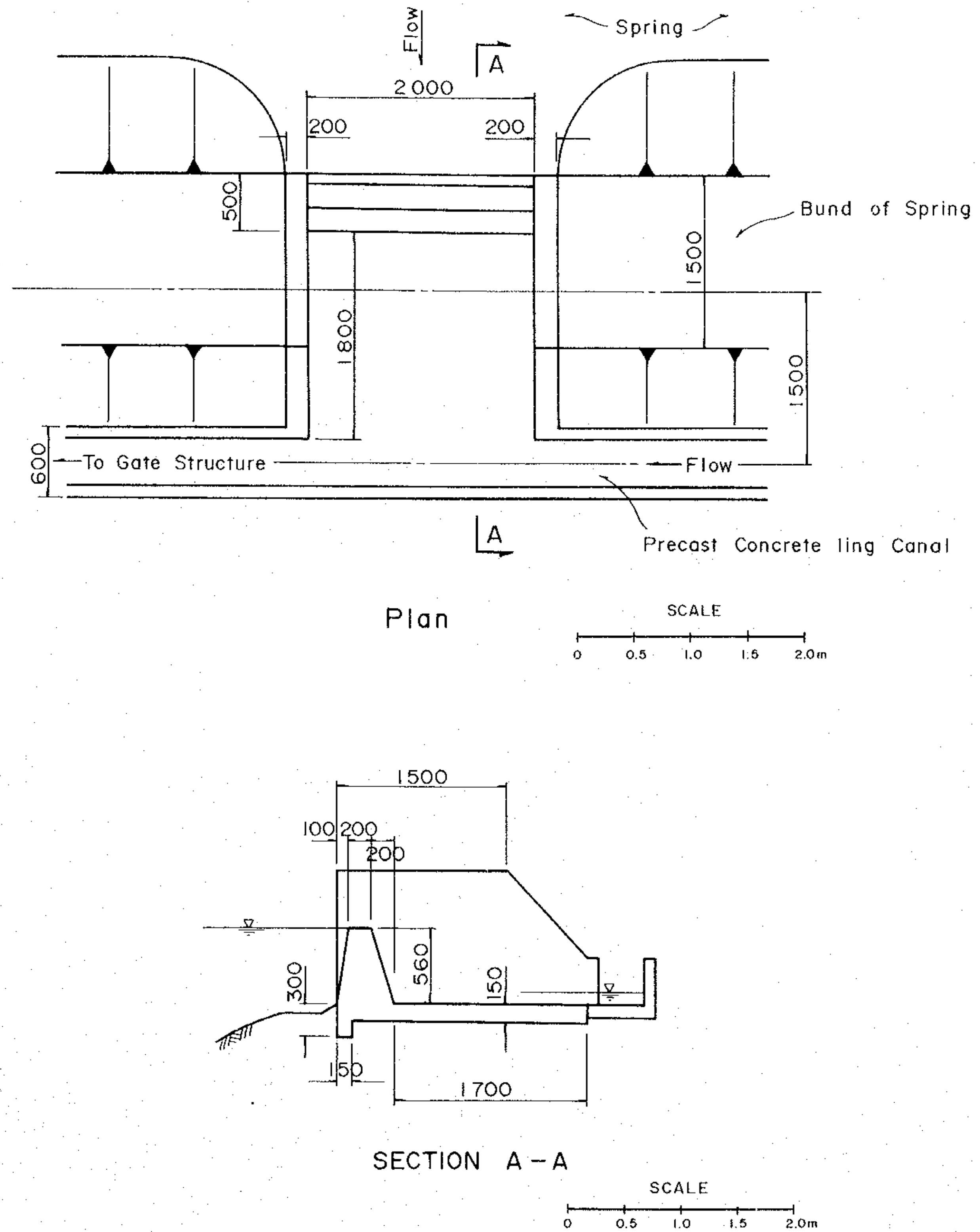


Typical Section of
Bund for Spring

DWG4003 Plan & Sections of Gate Structure and Bund for Spring
K. Kangkar Merlimau Project (JR.10)

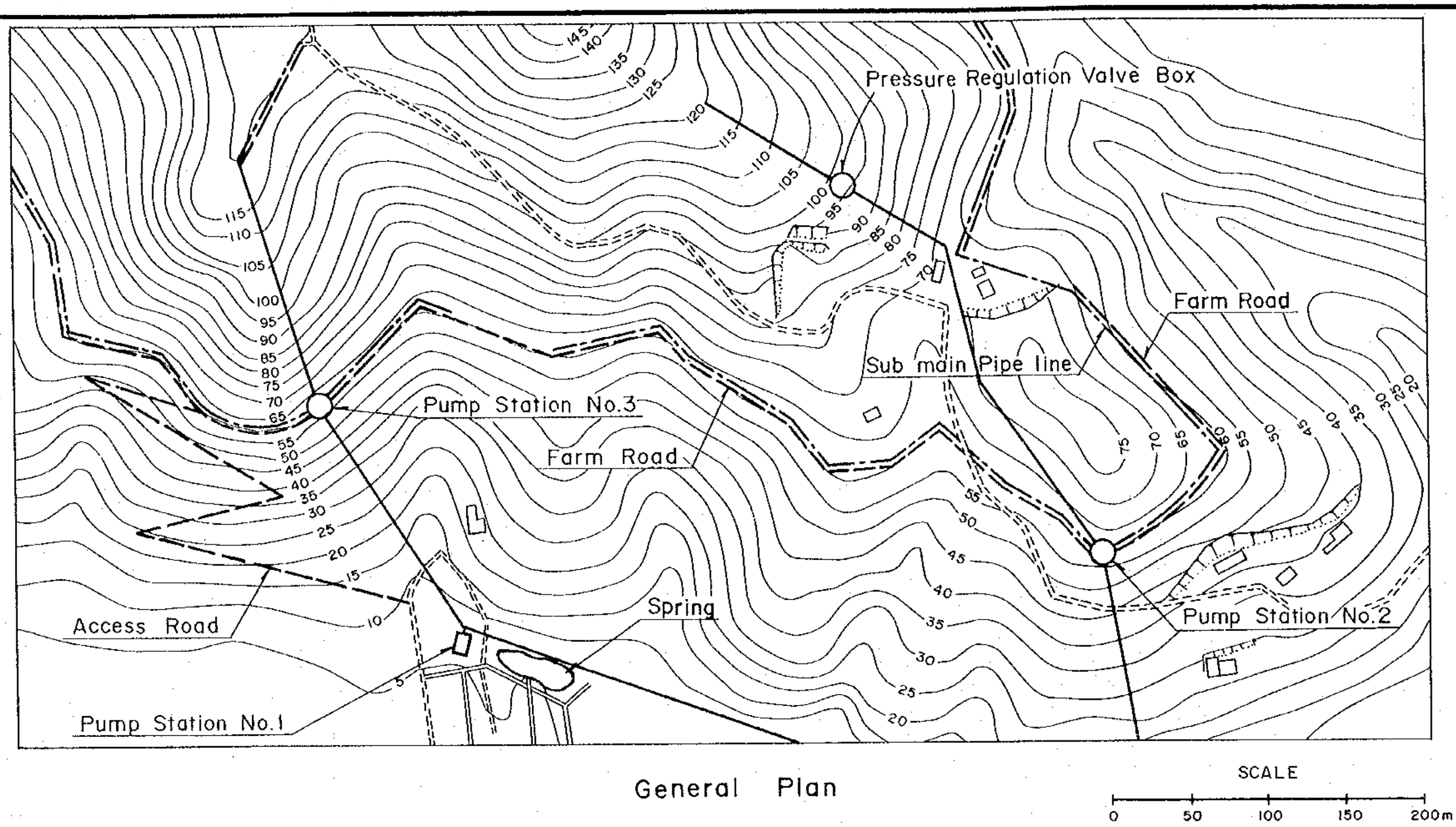


Intake Structure

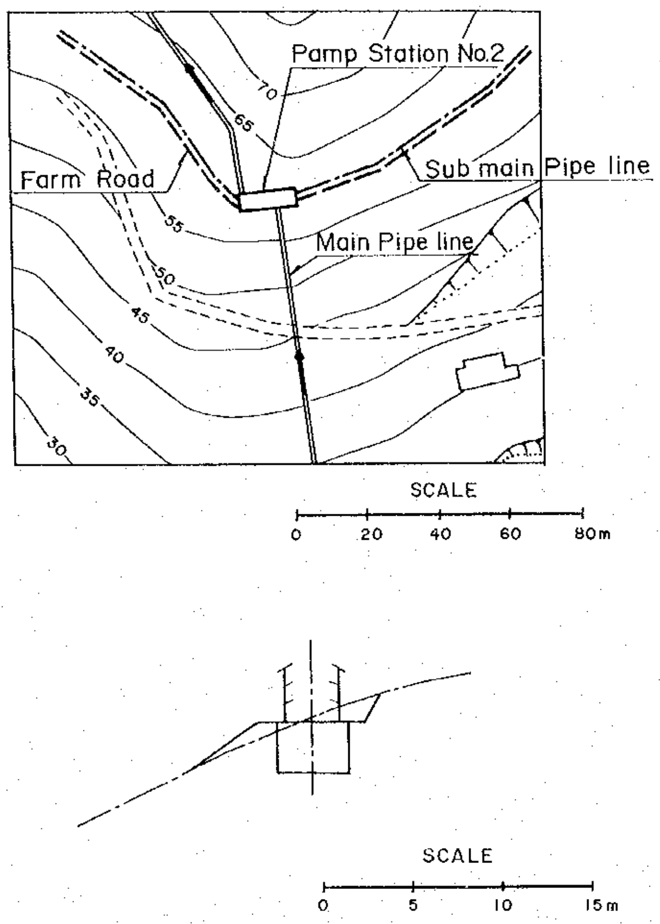


Spill way

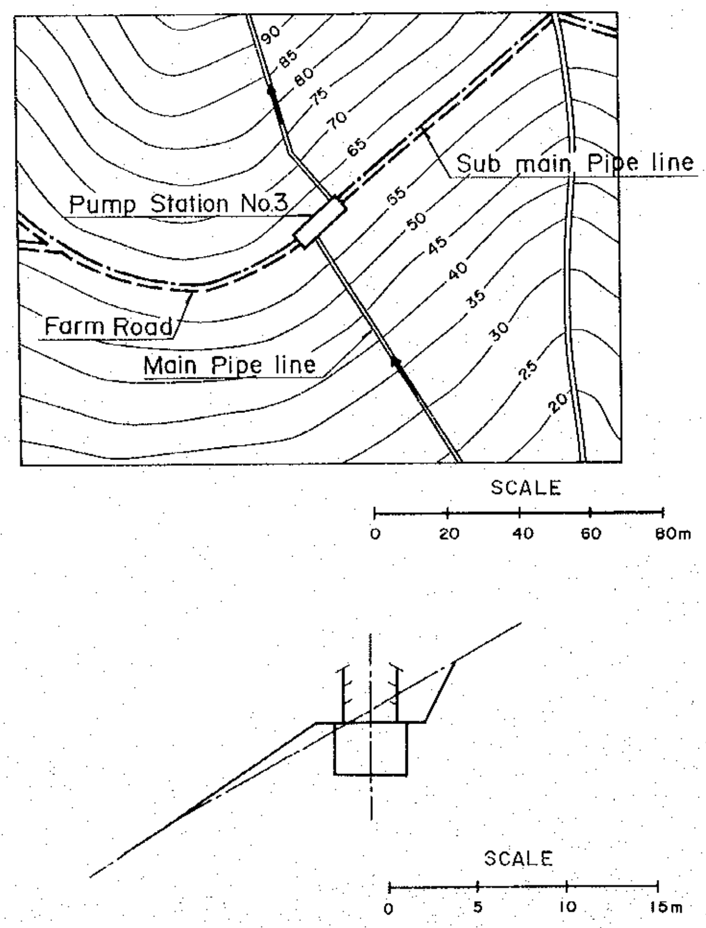
DWG4004 Plan & Sections of Intake Structure and Spillway
K. Kangkar Merlimau Project (JR.10)



