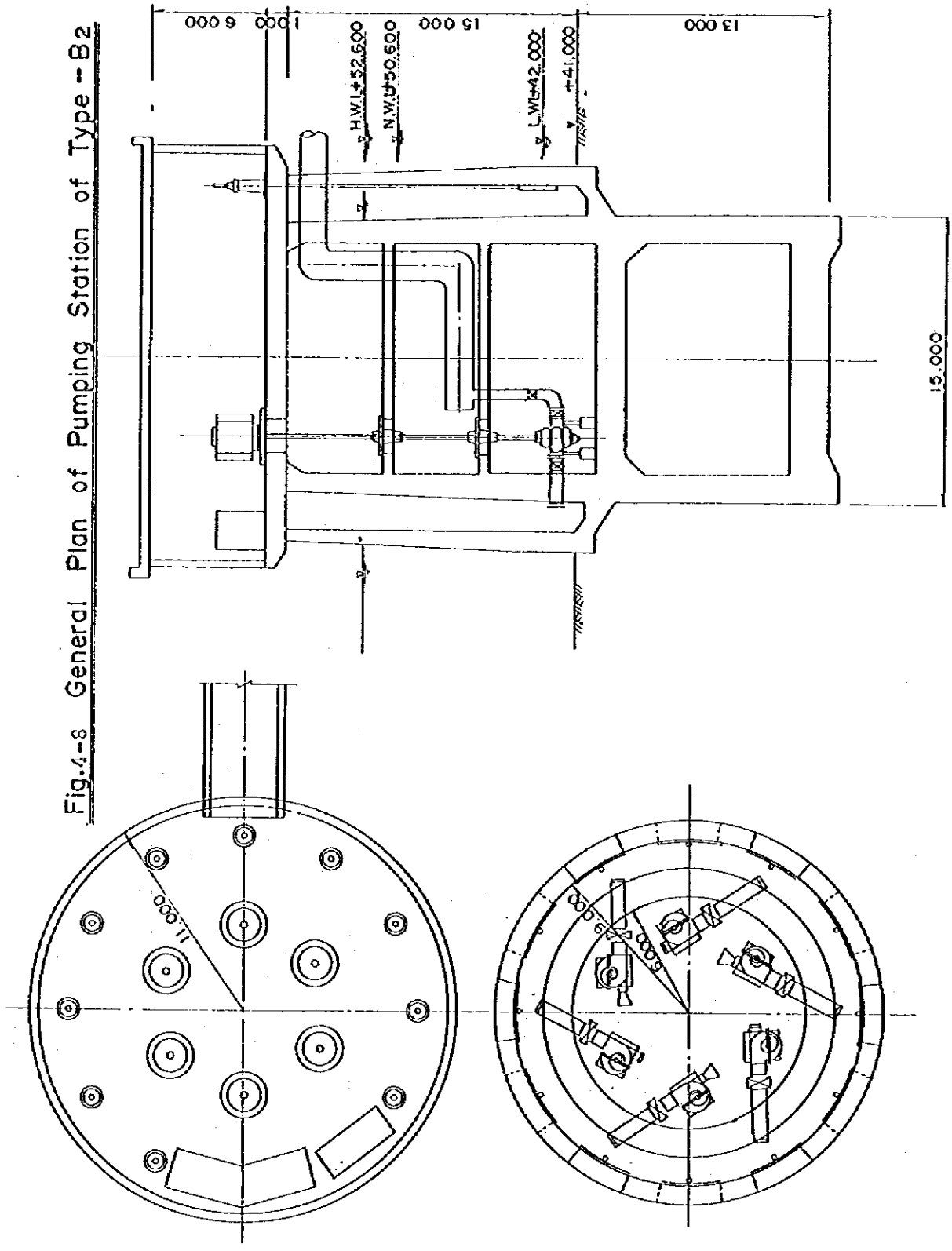


Fig.4-8 General Plan of Pumping Station of Type - B2

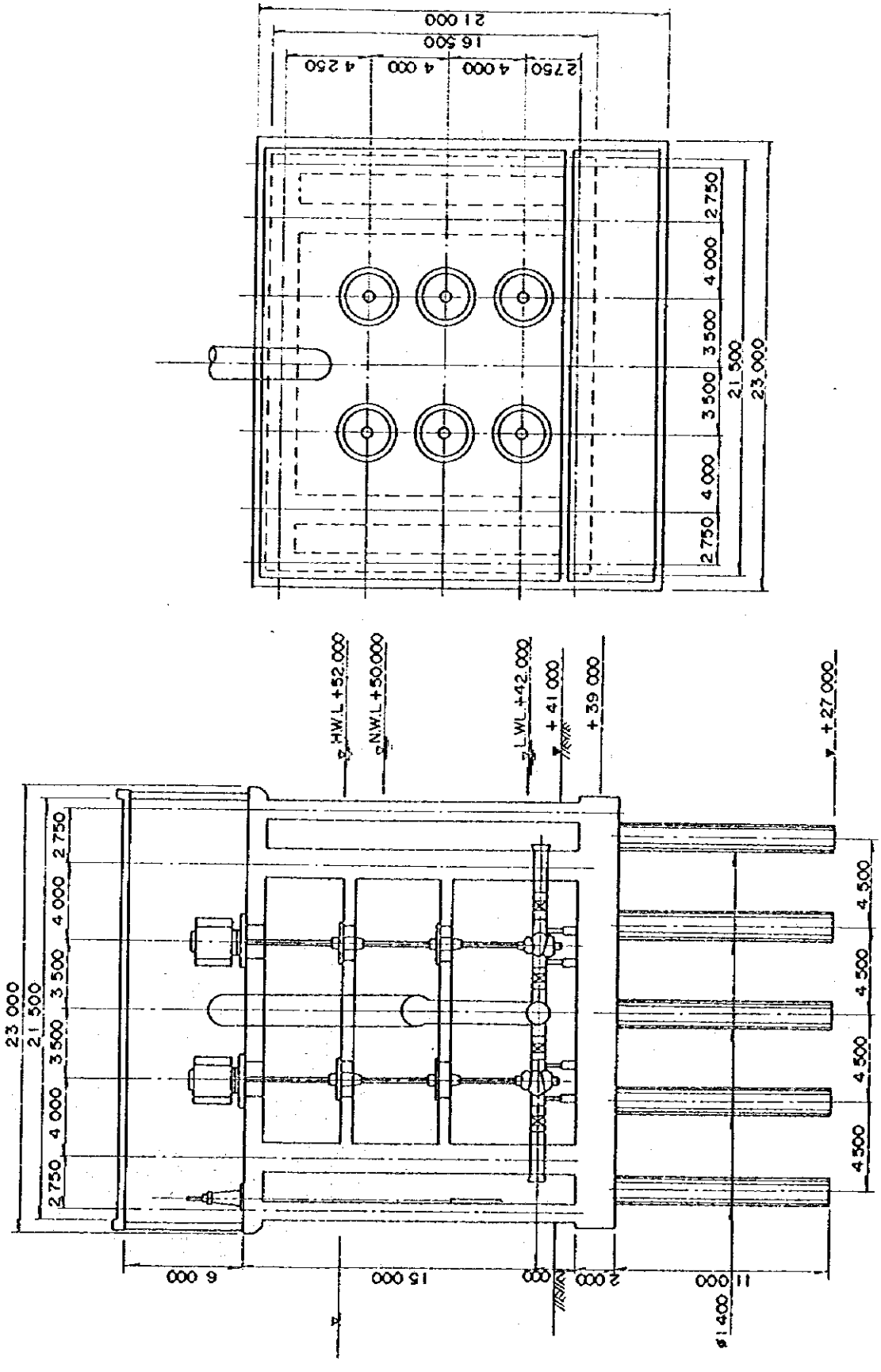


Fig. 4-9 General Plan of Pumping Station of Type - B3

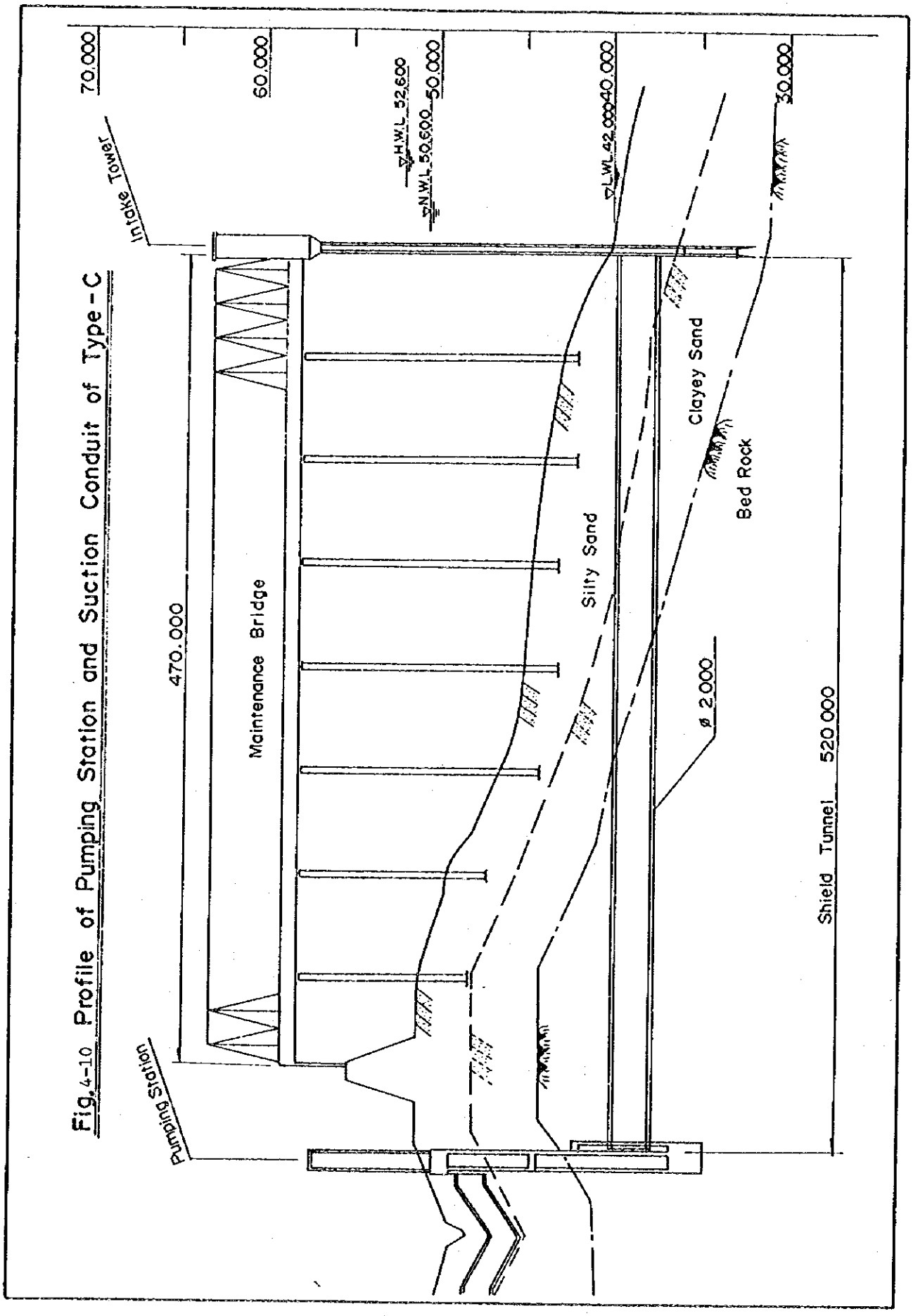
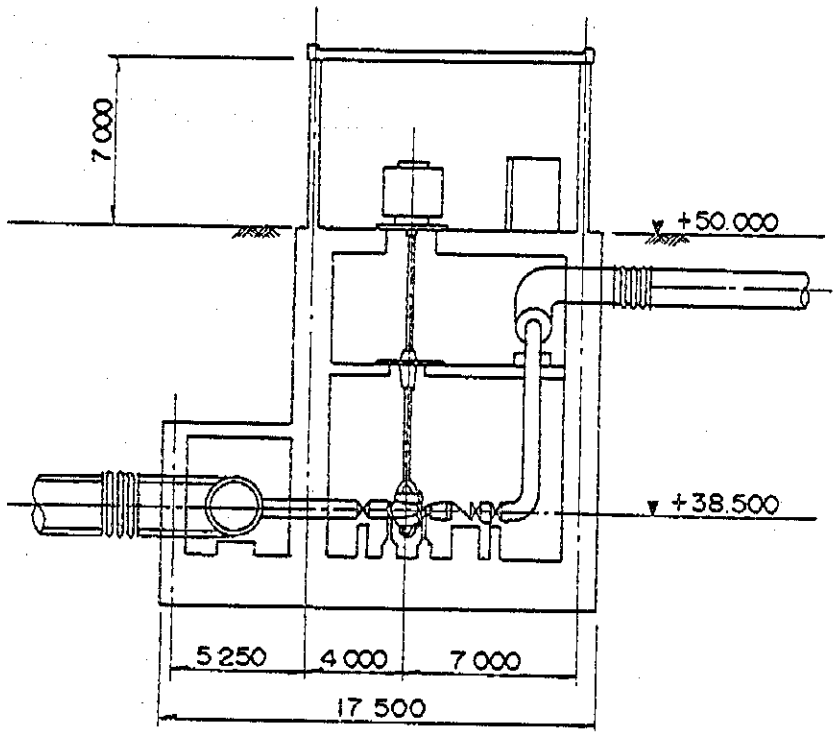
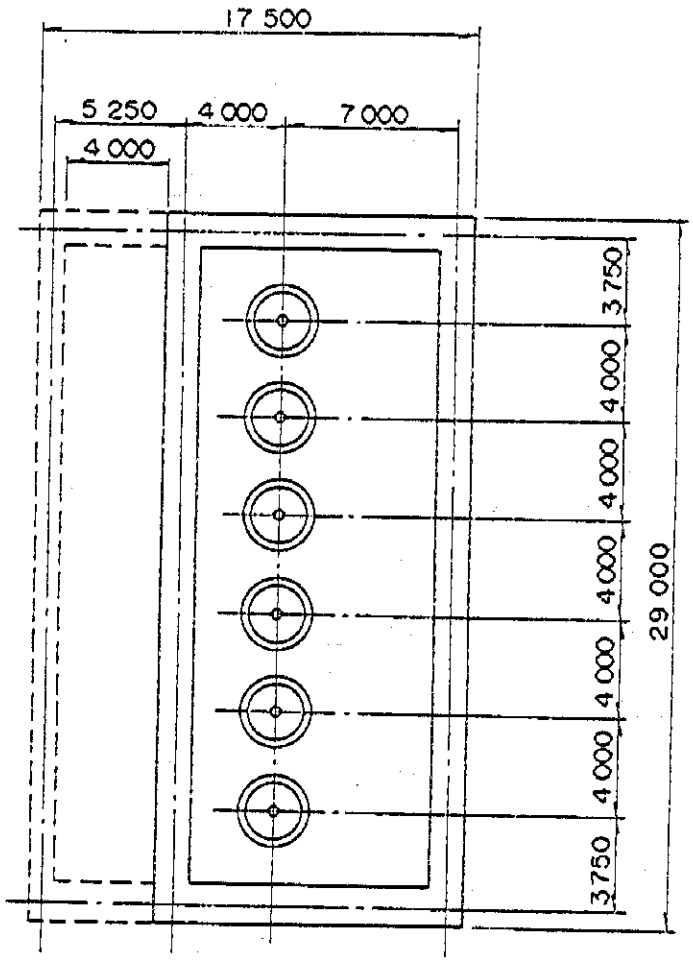