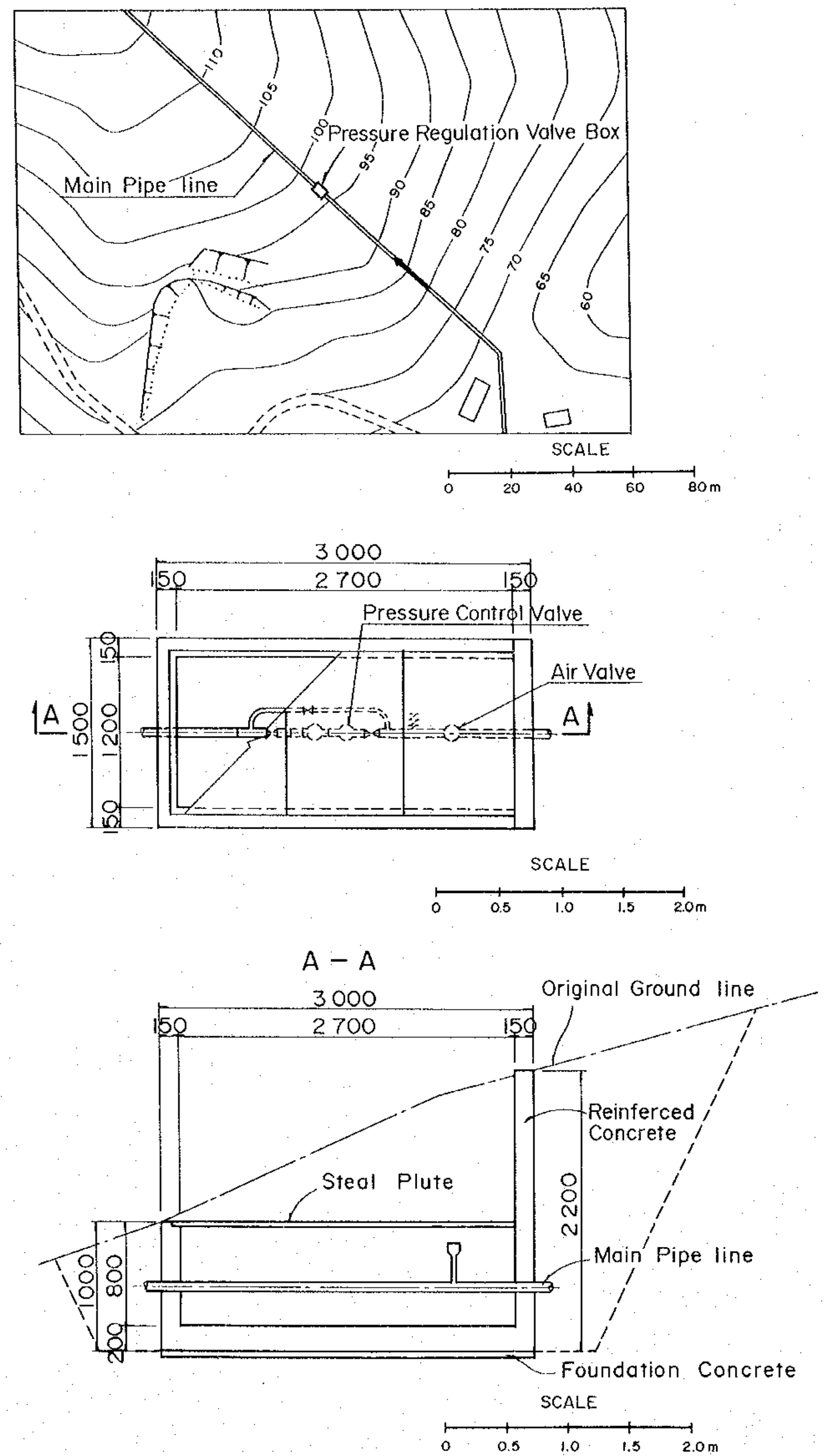
General Plan



Pump Station No.2

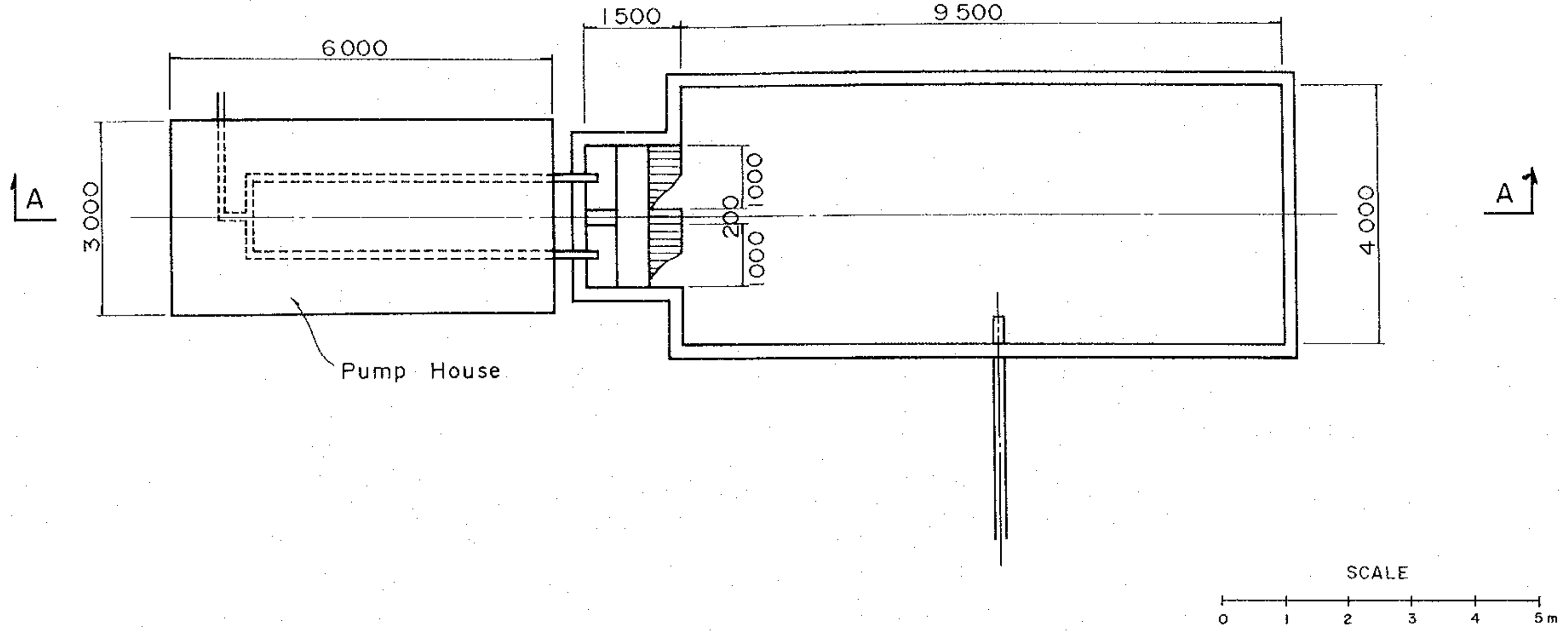


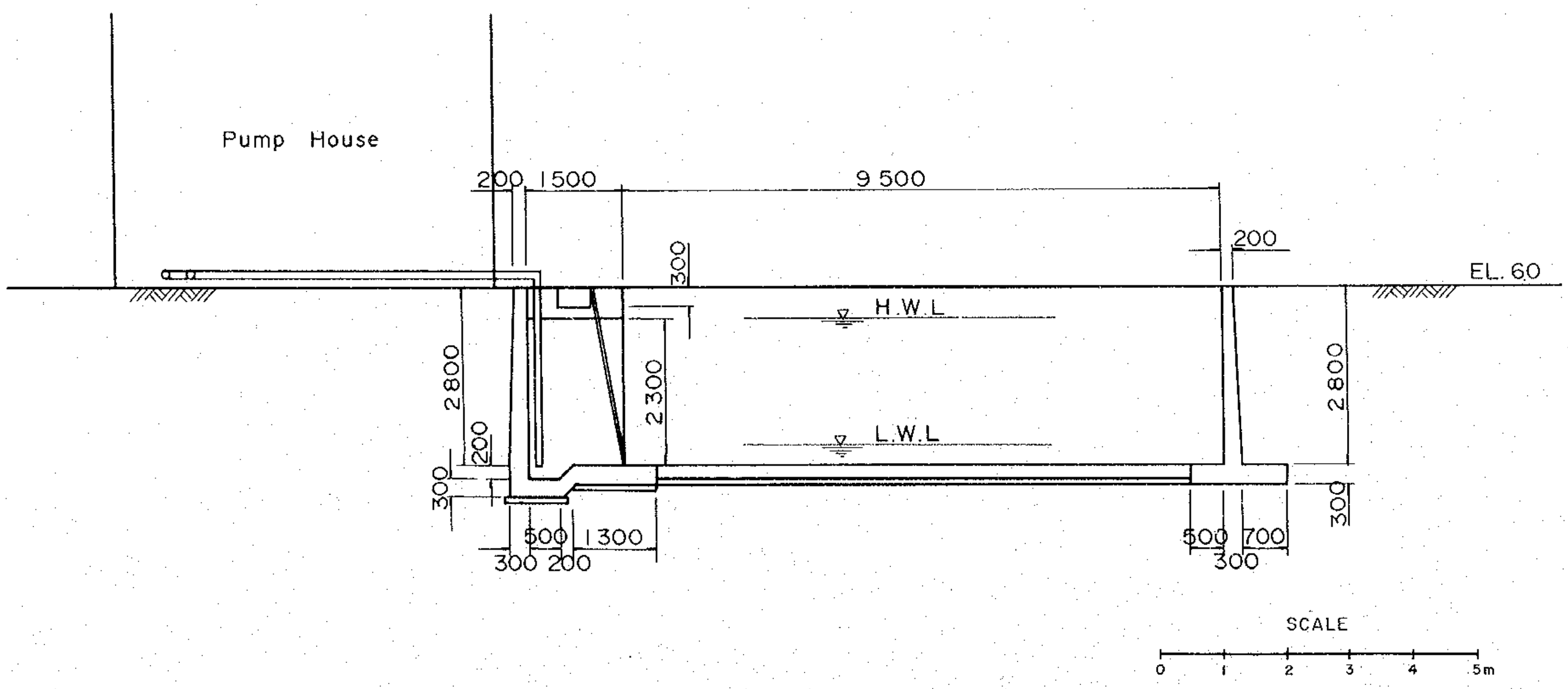
Pump Station No.3



Pressure Regulation Valve Box

DWG4005 Plan & Sections of Pump Station No.2 & No.3 and Pressure Regulation Valve Box
K. Kangkar Merlimau Project (JR 10)





DWG.4006 Plan and Sections of Pump Station No.2 & No.3
K. Kangkar Merlimau Project (JR 10)

5 Pasir Nering Project (TR-44)

5.1 Present Condition

5.1.1 Project Area

The Project area is located in hilly areas about 4 km Southwest from Kuala Brang town, Huluh Terengganu District. The majority of the Project area is covered by bush and rubber plantation. Agriculture land has been newly converted from rubber plantation area, to commercial crop cultivation under the State DOA's crop diversification program. The project area has one (1) stream and 2 tributaries. Irrigation water resource is the Peching river.

5.1.2 Irrigation and Drainage Facilities

The area has existing irrigation facilities such as a pump station and a pipe line covering about 2 ha. A simple sprinkler irrigation system is used for vegetable cultivation, using the water of the Peching stream under the State DOA's crop diversification program.

5.1.3 Social Facilities

An unpaved access road of about 2.5 km, to the Project area has been newly opened, but is jeepable in the main season. The access road extends into the centre of Project area, and 2 simple bridges have been constructed using concrete poles.

An electric distribution line is not constructed in the Project area.

5.2 The Project

5.2.1 Background of the Project

The State DOA promotes the initial stage of pilot farms of roselle cultivation and other upland crops in the Project area under the crop diversification program and intends to expand the roselle cultivation area by more than 38 ha following the expansion program on processing facilities for roselle. New water resources development for the implementation of the crop diversification program is currently required.

5.2.2 Proposed Irrigation Area

The Project area will be a roselle cultivation area of 42 ha including existing vegetable cultivation farms. The majority of the Project area is rubber plantation, bush, and opened agriculture land.

The area has a little undulation but, is predominantly flat. 3 small streams, the Por river, Peching and Udang streams, flow out in and around the proposed irrigation area.

5.2.3 Irrigation Water Requirement

(1) Seasonal irrigation water requirement of durian and vegetable

the main crop of the Project area is roselle. The rrigation water requirement for roselle is basically calculated to follow the procedure of the FAO Irrigation and Drainage Paper No. 24, and the State DOA' s information and opinions which are based on his experience of roselle plantation in other areas.

Potential evapo transpiration (ETo) is estimated at 1,241 mm/year by the modified Penman method, using meteorological data from the Kuala Terengganu station.

The crop coefficient (Kc) of roselle is not clarified at present but is estimated using the sub family crops of roselle such as lady' s fingers based on the State DOA's information and opinion.

The effective rainfall is estimated by the USDA SCS method, using monthly rainfall data.

The irrigation method is designed as a micro jet sprinkler irrigation, and overall irrigation efficiency is adopted as 75 %.

The seasonal irrigation water requirement is 296 mm/year under the drought year with a return period of 5 years. Detailed calculations of the irrigation water requirement are described in Table.3.5.1.

(2) Design irrigation water requirement for facilities

The design irrigation water requirement is calculated to use the peak irrigation water requirement based on the seasonal irrigation water requirement for crops using probable rainfall with a return period of 5 years.

The peak irrigation water requirement for the Project is calculated at 0.44 lit/sec/ha.

The design irrigation water requirement for irrigation facilities are calculated as follows, taking into consideration rotation of the irrigation water supply and the design conditions of the facilities.