Fig. 4-10 Profile of Pumping Station and Suction Conduit of Type - C

Fig. 4-11 General Plan of Pumping Station of Type - C





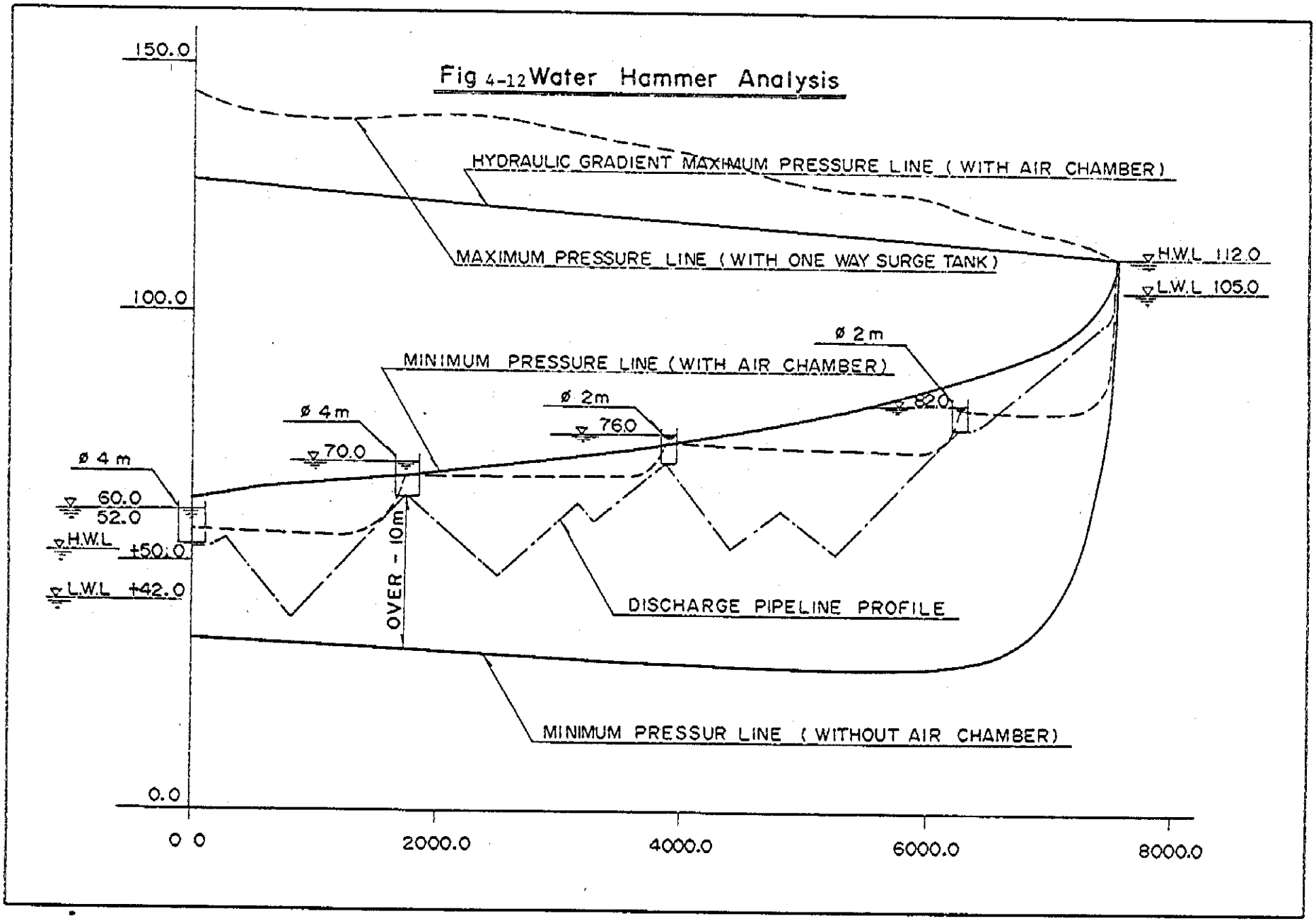


Fig 4-12 Water Hammer Analysis
150.0
100.0
0.0
HYDRAULIC GRADIENT MAXIMUM PRESSURE LINE (WITH AIR CHAMBER)
MAXIMUM PRESSURE LINE (WITH ONE WAY SURGE TANK)
H.W.L 112.0
L.W.L 105.0
ø 2m
MINIMUM PRESSURE LINE (WITH AIR CHAMBER)
ø 4m
70.0
ø 2m
76.0
82.0
ø 4m
60.0
52.0
H.W.L +50.0
L.W.L +42.0
OVER - 10m
DISCHARGE PIPELINE PROFILE
MINIMUM PRESSUR LINE (WITHOUT AIR CHAMBER)
0 0
2000.0
4000.0
6000.0
8000.0

Fig. 5-1 General Construction Procedures

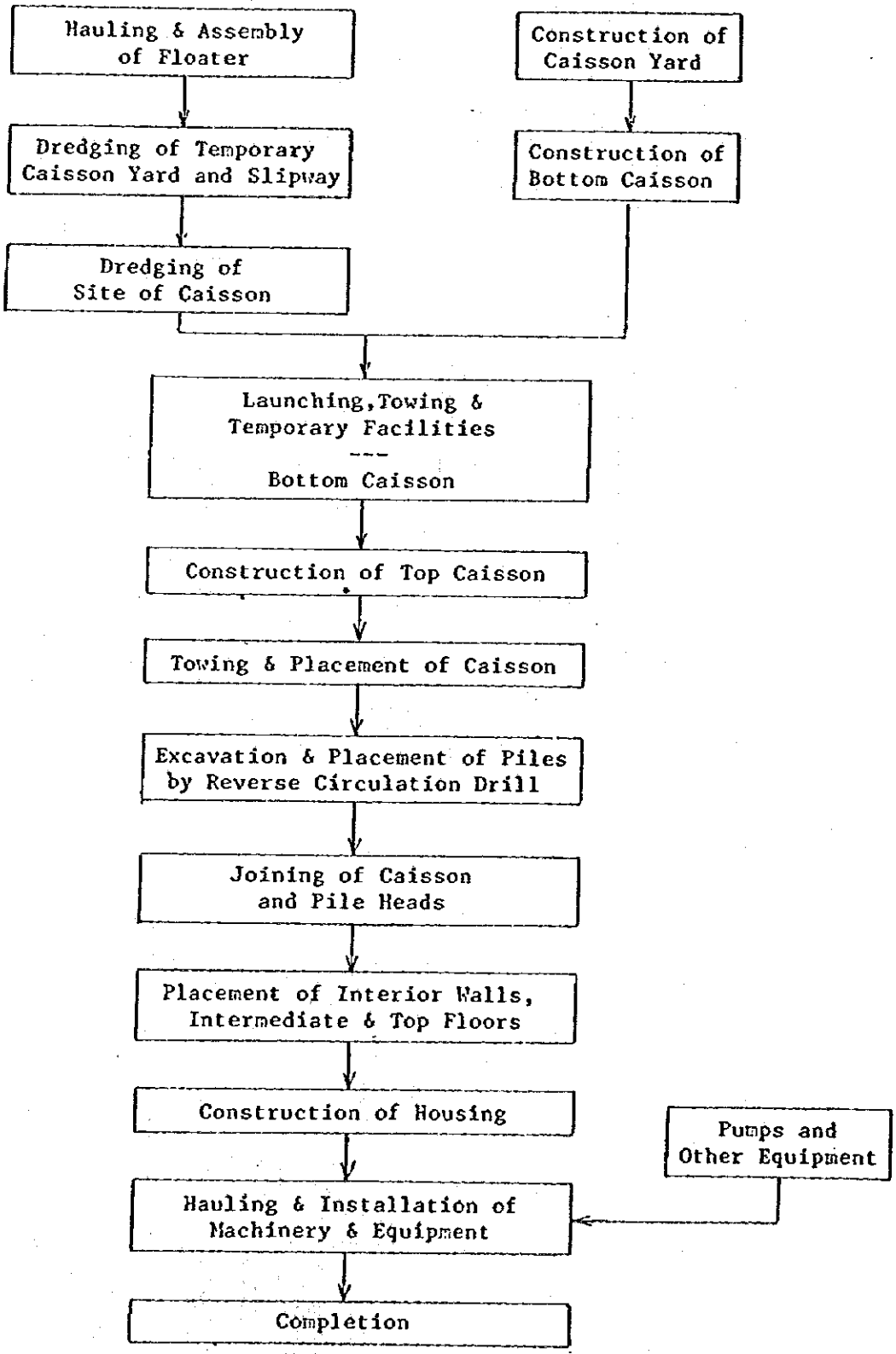


Fig. 5-2 Procedure of Field Execution

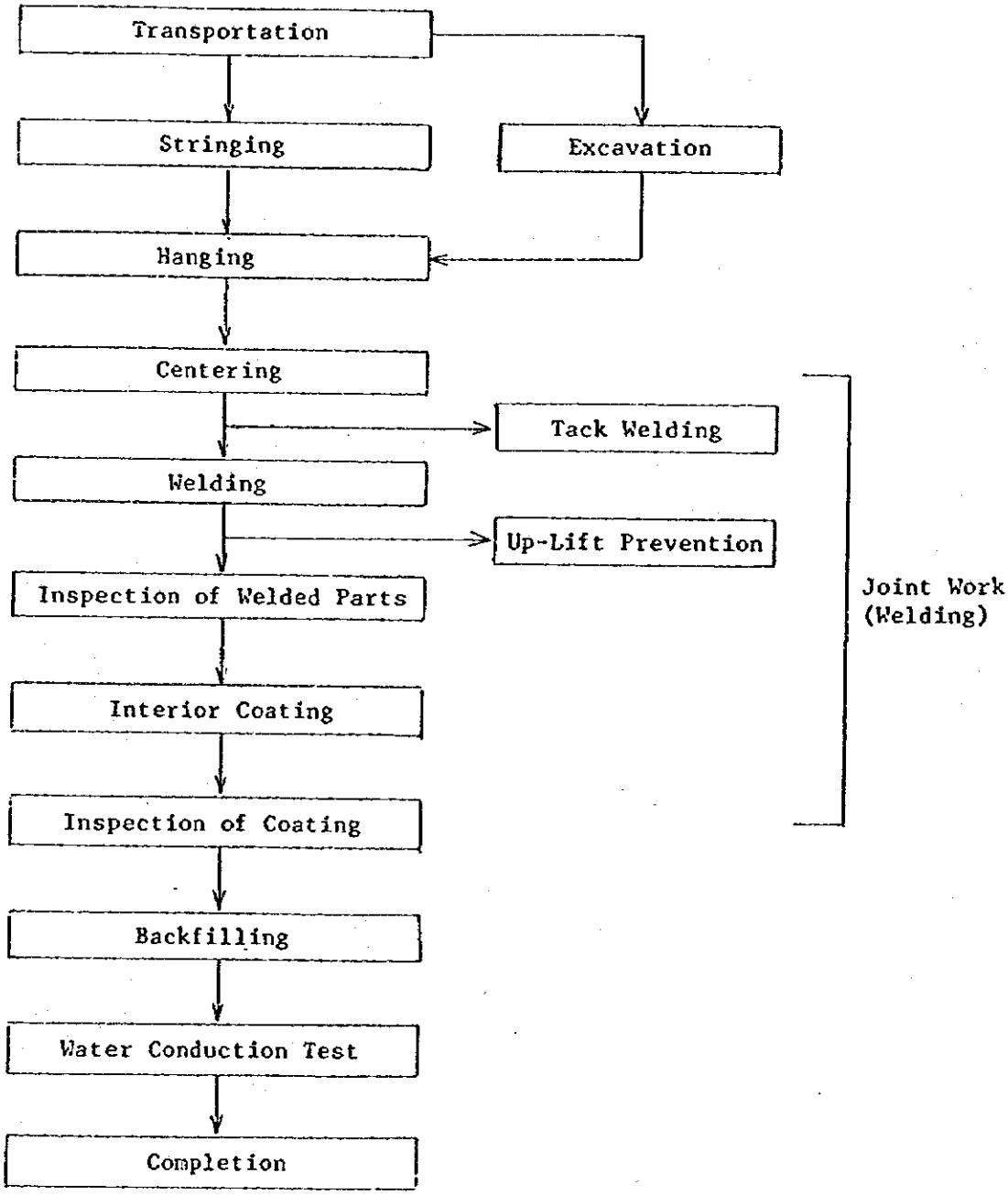


Fig. 7-1 Water Demand and Supply by the Pipeline System (Mab Ta Pud - Sattahip Area)