The irrigation water supply for the area is applied the rotation system. For rotation of water supply, irrigation areas is broadly divided into three (3) sub irrigation areas with similar hectares of the areas. Thehectares of the sub irrigation blocks range from 6.0 ha to 17.0 ha.

Irrigation water is scheduled to be supplied to each the sub irrigation area for 8 hours during the peak requirement of irrigation water.

Using the above irrigation rotation system, the design irrigation water requirement for the facilities is 1.32 lit / sec /ha. The design discharge of the main pipe lines ranges from 17.7 lit / sec to 20.3 lit / sec.

5.2.4 Reservoir Operation Calculation

The reservoir operations at the proposed pump station site are calculated for half month periods based on the estimated runoff irrigation requirement, and water loss from the reservoir. The runoff from 1960 to 1991 are applied in the reservoir operation calculation.

As a result of these reservoir operation calculations, the reservoir capacity is clarified as follows :

Pilot Project/Reservoir	Type of Reservoir	Capacities(1,000 m3)
TR-44	Excavated Pond	0.1

A detailed calculation of the reservoir operations are described in Table 3.5.2.

5.2.5 Drainage Water Requirement

Drainage water requirement in the Project area is computed under the condition of 3 consecutive days rainfall with an exceeding probability of 80 % and 3 days of drainage period. The 3 consecutive days rainfall with a return period of 5 years at Kuala Terengganu station is adopted based on the 35 years of rainfall data.

The 3 consecutive days rainfall with a return period of 5 years is 310 mm, and the design discharge of the drainage canals is estimated at 12.0 lit/sec/ha.

The Peching river treatment works for the development of the pump station adopted a design flood with a return period of 10 years. The design flood discharge is estimated at 27.95 m3/sec.

5.2.6 Water Resources Development Facilities

Water resources development facilities are basically designed using the draft design standard discussed between DID and JICA Study Team during the Feasibility Study, and design standards issued by the Ministry of Agriculture, Forestry and Fishery, Government of Japan.

The general lay out of the water resources development is shown in DWG 5001 and DWG 5002.

The water resource of the Project is the Peching river. Since the river meanders near the proposed pump station, as short cut of the river course is designed to provide a small excavated pond in the existing meandering section of river, in order to sustain the stable river course and to off take the river water into the pond.

The river section of the short cut is laid out 130 m upstream from the pump station, and the design discharge is a 10 year flood of 27.95 m3/sec. The river section has a low water channel with a width of 5 m and high water channel with a width of 20 m, and the high water depth of river is designed as 2.85 m.

Two gate structures are provided at the inlet and outlet sections of the pond. The pond is designed to be excavated 0.5 m with a trapezoidal section along the existing river course. The width of the pond base is 4 m. The minimum storage capacity of the excavated pond is 100 m3.

The designs of the major structures are illustrated in DWG.5002 to DWG. 5003, and salient features of these facilities are described below.

Excavated pond	H x W x L, 1.5 m x 5 m x 15 m
Gate structures	2 nos.
River treatment	short cut of existing river course length 130 m bottom width of lower channel 5 m

5.2.7 Irrigation and Drainage Facilities

Irrigation development facilities are basically designed using the draft design standard discussed between DID and JICA Study Team during the Feasibility Study and design standards issued by the Ministry of Agriculture, Forestry and Fishery, Government of Japan.

The general lay out of irrigation development is shown in DWG 5001.

The irrigation system in the Project area is a pump and pipe line system for roselle cultivation. Irrigation areas are scattered a both banks of the Peching and Udang rivers. The irrigation system consists of a pump and main pipe line.

The irrigation area expands in an undulated area ranging from EL. 11.00 m to EL 14.00 m.The maximum suction head of the pump is 4 m at the low water level of river, EL 8.00 m. Therefore, the required water heads of pump and pipe lines are less than 10 m. including the water head loss of pumps.

The design discharge of the pumps and main pipes vary from 1.06 m3/min to 1.22 m3/min, and the maximum suction head of the pump is about 5 m by L.W.L of the reservoir.

Taking into consideration the elevation of the irrigation area and the design discharge and suction head of the pumps, an ordinary volute pump is selected. the required number of pumps are 2 units including one (1) unit standby, and PVC pipe is selected for the pipe line.

Water hammers in the pipe line are not expected to occur because the Project area is in a flat plain with small undulation.

Design of the typical structures are illustrated in DWG.5002 to DWG.5004, and salient features of these facilities are described below.

Irrigation area	42 ha
Pump station	1 sites
Pump(volute pump) 3.0 kw (h=20 m)	2 units.
Pipeline	3,300 m
Farm road	2,400 m
Culvert of farm road	8 nos.
Access road to pump station	60 m
On farm facilities	Micro jet sprinkler irrigation facilities 42 ha

5.2.8 Necessary Infrastructure Facilities

For strengthening of the existing access road to the Project area, an additional laterite pavement with a width of 3 m totalling 1,300 m is required, and extension of the electric distribution line to the pump station is also required. The extension distance of the electric distribution line is about 1,000 m.

5.2.9 Construction Plan

Mechanical construction methods will be applied to construction of the Project. Major structures are the pump station, pipe line, and access and farm roads.

Main construction volume such as the embankment of the access and farm roads and concrete work of the pump station are roughly estimated at 5,300 m3 of embankment, about 2,000 m3 of excavation, 270 m of piling work, and about 50 m3 of concrete works.

Taking into consideration th eabove construction volume, the construction schedule is assumed at 5 months consisting of 1 month for mobilisation, preparatory work, and demobilisation periods, and 4 months for the construction period.

5.3 Estimate of Project Cost

5.3.1 Unit Price Analysis

Unit prices of the respective works of the project are estimated to make up-dating the bidding prices of similar works in Terengganu State and the Government price schedule issued in 1993, using the annual inflation rate of commodity issued by the Central Bank of Malaysia.

Reference data of bidding prices for similar works are as follows:

1) Revetment Project in Trengganu 1991,

The updated unit prices of the respective works are shown in Table 3.5.3.

5.3.2 Estimate of Quantity

All quantities are estimated, based on the desig mentioned above. The quantities estimated are shown in Table 3.5.4.

5.3.3 Estimate of Construction Cost

Total construction cost consisting of direct construction cost, land acquisition cost and physical contingency is estimated at about RM 864,800 at 1994 price levels, as shown below.

Physical contingency is assumed as 15 % of direct construction costs.

Description	Cost (RM)
	Pasir Nering
1 Direct construction cost	665,200
2 Land Acquisition	0
3 Physical Contingency	99,800
4 Engineering cost	66,500
5 Administration cost	33,300
Total	864,800

The detailed costs are shown in Table 3.5.4.

Table 3.5.1 Irrigation Water Requirement (TR 44)
Roselle

TR-44	Jan	Feb	Mar.	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Rozelle													
Monthly Rainfall 1976	7.5	14.0	18.0	157.0	231.2	252.0	179.0	303.5	139.0	156.0	508.0	548.7	2,514
Potential Evapotranspiration	98.3	99.1	115.9	118.2	117.5	106.2	108.5	105.1	98.7	98.6	87.6	87.1	1240.8

Rozelle

	Jan	Feb	Mar.	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Crop coefficient (Kc)	0.9	0.78	0.64	0.69	0.88	0.9	0.78	0.35	0	0.29	0.69	0.88	Average Kc 0.85
Crop Evapotranspiration (ETc)	88.4	77.3	74.2	81.6	103.4	95.6	84.6	36.8	0.0	28.6	60.4	76.7	808
Effective Rainfall	0.0	8.7	9.0	81.6	103.4	95.6	84.6	36.8	0.0	28.6	60.4	76.7	585
Net Irrigation Requirement	88	69	65	0	0	0	0	0	0	0	0	0	222
Irrigation Efficiency	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	
Conveyance efficiency													
Application Efficiency													
Gross Irrigation Requirement	118	91	87	0	0	0	0	0	0	0	0	0	296

Table 3.5.2 Water Balance at the Proposed Pump Station (TR-44)

									SUMMARY OF RESERVOIR OPERATION																	
		Jan(1)	Jan(2)	Feb(1)	Feb(2)	Mar(1)	Mar(2)	Apr(1)	Apr(2)	May(1)	May(2)	June(1)	June(2)	July(1)	July(2)	Aug(1)	Aug(2)	Sept(1)	Sept(2)	Oct(1)	Oct(2)	Nov(1)	Nov(2)	Dec(1)	Dec(2)	Total
1	1960	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
2	1961	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
3	1962	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
4	1963	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
5	1964	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
6	1965	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
7	1966	0.1	0.1	0.1	0.1	0.1	0.1	[redacted]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
8	1967	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
9	1968	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
10	1969	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
11	1970	0.1	0.1	0.1	0.1	0.1	0.1	0.1	[redacted]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
12	1971	0.1	0.1	0.1	0.1	0.1	0.1	[redacted]	[redacted]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
13	1972	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
14	1973	0.1	0.1	0.1	0.1	0.1	0.1	[redacted]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
15	1974	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
16	1975	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
17	1976	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
18	1977	0.1	0.1	0.1	0.1	0.1	0.1	0.1	[redacted]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
19	1978	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
20	1979	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
21	1980	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
22	1981	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
23	1982	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
24	1983	0.1	0.1	0.1	0.1	0.1	0.1	[redacted]	[redacted]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
25	1984	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
26	1985	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
27	1986	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
28	1987	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
29	1988	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
30	1989	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
31	1990	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
32	1991	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	[redacted]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	

Table 3.5.3 Unite Price Analysis (TR-44)

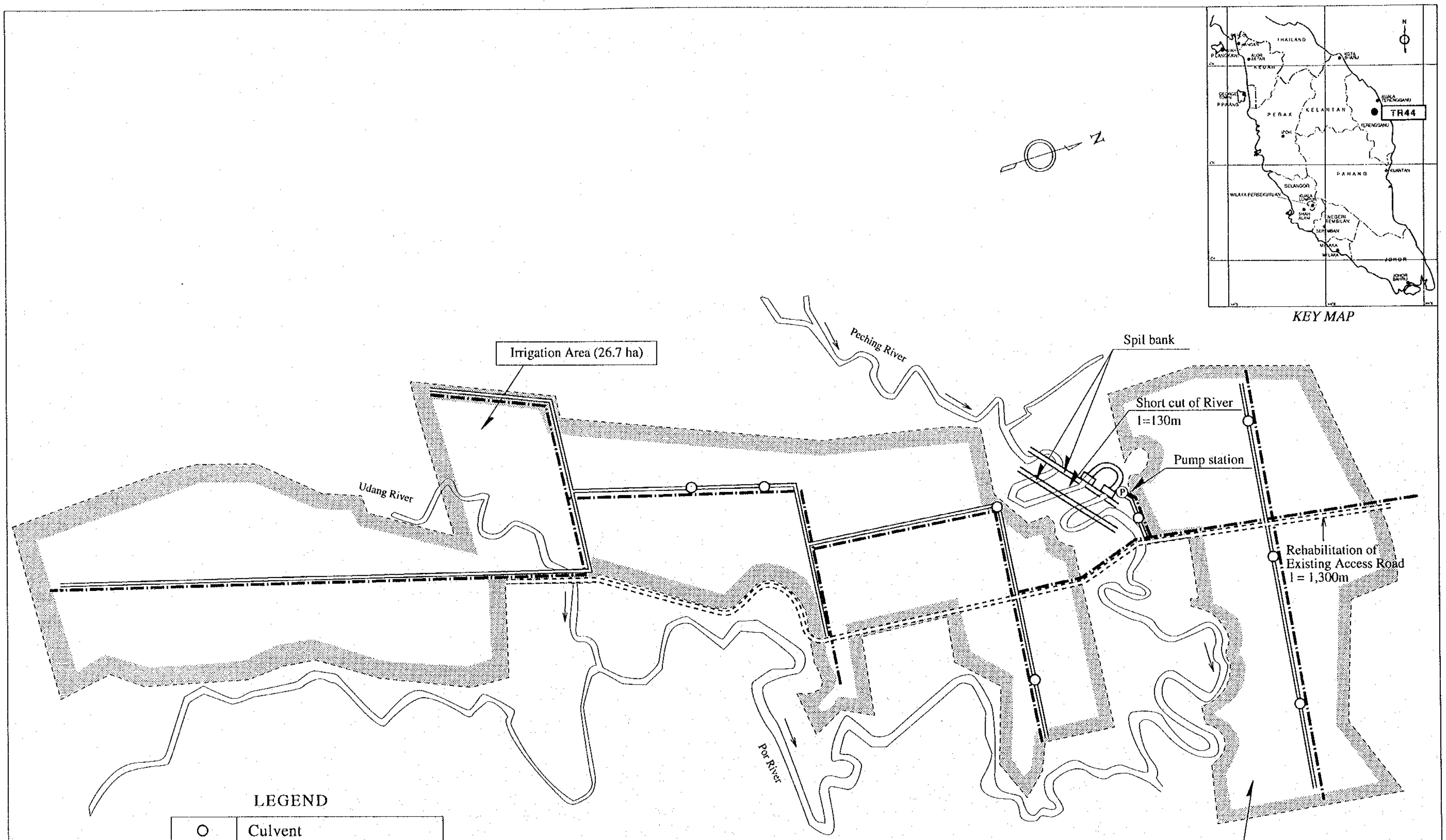
Description	Unit	Tender Price	Tender Year	Infration Rate (%)	Up-dated Price (RM)	Adopted Price (RM)	Remarks Data sources
Access Road							
Stripping	m3	2.7	1991	1.131	3.1	3.1	JPS Price List 1993 Average price
Excavation	m3	9.3	1993	1.035	9.6		JPS Schedule of Rate 1993
		8.0	1991	1.131	9.0	9.3	Revetment project 1991
Embankment	m3	10.0	1991	1.131	11.3	11	Revetment project 1991
Laterite pavement	m3	14.4	1993	1.035	14.9	14.9	JPS Price List 1993 Average price
Pump Station							
Excavation	m3	6.0	1991	1.131	6.8		Revetment project 1991
		9.3	1993	1.035	9.6	8.2	JPS Schedule of Rate 1993
Embankment	m3	10.0	1991	1.131	11.3		Revetment project 1991
		15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Backfill	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Reinforced Concrete	m3	490.0	1991	1.131	554.2		JPS Price List 1993
		500.0	1993	1.035	517.5		JPS Schedule of Rate 1993
		514.0	1991	1.131	581.3	551.0	Revetment project 1991
Foundation Concrete	m3	80.0	1991	1.131	90.5	90.0	JPS Price List 1993
Trash screen	m2	444.4	1991	1.131	502.7	502.7	JPS Price List 1993
Gabion		90.0	1991	1.131	101.8	101.8	JPS Price List 1993 Average price)
Volute Pumps							
Type 3.0 kw H 20 m	nos.	8,200.0	1994	1	8,200.0	8,200.0	Supplyers' estimate
Pipe line							
Excavation for pipe	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Excavation for anchor block	m3	9.3	1993	1.035	9.6	9.6	JPS Schedule of Rate 1993
Backfill	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Sand bed	m3	15.6	1992	1.084	16.9	21.7	JPS Price List 1993
Reinforced Concrete of anchor	m3	490.0	1991	1.131	554.2		JPS Price List 1993
		500.0	1993	1.035	517.5		JPS Schedule of Rate 1993
		514.0	1991	1.131	581.3	551.0	Revetment project 1991
PVC Pipe							
dia. less than 75 mm	m	17.0	1991	1.131	19.2	25.0	JPS Price List 1993
dia. 100 mm	m	17.0	1991	1.131	19.2	25.0	JPS Price List 1993
dia. 150 mm	m	22.5	1991	1.131	25.4	33.0	JPS Price List 1993