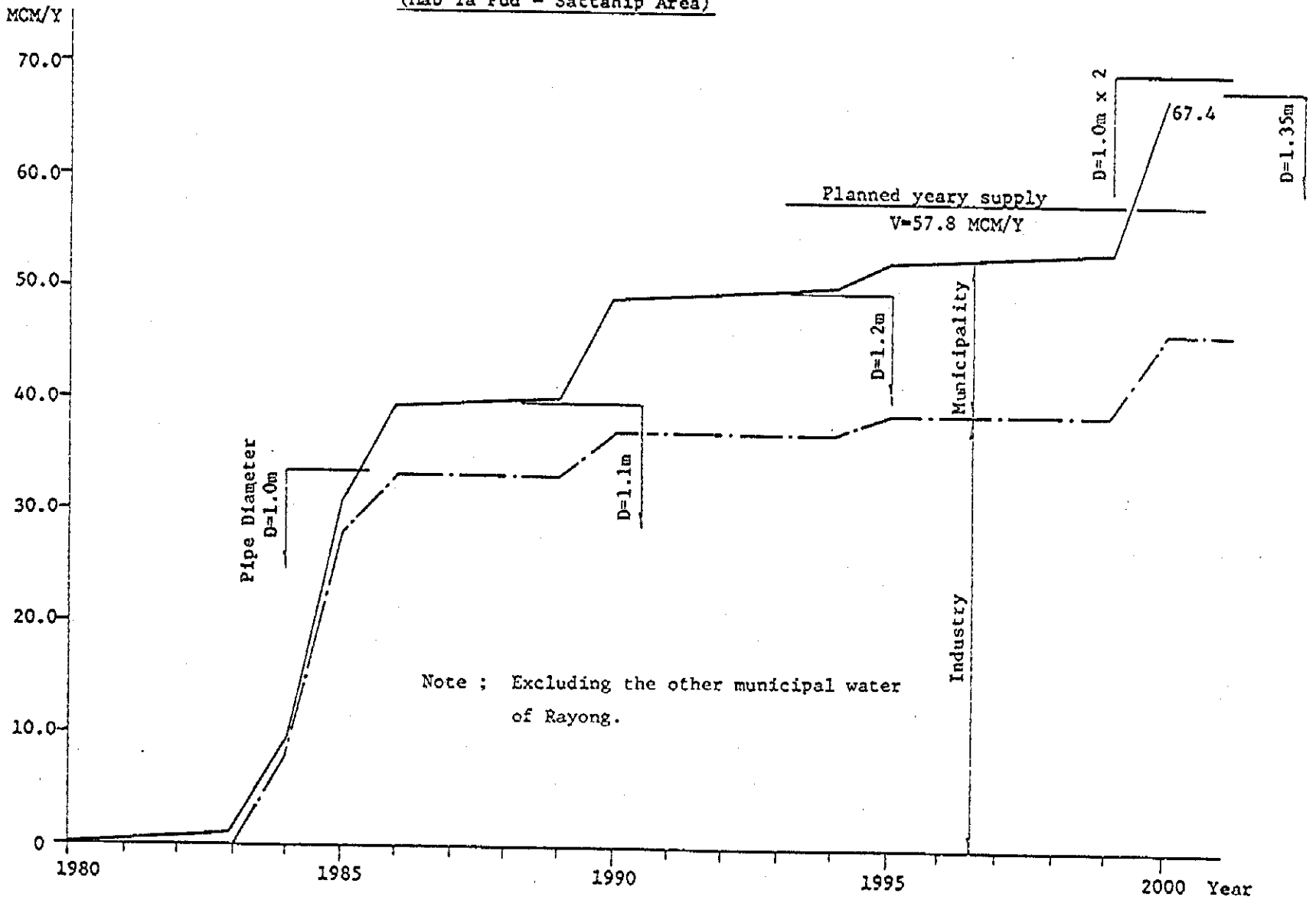


Fig. 8-1 General Plan of Water Supply System

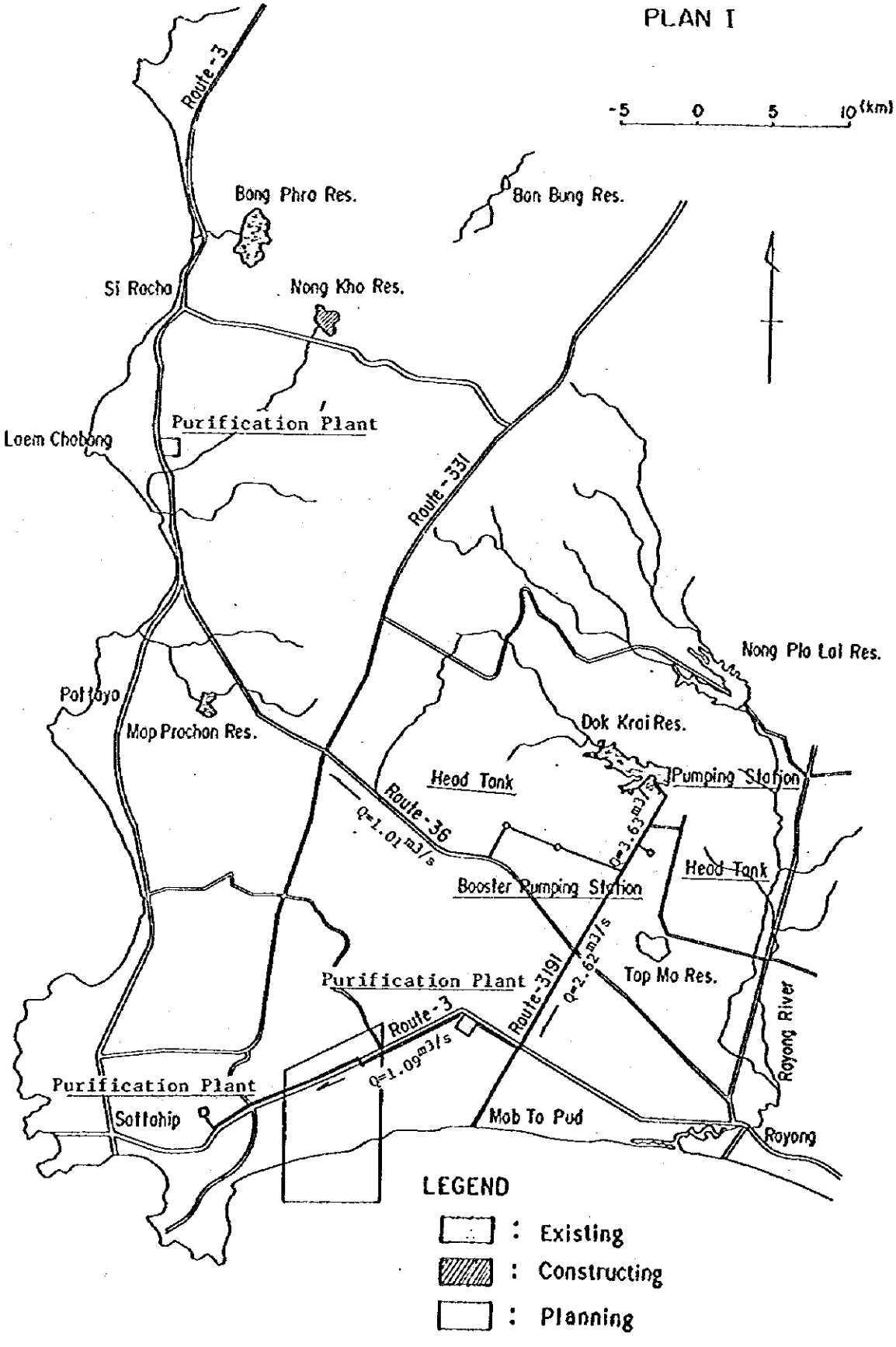


Fig. 8-2 Hydraulic gradient of the pipeline

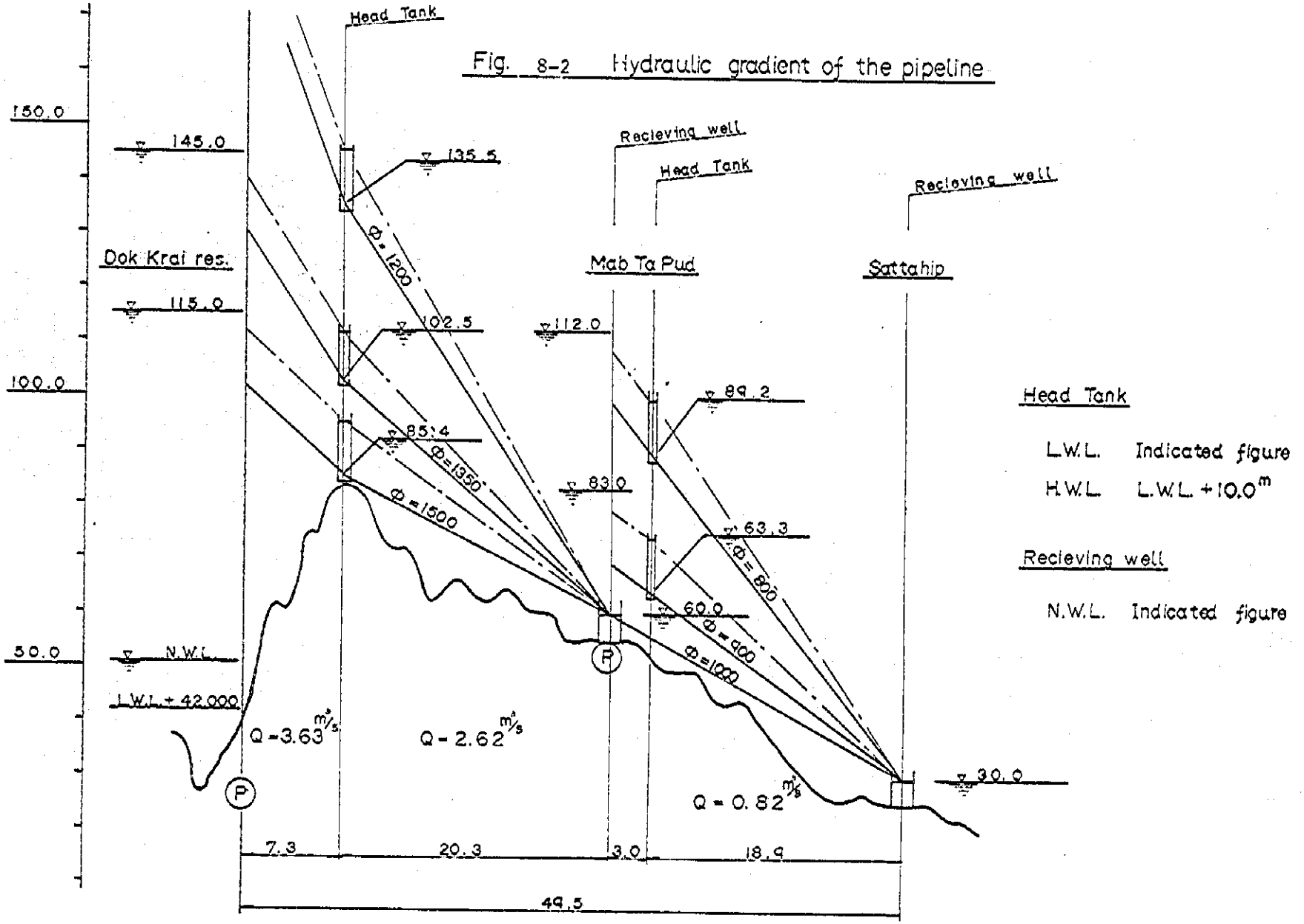