Sluice Valve	nos.						
Flange & valve	nos.						
Canal & Related Structures							
Reinforced Concrete	m3	490.0	1991	1.131	554.2		JPS Price List 1993
		500.0	1993	1.035	517.5		JPS Schedule of Rate 1993
		514.0	1991	1.131	581.3	551.0	Revetment project 1991
Foundation Concrete	m3	80.0	1991	1.131	90.5	90.0	JPS Price List 1993
Concrete Pile dia. 150	m	60.0	1991	1.131	67.9	67.9	JPS Price List 1993
Excavation	m3	6.0	1991	1.131	6.8		Revetment project 1991
		9.3	1993	1.035	9.6	8.2	JPS Schedule of Rate 1993
Embankment	m3	10.0	1991	1.131	11.3		Revetment project 1991
		15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Backfill	m3	15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Gate							
1m x 2m		2,000.0	1991	1.131	2,262.0	2,260.0	JPS Price List 1993
Farm Road							
Stripping	m3	2.7	1991	1.131	3.1	3.1	JPS Price List 1993 Average price
Embankment	m3	10.0	1991	1.131	11.3		Revetment project 1991
		15.0	1991	1.131	17.0	17.0	JPS Price List 1993
Laterite pavement	m3	12.5	1993	1.035	12.9	12.9	JPS Price List 1993 Average price
Concrete Pipe dia. 500	m	190.0	1991	1.131	214.9	215	JPS Price List 1993 Average price
Reinforced Concrete	m3	490.0	1991	1.131	554.2		JPS Price List 1993
		500.0	1993	1.035	517.5		JPS Schedule of Rate 1993
		514.0	1991	1.131	581.3	551.0	Revetment project 1991
Plain Concrete	m3	274.0	1991	1.131	309.9	309.9	Revetment project 1991
Drainage & River Treatment							
Excavation	m3	8.0	1991	1.131	9.0	9.0	Revetment project 1991
Gabion	m3	90.0	1991	1.131	101.8	101.8	JPS Price List 1993 Average price)
On-farm development							
Sprinkler irrigation facilities	ha	4,300.0	1994	1	4,300.0	4,300 *	Supplyer's price
Land Acquisition	ha	100,000.0	1994	1	100,000.0	100,000.0	

Table 3.5.4 Estimate of Construction Cost (TR-44)

Work Item	Unit	Quantity	Unit Price(RM)	Amount(RM)
Access Road				
Excavation	m3	0.0	9.3	0.0
Stripping	m3	50.0	3.1	155.0
Embankment	m3	170.0	11.0	1,870.0
Laterite pavement	m2	200.0	14.9	2,980.0
Subtotal				5,005.0
Pump Station				
Excavation	m3	220.0	8.2	1,804.0
Embankment	m3	0.0	17.0	0.0
Backfill	m3	35.0	17.0	595.0
Reinforced Concrete	m3	20.0	551.0	11,020.0
Foundation Concrete	m3	1.0	90.0	90.0
Trash screen	m2	11.0	502.7	5,529.7
Gabion	m3	80.0	101.8	8,144.0
Volute Pumps				
Type 3.0 kw H 20 m	nos.	2.0	8,200.0	16,400.0
Pump House	m2	12.5	1,000.0	12,500.0
Subtotal				56,082.7
Pipe line				
Excavation for pipe	m3	650.0	9.6	6,240.0
Excavation for anchor block	m3	2.0	9.6	19.2
Backfill	m3	560.0	17.0	9,520.0
Sand bed	m3	80.0	21.7	1,736.0
Reinforced Concrete of anchor	m3	1.0	551.0	551.0
PVC Pipe				
dia. less than 75 mm	m	160.0	25.0	4,000.0
dia. 100 mm	m	1,560.0	25.0	39,000.0
dia. 150 mm	m	1,740.0	33.0	57,420.0
Sluice Valve	nos.			0.0
Flange & valve	nos.			0.0
Subtotal				118,486.2
Canal & Related Structures				
Reinforced Concrete	m3	21.0	551.0	11,571.0
Foundation Concrete	m3	2.0	90.0	180.0
Concrete Pile dia. 150	m	270.0	67.9	18,333.0
Excavation	m3	460.0	8.2	3,772.0
Backfill	m3	280.0	17.0	4,760.0
Gate				
1m x 2m	nos.	2.0	2,260.0	4,520.0
Subtotal				43,136.0
Farm Road				
Stripping	m3	1,900.0	3.1	5,890.0
Embankment	m3	5,300.0	17.0	90,100.0
Laterite pavement	m2	9,810.0	12.9	126,549.0
Concrete Pipe dia. 500	m	87.0	215.0	18,705.0
Reinforced Concrete	m3	1.0	551.0	551.0
Plain Concrete	m3	8.0	309.9	2,479.2
Subtotal				244,274.2
Drainage & River Treatment				
Excavation	m3	1,100.0	9.0	9,900.0
Gabion	m3	75.0	101.8	7,635.0
Subtotal				17,535.0

On-farm development				
Sprinkler irrigation facilities	ha	42.0	4,300.0	180,600.0
SUBTOTAL				665,119.1
Land Acquisition	ha	0.0	100,000.0	0.0
Physical Contingency (15 % of Subtotal)				99,767.9
Engineering Cost (10 % of Subtotal)				66,511.9
Administration cost (5 % of Subtotal)				33,256.0
TOTAL				864,654.8