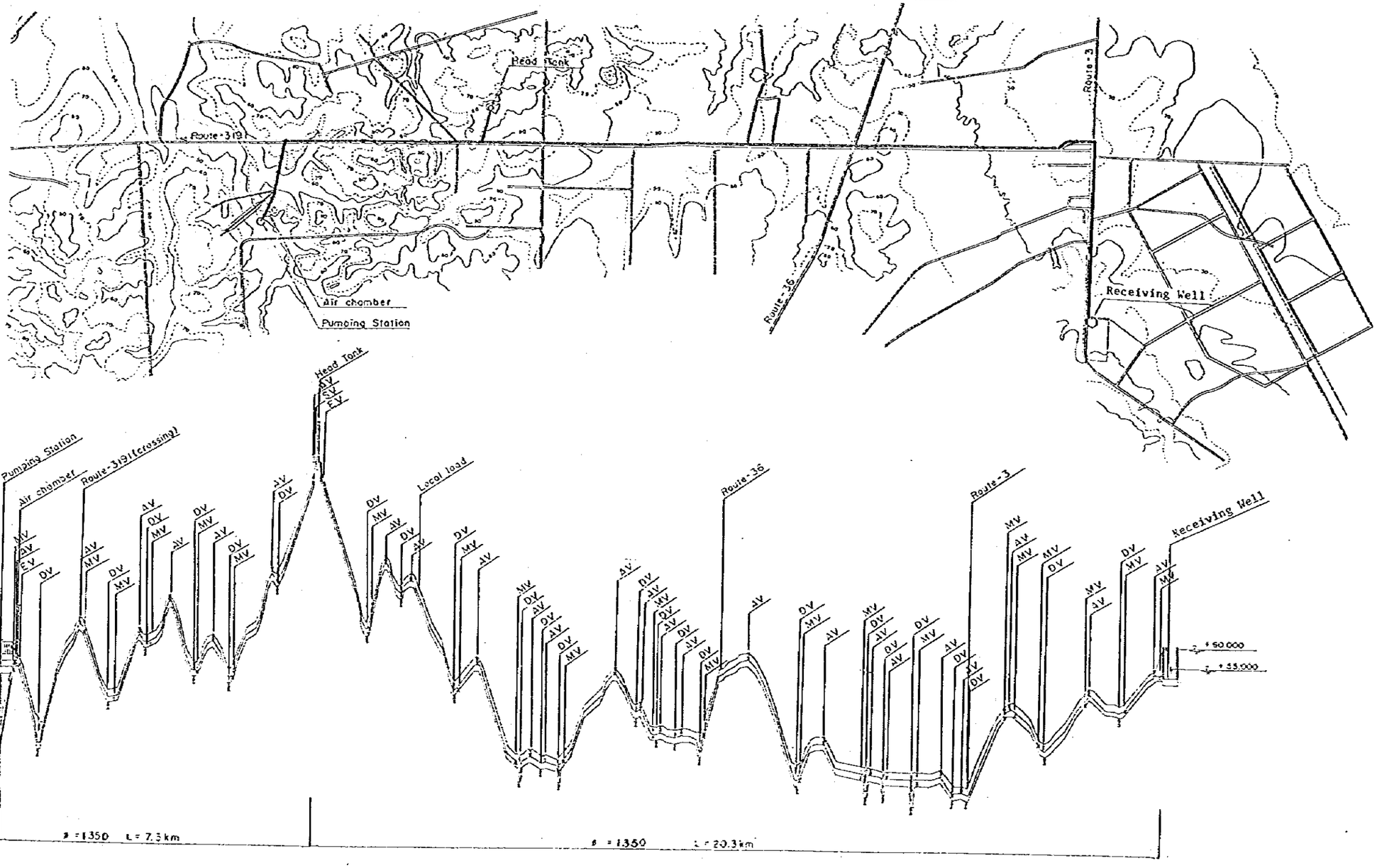
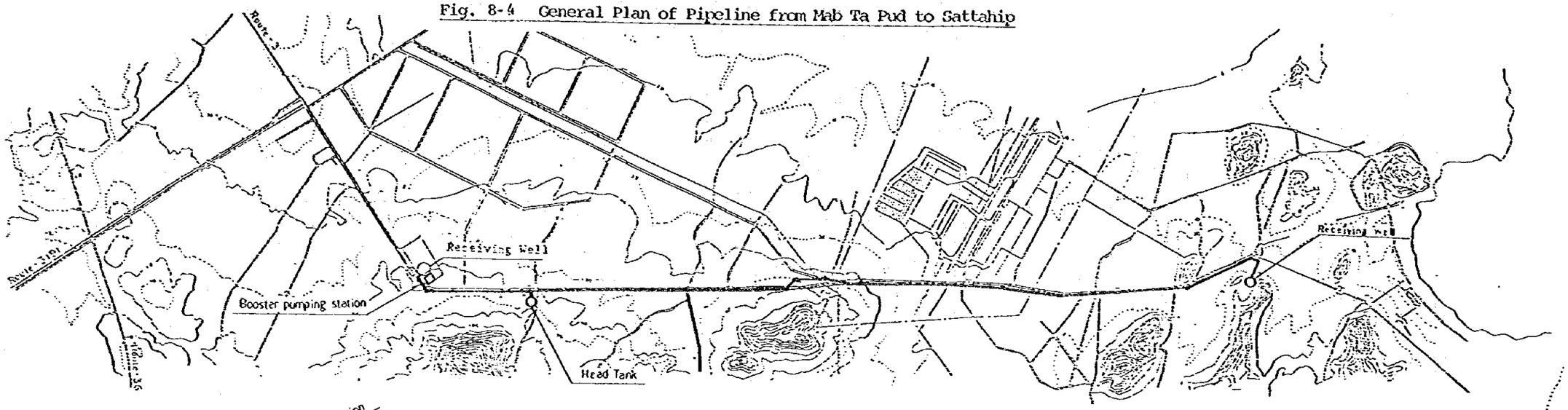