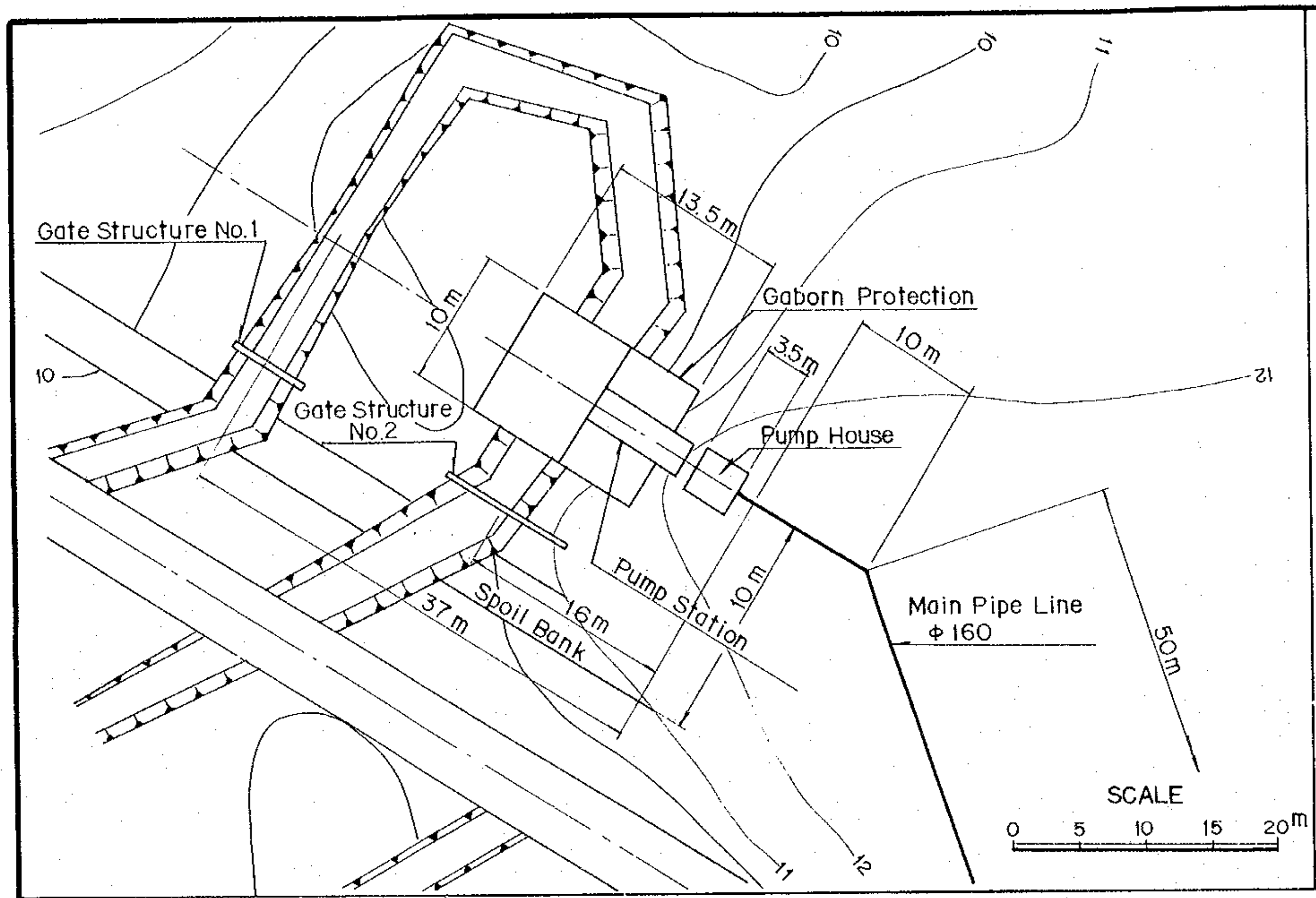


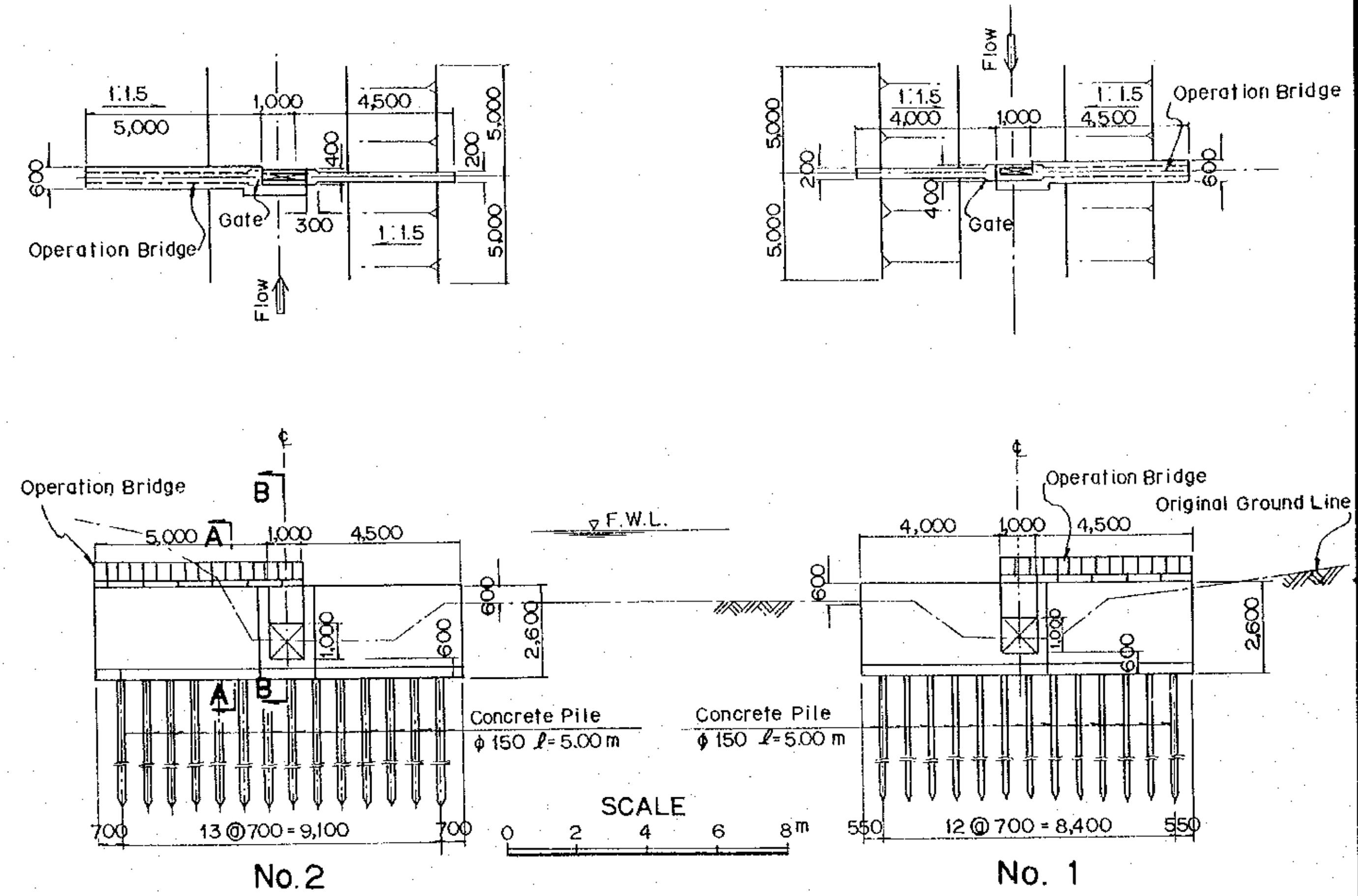
LEGEND

○	Culvent
▭	Pump station
══	Farm / Access Road
—·—·	Pipe line
======	Existing Roads
- - - -	Boundary of Project Area

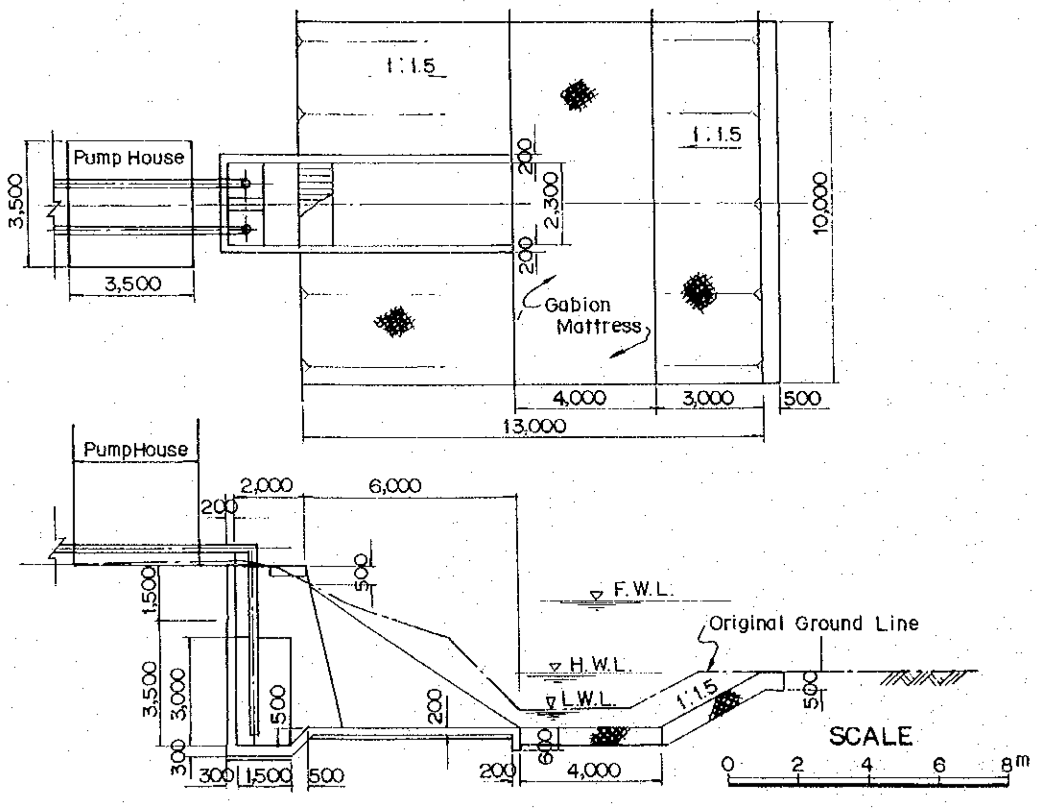
SCALE
0 100 200m

DWG5001 General Layout of Pasir Nering Project

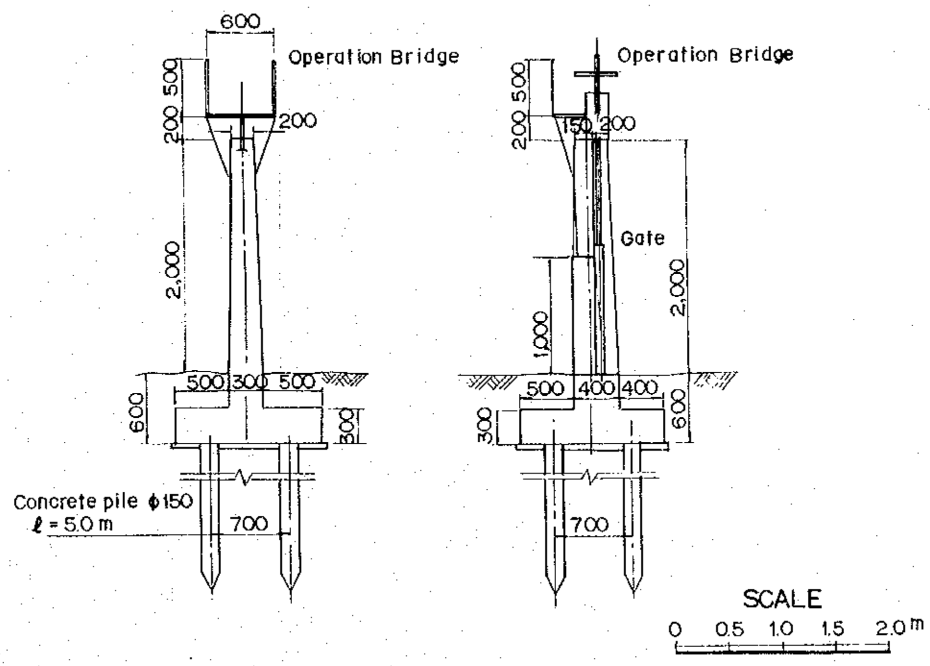




GATE STRUCTURE



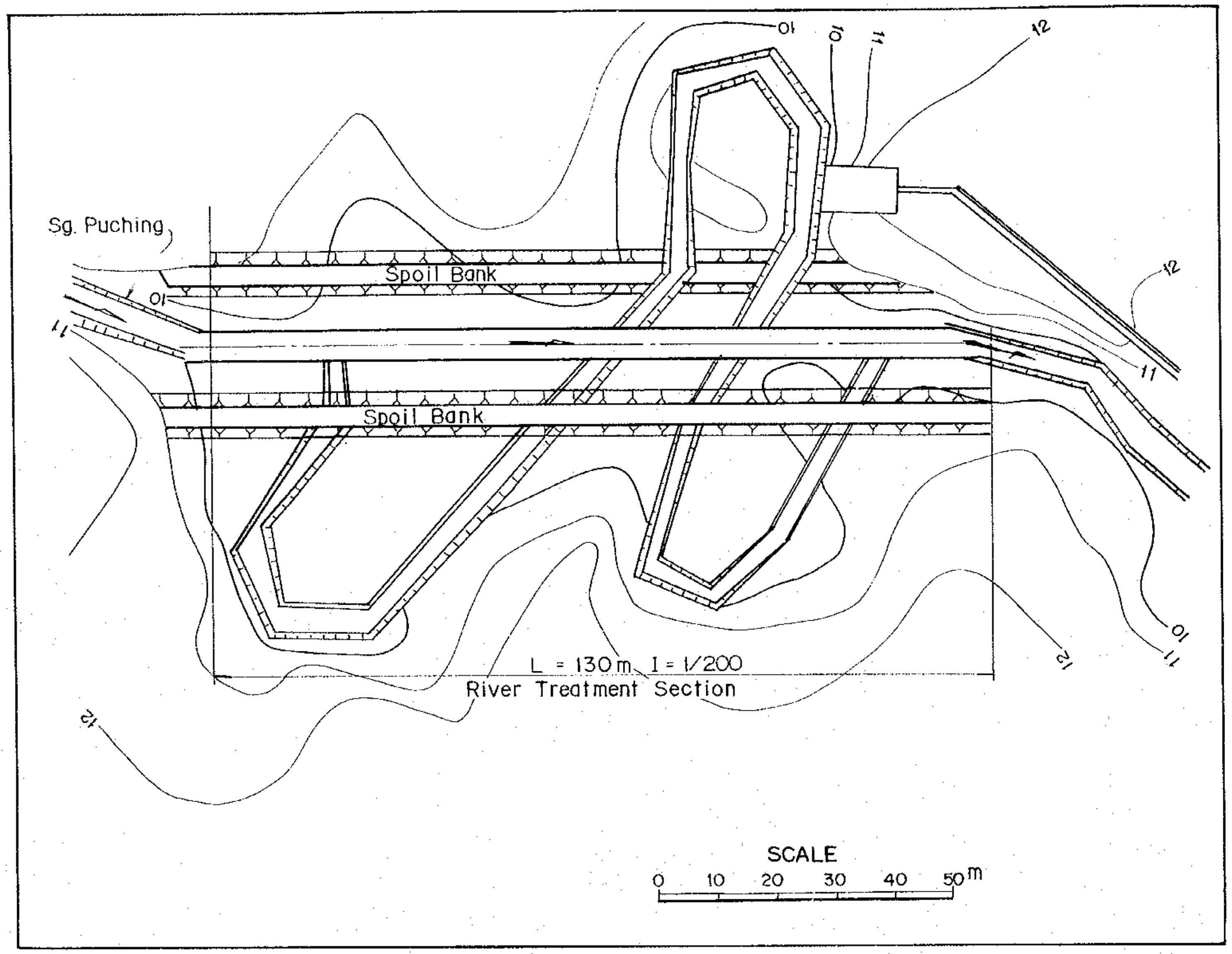
PUMP STATION

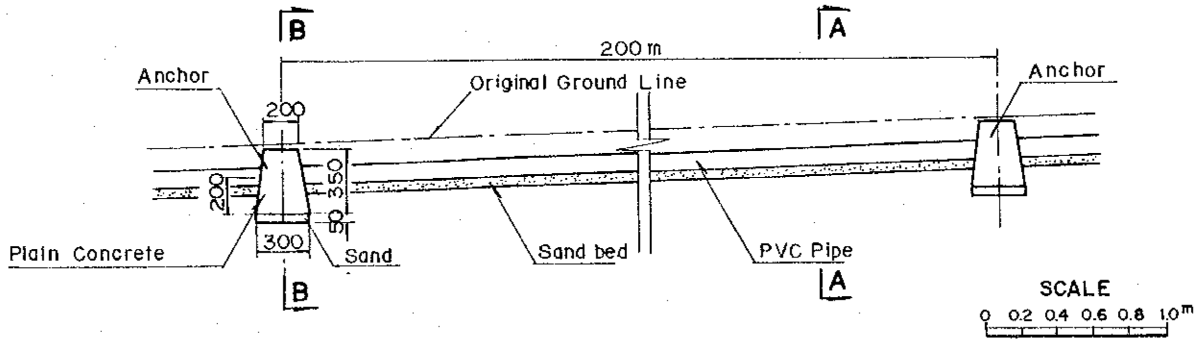


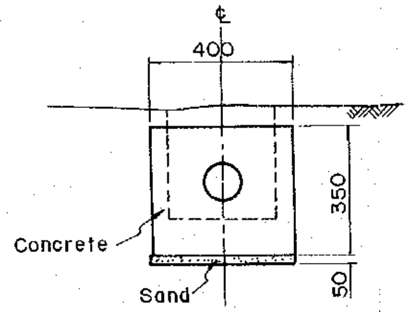
SECTION A-A

SECTION B-B

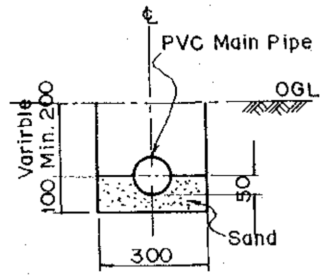
DWG5002 Plan & Sections of Pump Station and Gate Structure No.1 & No.2
Pasir Nering Project (TR.44)



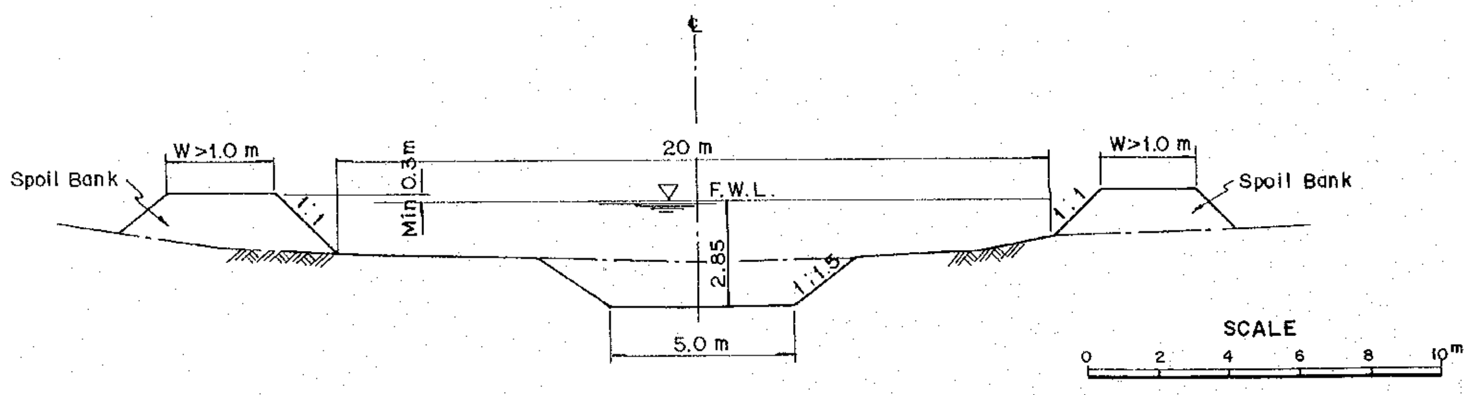




SECTION B-B

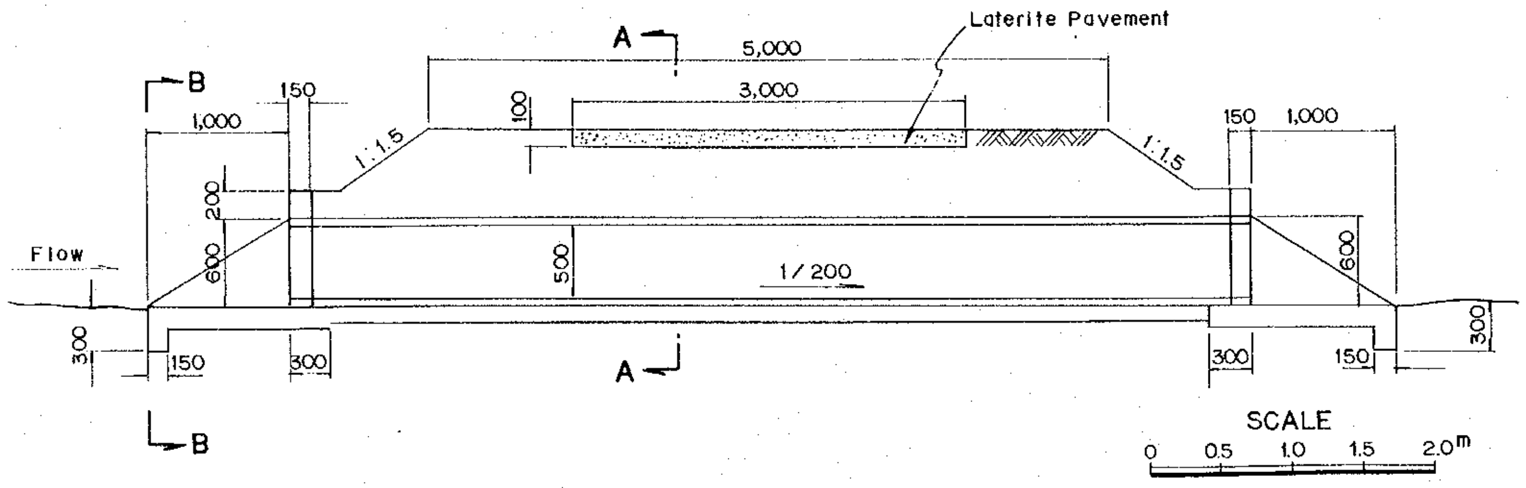


SECTION A-A

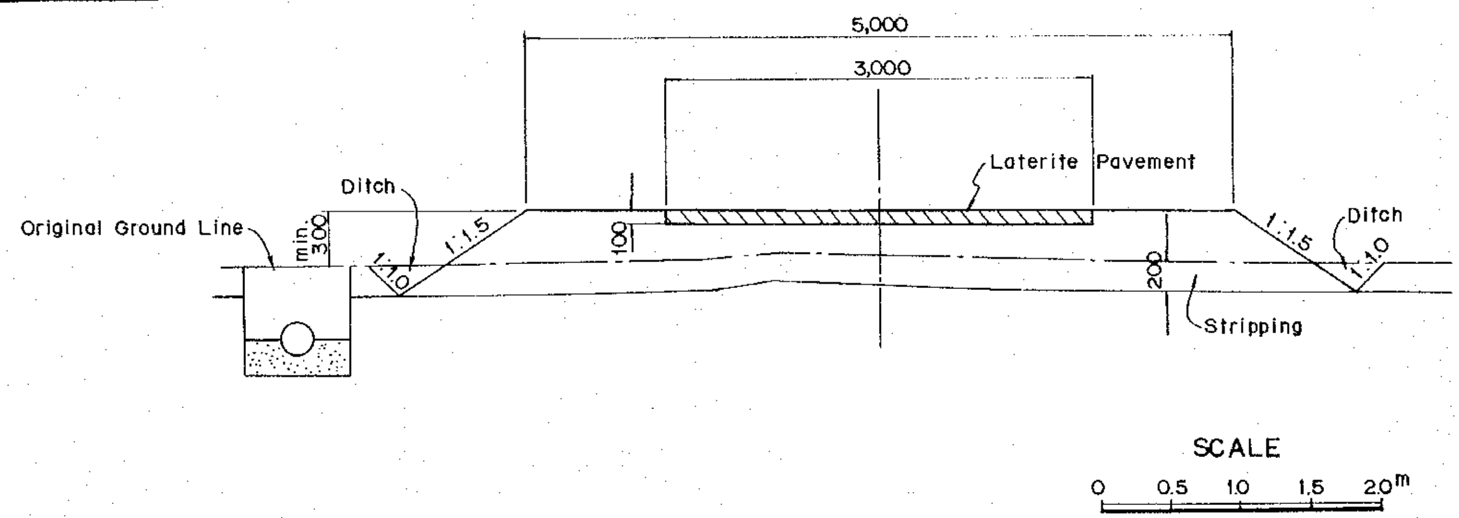


TYPICAL CROSS SECTION OF RIVER

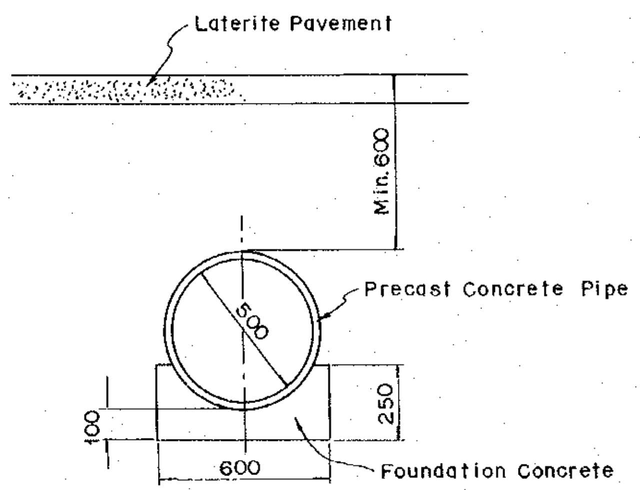
DWG5003 Typical Section of Pipe Line and Plan and Sections of River Treatment
Pasir Nering Project (TR.44)



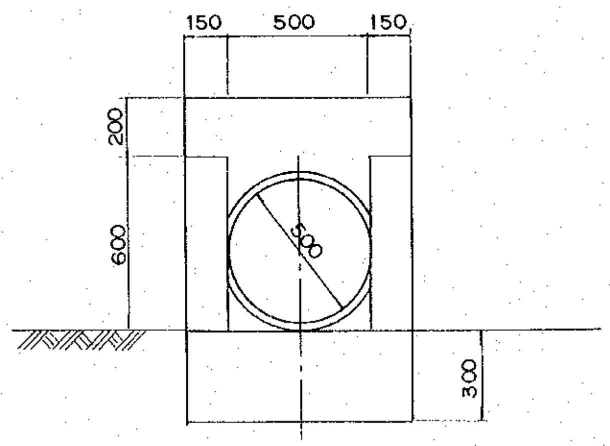
CULVERT



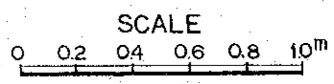
TYPICAL SECTION OF FARM ROAD



SECTION A-A



SECTION B-B



DWG.5004 Typical Sections of Culvert and Farm Road
Pasir Nering Project (TR 44)

ANNEX IV
GEOLOGY

ANNEX IV
GEOLOGY

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I. INTRODUCTION

This report is prepared on geological investigation, which was carried out for "The Feasibility Study on Small Reservoir Development in Peninsular Malaysia". The geological investigation was executed in two phases; the first phase (Phase I Study) was during the periods from September to October, 1993 (1st stage) and from February to March, 1994 (2nd stage), and the second phase (Phase II Study) was during the period from May to September, 1994.
The main works are as follows;

(1) Phase I Study

(a) 1st stage

- Establishment of selection criteria for potential sites
- Preparation of data base format (Questionnaires)

(b) 2nd stage

- Categorization and priority ranking of the potential sites
- Approach to the feasibility study(Preparation for the feasibility study on the selected pilot projects)

(2) Phase II Study

- Feasibility studies(Geological investigation) on small reservoir development projects at the selected pilot project sites
- Formulation of the draft guidelines for small reservoir development

"Identification of potential sites" and "Establishment of data base of potential sites" were carried out by the counterpart agencies in each state(State DID) and Sepakat Setia Peruding SDN,BHD.,Kuala Lumpur, according to the selection criteria and the data base format prepared by the JICA Study Team, during the period between the 1st and 2nd stage of the Phase I Study.

"Geological investigation" including soil-mechanical tests in laboratory during the Phase II Study was performed by Soil Centralab(CSL) SDN,BHD.,Kuala Lumpur, according to the specification prepared and under supervision made by the JICA Study Team.

II. INVESTIGATION

2.1 Phase I Study

2.1.1 Basic geological concept in the project

The outline of topographic and geologic conditions in the project area(Peninsular Malaysia) were identified with the assistance of collected data and the field reconnaissance survey.

Taking the topographic and geologic conditions of the project area, and the proposed "small scale" and "diversified development methods" of constructions or facilities in the project into account, the topographical and geological study in the project seem to be limited to the problems relating to the unconsolidated or semi-consolidated Quaternary deposits or weathered rocks. Therefore, for the geological selection criteria for potential sites for small reservoir development, the following information seems to be important;

1) Types of the Quaternary deposits,
2) Weathered conditions of the rocks, and
3) Existence of the damages such as landslide, slope failure, etc., on or around the existing constructions, facilities, cut or natural slopes, etc.

Therefore, the questionnaire targeting at obtaining the information mentioned above was prepared for the inventory survey. The questionnaire is given in Annex***1. Furthermore, the following guidelines were prepared for the inventory survey carried out by the DID and the local consultants.

2.1.2 Guidelines for inventory survey

These guidelines are applicable for planning of earth fill dams, lower than 10 m in height for the inventory survey carried out by the DID and local consultants.

(1) Cut Slope

The cut slope gradients are proposed as follows.

Natural ground	Gradient
Rocks	1:0.8
Sand or Sandy soil	1:1.5
Clay or Clayey soil	1:1.2

The slope protection works such as sodding is required for the cut slope higher than 5 m, except for hard and soft rocks.

(2) Embankment

2)-1 Embankment material

The embankment material for dam is required to possess sufficient water tightness and strength properties. Therefore, the materials such as gravel, gravelly soil, sand, sandy soil, etc. are not recommended for homogeneous type dam. Also, peat is not recommended, not only for the embankment material for dam, but also for the other facilities like a farm road.

2)-2 Embankment slope

The embankment slope gradient for dam and the other facilities are proposed as follows;

a) For dams

Slope	Gradient
Upstream	1:2.5
Downstream	1:2.5

b) For the other facilities

Materials	Height	Gradient
All material	Up to 5 m	1:1.8
All material	More than 5 m	1:2.0

The slope protection works required for the dam are, rip-rap protection for upstream slope and sodding for downstream slope.

The embankment slope protection works for the other facilities with slopes higher than 5 m, are proposed as sodding .

(3) Dam Foundation

The dam foundation shall possess the required water tightness and strength, and be sufficiently safe against sliding failure and seepage failure. Therefore, following criteria are required to be taken into consideration.

a) The area underlain by thick peat or soft clay layer is not recommended for dam-site.

b) The dam foundation excavation needs to carry out to the depth of 1.0 m in order to remove humic and/or loose surface soil.

c) If the dam foundation consists of pervious materials such as gravel, gravelly soil, loose sand or sandy soil, an impervious blanket with a thickness of 1.0 m and a length of five times the dam height shall be considered to prevent seepage from the reservoir.

2.1.3 Categorization and priority ranking of potential sites

Table 4.1 shows the list of identified potential sites and the questionnaire survey results in the geology section.

Generally, geological conditions would not be primary, but be incidental in the priority ranking for the potential sites in a agricultural development plan. For example, if all other conditions are the same, the difference of the geological conditions would decide whether the project is economical or not. In some cases, the geological conditions would make the project impossible, for example, because of in adequate of the bearing capacity for a foundation of a large dam or facilities planned in the project.

Any project in the list, however, did not require the geological procedure in the priority ranking for the potential sites. Because, the priority of all of the potential sites were ranked sufficiently with the only primary selection criteria and there was no project including such a plan of large dam or facilities as the geological judgment is required.

Due to the reasons mentioned above, any categorization work was not necessary for the selection of the pilot sites in the geology section.

The main points of the questionnaire survey results are as follows.

a) Answers for 115 projects out of 145 short listed projects were collected(79.3 %).

b) The map with a scale of 1 to 63,360(1 inch to 1 mile) or 1 to 50,000 is not prepared in 39 projects, i.e., 33.9 % of the 115 answered projects. The 39 projects included 6 unanswered projects. The projects which did not prepare the map described above, or did not answer, are in Perak, Selangor, Negeri Sembilan and Terengganu.

   The above results means that in those four States DID did not prepare a complete set of maps. According to the collected information by the JICA Study Team, the map of 1 inch to 1 mile covers all of Peninsular Malaysia.(G_MAP:Existing topographic map)

c) Aerial photograph was not prepared in any project. (G_PSCALE:Scale of aerial photographs)

d) The maps, except for the map described in "b)", are prepared in 23(20 %) projects. The scale of the maps is mostly 1 to 25,000 and the rest are 1 to 6,336 or 1 to 3,168. The maps are prepared in many projects in Pulau Pinang, Melaka andTerengganu.(G_MSCALE:Scale of other maps)

e) Answers to "Geologic condition" are collected in almost all projects. The number of projects with an answer, "Unknown", is 4.(G_COND:Geologic condition in the scheme area)

f) Some geological data are prepared in 5 projects. Four of them are in Pulau Pinang and the other is in Kelantan. The type of geological data prepared in the former 4 are "Geological Map or Profile", and in the latter is "Geological Survey Report".

   According to the collected information by the JICA Study Team, the geological map with a scale of 1 to 500,000 covers the entire Malaysia and a scale of 1 to 63,360 covers the whole area of Peninsular Malaysia. Furthermore, many kinds of geological data are published by the Geological Survey of Malaysia.(G_DATA:Existing geological data in the vicinity)

g) Answers of "Yes" to " Damage" including the answers indicating "Place of Damage", nevertheless "No" are 15(13.0%). The type and places of damage are as follows.(G_DAMG:Damage in the vicinity, G_PDAMG:Place of the damage, G_SDMAG:Scale of the damage, G_MDAMAG:measures against the damage)

Slope failure	9	Natural slope	5
		Cut slope	4
Foundation	5	Foundation of facilities	5
Others	1	River bank washed away by flood	1

   The remedial measures are taken against 3 slope failure damages only. In the case of the damages of the foundation facilities, type and magnitude of the damages and measures taken against them are not mentioned. Therefore, they are assumed to be not significant.

2.2 Phase II Study

2.2.1 Feasibility study

The 5 pilot project sites were selected for JICA feasibility study through the Phase I Study. Among the 5 pilot projects, geological investigations at the dam-sites and soil-mechanical tests for dam materials were conducted on 3 project sites(5 dam-sites in 3 projects) during the Phase II Study. They are Project KH 4 and KH 5 in Kedah, Project TR 44 in Terengganu, and Project MA 16 in Melaka. On the other hand, the other 3 project sites were selected for GOM(DID) feasibility study by themselves, namely Project PP 3 in Pulau Pinang, Project KN 16 in Kelantan, and Project NS 1 in Negeri Sembilan. The necessary geotechnical advice was also provided for DID's feasibility studies on those 3 projects only during the period of stay in Malaysia, in a manner similar to the other experts of the JICA Study Team, in accordance with the agreement between GOJ and GOM.

The geological investigations were carried out at the dam-sites and consist of the core drilling with the borehole tests(Standard Penetration Test and Permeability Test).

The core drilling was carried out using hydraulic-feeding rotary drilling rigs with triple tube core barrel(Mazier Sampler). In cases where rock is encountered, rock corings were carried out. Core samples taken through the drilling were arranged in core boxes in order and then stored in a warehouse of DID.

Standard Penetration Tests according to the USBR Specification were performed to evaluate strength of unconsolidated deposits and completely weathered rock zones.

Borehole Permeability Tests according to the BS(British Standard: Open-end, falling head method) were performed to estimate the coefficient of permeability.

Soil-mechanical tests for dam material were carried out on samples collected from cut faces at the proposed borrow areas. All tests were carried out in a laboratory in Kuala Lumpur in accordance with the procedure of the BS. Testing items are as follows.

Physical Test
- Specific Gravity
- Natural Water Content
- Grain Size Analysis
- Liquid/Plastic Limit Test

Mechanical Test
- Compaction Test
- Permeability Test
- UU Triaxial Compression Test
- CU Triaxial Compression Test with measurement of pore pressure

Table 4.2 shows the list of contracted and actually implemented geological investigations and soil mechanical tests.

2.2.2 Formulation of the draft guidelines

Guidelines for geological investigations and soil-mechanical tests for project planning, facility design, and O&M of small reservoir development projects were prepared in a separate volume. The guidelines were formulated taking into account the results of the F/S study on the pilot projects, and to be used by the GOM in the future.

III. GEOLOGY AND FOUNDATION ENGINEERING

3.1 Regional Geology(Geology of Peninsular Malaysia)

Titiwangsa) runs from the Thai border to Negeri Sembilan on the western flank of the Peninsular, effectively separating the eastern part of the peninsular from the western and rising to more than 2,100 m above sea level in some places. A considerable part of the interior of Kelantan, Terengganu and Pahang is also mountainous and contains the highest peak in the Peninsular, Gunung Tahan which reaches to 2,187 m in elevation.

As a result of the configuration of the country and of the heavy rainfall, there are many rivers which, until just over one hundred years ago, formed the main arteries for trade and travel. The longest of these rivers is the Sungai Pahang (475 km), followed by the Sungai Perak (400 km) and the Sungai Kelantan.

Geological tectonically, Peninsular Malaysia forms a part of the Sunda Shield, one of the stable cratonic blocks. The western margin of this block is situated in the Indian Ocean along off-shore Sumatra Island. Whereas Sumatra is seismically and volcanically active in the recent age, Peninsular Malaysia situated back inside the cratonic block is fairly stable in both aspects. Its fold-mountain system, the dominant regional trend of which is northerly to north-northwesterly, is a southerly continuation of that extending from eastern Myanmar through Thailand, Peninsular Malaysia, the Banka and Billiton Islands of Indonesia, and eastward into Indonesian Borneo.

The geology of Peninsular Malaysia ranges in age from the Cambrian to the Quaternary as shown in Fig. 4.1. The pre-Triassic rocks are essentially marine whereas the post-Triassic rocks are characteristically non-marine. The Triassic rocks themselves are of both marine and non-marine origins but in general, the non-marine where present, occurred in the Upper Triassic. The bulk of the Peninsular's sedimentary rocks falls within the Carboniferous to the Triassic periods, which indicates that the greater part of the area lay below the sea during that time. The rocks consist of repeated series of sandstones and shales interbedded with limestones and volcanic rocks. These rocks are found most extensively in Pahang and Kelantan, with extensions into the surrounding states.

Almost half of the total surface area of the Peninsular consists of granite which forms the Main Range as well as lesser ridges. Although many of the granite bodies are aligned parallel to the structure trend, they do not always occupy the anticlinal ridges oIn Peninsular Malaysia, a mountainous spine known as the Main Range(or Banjaran f the sedimentary covers and some of the smaller bodies are found to cut across the structural trend. The granite is believed to be mainly of the Triassic Age, and during its emplacement the older sedimentary rocks into which it was intruded, folded and buckled into the ranges that make up the present topography of the Peninsular. The granite is fairly uniform in character and is likely to be the main source of most of the economic minerals.

The youngest formation, Quaternary deposits, almost all of which are alluvium, consist mainly of unconsolidated to semi-consolidated gravel, sand, clay, silt, and peat formed by the erosion of the older rocks over long periods, and are distributed over the coastal terrains forming the soft ground areas which occur around the peninsular with a width varying from 10 to 20 km, and on floors of some of the inland valleys (see Fig. 4.2). These deposits reach to the depths of more than 180 m and 150 m below mean sea level in the west and east coasts respectively, and contain valuable concentrations of tin ore. The deposits inshore can be grouped into four lithostratigraphic units given below. The boundary between Simpang and Kemmpandang Formation, however, can not distinguish on the geological map.

(a) Simpang Formation

Continental, fluviatile sediments made up with gravel, sand, clay and silt of Pleistocene age. The bulk of the placer tin is derived from this unit which overlies bedrock.

(b) Kempandang Formation

Pleistocene marine sediments made up of clay with shells and sand.

(c) Gula Formation

Holocene grey to greenish-grey marine to estuarine clay and subordinate to sand covering the coastal areas of peninsular. Included in this unit are the beach ridges, mangrove, and the riverine nipah deposits.

(d) Beruas Formation

Fluviatile-estuarine-lacustrine deposits, made up of clay, sandy clay, sandy gravel, silt and peat of Holocene age. This unit overlies the Simpang Formation, filling channels, depressions as well as overlying bedrock at several places.

Above all the Quaternary deposits, the two Holocene formations, Gula and Beruas are required special attention in civil engineering works, because of the inclusion of peat layers. The main peat layer's distribution areas are Perak, Selangor, western Johor and Pahang.

Besides the stratified units which range from the Cambrian to the Quaternary in age and the granitic activities described above, laterite, bauxite, cave deposits, and intrusive and extrusive igneous activities have been recorded in several parts of the country.

Regional metamorphism is widespread and most of the Paleozoic and Mesozoic rocks show slight to moderate deformation. In general, the older rocks show a greater degree of metamorphism than the younger rocks. Contact metamorphism is not intense. The contact metamorphosed rocks generally form narrow aureoles around the igneous rocks.

Faulting is common in all rocks. Three prominent sets of fault were observed. The oldest is a northerly trending set of normal faults followed by a younger set of northwesterly trending wrench faults and a still younger set of north-north-easterly trending wrench faults. The youngest is at most post-Early Cretaceous in age.

3.2 Site Geology and Foundation Engineering

As described before, geological investigations and soil-mechanical tests were carried out at the 5 dam-sites in all 3 projects.
Fig. 4.3 and Table 4.3 show the results of the investigations and tests.

3.2.1 Project KH 4 & KH 5 (Kawasan Padi & Kedawang)

(1) Topography and geology

The project area is located in the northwest of Pulau Langkawi, near Langkawi Airport. It consists of alluvial plains following the coast, and mountains whose peaks ranges in altitude from 100 to 200 m. The area is underlain by Carboniferous sedimentary rocks intruded by granitic rocks of Triassic age. The fresh outcrops of the basement rocks, however, cannot be seen in and around the project area, due to the deep weathering and the alluvial deposits lying on.
There are three proposed dam sites in the area. Fig. 4.4 is the location map of the proposed 3 dam-sites. Those are named as follows.

1) Upstream Lembu
2) Lembu
3) Ketapang

Upstream Lembu and Lembu are located on the same nameless river. The former is on the upper reaches of the river, where the hillside slopes show comparatively narrow valley. The latter, however, is on the middle reaches of the river and is in the middle of the alluvial plain (paddy field) formed widely in the valley. On the other hand, Ketapang is located on the upper reaches of the another nameless river which cuts comparatively deep valley in the vicinities of the proposed dam site.

(2) Geological investigation

Geological investigations were carried out as shown in Table 4.2.

1) Upstream Lembu (KH-1:Left:D=5.0 m)

Fig. 4.5 shows the location of the borehole and the geological profile along the proposed dam axis.

0.00 m to 1.00 m Top soil	:Brown, medium stiff clayey silt with gravel and roots (N=6)
1.00 m to 4.75 m Alluvium	:Brown to grey, medium to very stiff silty clay or clayey silt with a lot of gravel (N=11-50+)
4.75 m to 5.00 m Residual soil	:Brown to grey hard clayey silt with weathered rock fragments (silt stone)

The results of KH-1 suggest the followings.

- From the geological viewpoint, the minimum depth of excavation for the dam foundation would be 1.0 m (up to the base of the top soil)
- As the coefficient of permeability of the foundation material(3.5 m to 4.0 m deep) indicates a low value ($k=3.71 \times 10^{-8}$ m/sec), measures against through the foundation seepage would not be required, particularly.

  Note:

  Generally, even in the case of a high dam, the target value of the coefficient of permeability after foundation treatment such as grouting is about 1×10^{-7} m/sec.

2) Lembu (KH-2:Left:D=10.0 m)

The originally planned number of boreholes(2) with the depth of 5.0 m each, was changed to 1 borehole with 10.0 m deep, due to the presence of deep soft layers (N<10) at the first borehole.

Fig. 4.6 shows the location of borehole and geological profile along the proposed dam axis.

0.00 m to 1.00 m Top soil	:Brown to grey, very soft clayey silt with gravel and roots(N=2)
1.00 m to 10.0 m Alluvium	:Brown to grey, silty clay with some sand, soft until 5.0 m deep but stiff to very stiff below that (N=5-20) Interbeded with soft clay layers (N=3-4) including organic matter at 3.2 m to 3.5 m and 6.0 m to 6.45 m deep, and with sand layers at 3.5 m to 4.8 m and 7.0 m to 8.0 m deep, respectively.

The results of KH-2 suggest the followings.

- The dam foundation excavation depth would be 1.0 m(up to the base of the top soil) at the minimum. In the case of the dam of higher than 5.0 m, however, careful study on stability and settlement of the foundation will be required, due to the presence of soft layers (N=2 to 8)up to 7.0 m deep.
- The coefficient of permeability of the foundation material shows low value($k<1x10^{-8}$ m/sec), therefore measures against seepage through the foundation would not be required, particularly.

Note:

According to Terzaghi and Peck's theory, in the case of clayey soil, the relationship between "N"(value of SPT) and "qac"(bearing capacity:tf/m^2) is as follows.

qac=1.2N

On the other hand, assuming "γ_t (unit weight of the soil)=2 tf/m^3, and the cross section of a dam is an isosceles triangle, the absolute value of "p"(load per unit area:tf/m^2) of the dam will be the same as the dam height in meters, in spite of slope gradients of the dam. Namely, if the dam height is 5 m, "p" on the foundation will be 5 tf/m^2.
Therefore, if the absolute value of "qac"=1.2N < proposed dam height in meters, it can be judged roughly whether stability and settlement analyses of dam foundation will be necessary or not.

3) Ketapang (KH-3:Left:D=10.0 m, KH-4:Right:D=7.0 m)

Fig. 4.7 shows the location of boreholes and geological profile along the proposed dam axis.

a) KH-3

0.00 m to 1.20 m	Top soil	:Brown to grey soft clayey silt with gravel and roots(N=4)
1.20 m to 5.30 m	Alluvium	:Brown to grey medium to stiff clayey silt with gravel(N=8-11)
5.30 m to 10.0 m	Residual soil/Completely weathered rocks	:Brown to grey very stiff to hard clayey silt with weathered rock fragments (mudstone) (N=36-50+)

b) KH-4

The original planned depth of 10.0 m was changed to 7.0 m, due to the appearance of the hard basement rocks at 5.1 m depth.

0.00 m to 0.95 m	Top soil	:Brown to grey, soft to medium clayey silt with roots(N=5)
0.95 m to 3.00 m	Alluvium	:Brown to grey stiff to very stiff clayey silt with a lot of gravel (N=19)
3.00 m to 5.10 m	Residual soil/Completely weathered rocks	:Brown very stiff clayey silt with a lot of weathered rock fragments (silt stone) (N=19)
5.10 m to 7.10 m	Rocks	:Weathered rocks (limestone)

The results of KH-3 and KH-4 suggest the followings.
- From the geological viewpoint, the minimum depth of dam foundation excavation would be 1.0 m to 1.2 m.
- The coefficients of permeability show comparatively high values (k=1.27 to $1.05x10^{-6}$m/sec), therefore measures against foundation seepage such as the provision of an impervious blanket needs to be investigated.

(3) Soil-mechanical test

A sample for soil-mechanical test on dam construction material was collected from the proposed borrow areas near the project area. It is one of the existing borrow area under mining and consists of residual soils of the granitic rocks. Fig. 4.4 shows the proposed borrow area(sampling place).
The test results are shown in Table 4.4, and Fig. 4.8 through to Fig 4.12. The results show the quality of material is good for homogeneous type dam, especially in the permeability and shearing strength properties.

3.2.2 Project TR 44 (Pasir Nering)

(1) Topography and geology

The project area is located about 20 km southwest of the center of Kuala Berang town. It is hilly area with about 30 m in altitude, and showing gentle slopes and broad, shallow valleys. The area is underlain by granitic rocks of Triassic age. The fresh outcrops of the basement rocks, however, cannot be seen in and around the project area, due to the deep weathering and the alluvial deposits lying on.
The proposed dam-site is on the lower reaches of the Sungai Peching which is one of tributaries of the Sungai Terengganu, and is located in a rubber plantation. The Sungai Peching meets the Sungai Por and flows into the Sungai Terengganu, 1 km and 2.5 km downstream from the proposed dam site, respectively. Fig. 4.13 shows the location of the proposed dam-site.

(2) Geological investigation

Geological investigations were carried out as shown in Table 4.2.
Fig. 4.14 shows the location of boreholes and geological profile along the proposed dam axis.

a) TR-1:Right:D=10.0 m

0.00 m to 2.00 m	Top soil	:Light brown soft silty clay with roots (N=3)
2.00 m to 8.90 m	Alluvium	:Light brown to light grey, very soft to soft silty clay or clayey sand (N=0-2) Interbeded with sand and gravel layer at 2.0 m to 3.5 m deep, and very soft silty sand layers (N=0-1) including organic matter at 6.2 m to 7.0 m and 8.7 m to 8.9 m deep.
8.90 m to 10.6 m	Residual soil	:Brown hard sandy silt (N=6-50+)

b) TR-2:Left:D=9.0 m

The original planned depth of 10.0 m was changed to 9.0 m, due to the appearance of the hard basement rocks at 6.8 m depth.

0.00 m to 0.95 m	Top soil	:Brown, very soft sandy silt with roots (N=0)
0.95 m to 6.80 m	Residual soil	:Brown to grey, very soft until 3.5 m deep (N=2) but stiff below that (N=9-11), sandy silt. Below 5.0 m, greenish grey hard sandy silt with gravel (N=50+)
6.80 m to 9.00 m	Rocks	:Weathered granite

The results of TR-1 and TR-2 suggest the followings.

- The dam foundation excavation depth would be 1.0 m to 2.0 m at the minimum. In design work of the dam, very careful attention on stability and settlement of foundation will be required, due to the presence of soft layers (N=0 to 6) up to 10.5 m deep, especially in the valley along the right bank of the river.

- The coefficients of permeability of foundation materials show low values ($k=2.82$ to $2.65x10^{-7}$m/sec), therefore measures against seepage through the foundation would not be required, particularly.

(3) Soil-mechanical test

A sample for soil-mechanical test on dam construction material was collected from the proposed borrow area near the project area. It is the existing small borrow area and consists of residual soils of the granitic rocks. Fig. 4.13 shows the proposed borrow area(sampling place)
The test results are shown in Table 4.3, and Fig. 4.15 through to Fig. 4.19. The test result of this sample also shows good quality for homogeneous type dam material.

3.2.3 Project MA 16 (Felcra BK. Sedanan)

(1) Topography and Geology

The project area is located about 10 km northwest of Jasin. The area is mountainous showing comparatively gentle slopes and ranging in altitude from 60 m to 200 m. It is underlain by granitic rocks of Triassic age. The fresh outcrops of the basement rocks, however, cannot be seen in and around the project area, due to the deep weathering and the alluvial deposits lying on.
The proposed dam-site is on the lower reaches of the Sungai Ayer Metangor, one of tributaries of the Sungai Kesang and is located in the Felcra farm. In the vicinities of the proposed dam-site, the valleys are broad and shallow, and in some part of the bottom of them, swamps are formed. Fig. 4.20 shows the proposed dam-site.

(2) Geological investigation

Geological investigations were carried out as shown in Table 4.2.

The original plan of drilling 2 boreholes with the depth of 5 m each was changed to 1 borehole with the depth of 10.0 m, due to the presence of deep soft layers (N<10) at the first borehole.
Fig. 4.21 shows the location of borehole and the geological profile along the proposed dam axis.

a) MA-1:Right:D=10.0 m

0.0 m to 1.9 m Top soil	:Light brown, very soft sandy silt with some organic matter and roots (N=2)
1.9 m to 10.0 m Residual soil	:Yellowish brown to whitish pink, medium to stiff, sandy silt (N=5-10)

The result of MA-1 suggests the followings.

- The dam foundation excavation depth would be 2.0 m at the minimum. If the proposed dam is higher than 5 m, careful study on stability and settlement of the foundation will be required, due to the presence of soft ground (N=5 to 10) up to 10 m deep, at least.
- The coefficient of permeability shows comparatively high value ($k=1.2x10^{-6}$m/sec), therefore measures against seepage through the foundation needs to be investigated.

(3) Soil-mechanical test

A sample for soil-mechanical test on dam construction material was collected from the cut slope in the proposed borrow area near the project area. It consists of residual soil of the granitic rocks. Fig. 4.20 shows the location of the proposed borrow area(sampling place).
The test results are shown in Table 4.3, and Fig. 4.22 through to Fig. 4.26. The test results of this sample also show the quality of materials is good for the homogeneous type dam.

3.2.4 Design parameters

The design parameters for permeability of foundation and dam material derived from the test results are given in Table 4.3 for each site. However, the values of the UU test results in the Project MA 16 are extremely high and are probably not representative of the soil samples. Therefore, "c" of 52.5 (kPa) and "ø" of 27.5 (deg.) which are the averages of the UU test results in the Project KH 4 & KH 5 and the Project TR 44, are recommended as the design parameters of the UU test results in the Project MA 16.

Furthermore there is no test results, which are available directly to analyze stability and settlement of foundation.

In the case of stability analysis, "c"(cohesion) and "ø"(friction angle) are the main parameters.

According to Terzaghi and Peck's theory, in case of clayey soil, the relationship between "N"(value of SPT) and "c" are as follows.

$c=2N/3$ (ton/m^2)

Here, assuming ø=0 for the critical case, stability of foundation can be analyzed.

Within many parameters which indicate the characteristics of consolidation settlement, "mv"(coefficient of compressibility) is the main one for a total quantity of settlement.

Generally, the "mv" can be obtained from the laboratory test. A.W.Skemton, however, advanced "mv" of 6×10^{-4} m^2/kN(at $p=1 \times 10^2$ kN/m^2, p:load) as a general value for normally consolidated clay. By using this value of "mv", a total quantity of settlement can be calculated.

As described above that the test results of dam material are available for design parameters except for the UU test results in the Project MA 16, however, attention should be paid for that the all of mechanical test results in Table 4.3 show the tendency for higher value (lower value in the permeability) than those predicted empirically from the physical test results.

Further testing in a laboratory and in the field during the detailed design stage is recommended for the final determination of reliable parameters. In the further testing, attention should be paid for the followings, particularly.

a) Compaction test should be carried out with small energy for example like the "Standard compaction test" in BS, because the proposed dam is small.
b) The other physical tests should be carried out based on the results (optimum moisture content, maximum dry density, etc.) of the compaction test with small energy mentioned above.
c) Adjustment of test equipment and preparation of specimen.
Furthermore, in the further testing, soil-mechanical tests for dam foundation seem to be more important and more necessary than those for the dam construction materials.