Fig. 8-3 General Plan of Pipeline from Dok Krai to Mab Ta Pud



STATION NO.	ACCUM DIST	GROUND ELEV.
	K.	
0.000	0.000	54.92
1.000	1.000	53.78
2.000	2.000	51.10
3.000	3.000	60.62
4.000	4.000	57.51
5.000	5.000	52.21
6.000	6.000	77.40
7.000	7.000	100.00
8.000	8.000	70.00
9.000	9.000	73.50
10.000	10.000	60.31
11.000	11.000	54.57
12.000	12.000	33.53
13.000	13.000	34.33
14.000	14.000	33.45
15.000	15.000	40.25
16.000	16.000	39.12
17.000	17.000	36.44
18.000	18.000	44.05
19.000	19.000	37.95
20.000	20.000	31.01
21.000	21.000	29.95
22.000	22.000	29.70
23.000	23.000	36.00
24.000	24.000	43.00
25.000	25.000	44.00
26.000	26.000	46.00
27.000	27.000	54.00

Fig. 8-4 General Plan of Pipeline from Mab Ta Pud to Sattahip



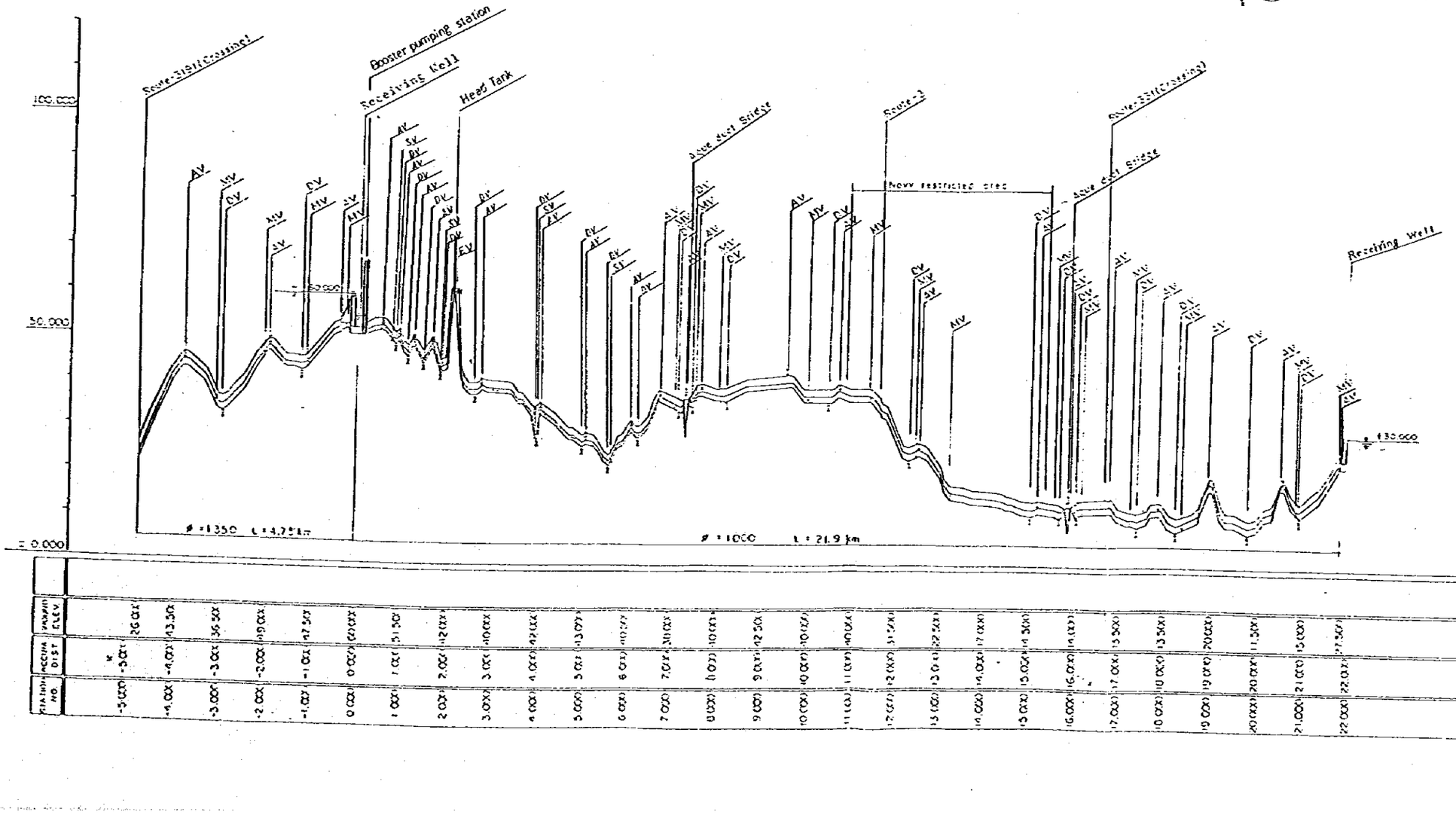
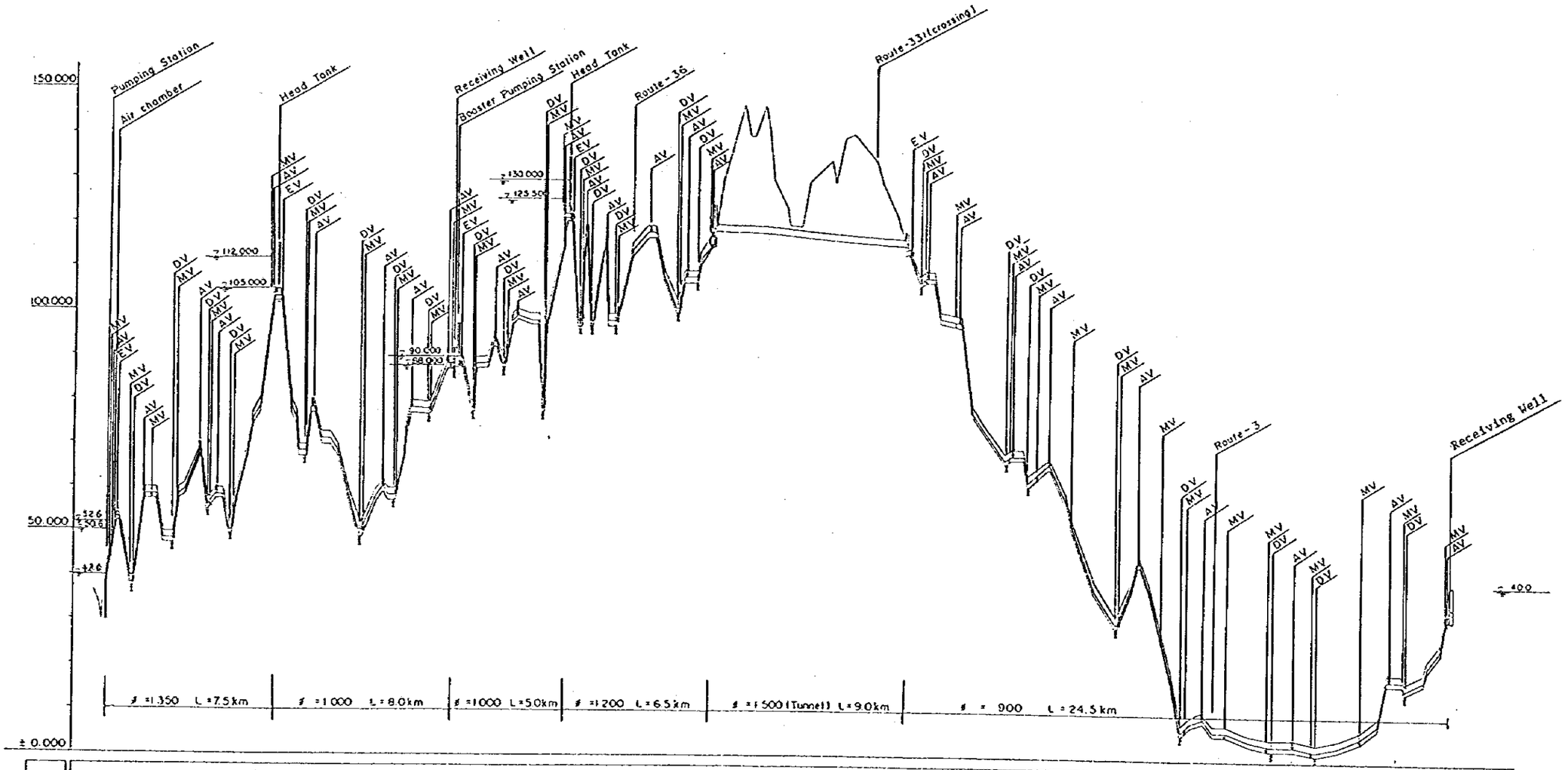


Fig. 8- 5 General Plan of Pipeline from Dok Krai to Laem Chabang



STATION NO.	ACCUM DIST	GROUND ELEV
0.000	K 0.000	55.00
1.000	1.000	54.00
2.000	2.000	51.00
3.000	3.000	61.00
4.000	4.000	57.50
5.000	5.000	52.00
6.000	6.000	77.50
7.000	7.000	100.00
8.000	8.000	70.00
9.000	9.000	73.00
10.000	10.000	65.00
11.000	11.000	54.00
12.000	12.000	60.00
13.000	13.000	80.00
14.000	14.000	81.00
15.000	15.000	90.00
16.000	16.000	90.00
17.000	17.000	92.50
18.000	18.000	100.50
19.000	19.000	80.00
20.000	20.000	120.00
21.000	21.000	120.00
22.000	22.000	100.00
23.000	23.000	116.00
24.000	24.000	120.00
25.000	25.000	103.00
26.000	26.000	114.00
27.000	27.000	130.00
28.000	28.000	147.00
29.000	29.000	147.00
30.000	30.000	124.00
31.000	31.000	130.00
32.000	32.000	135.00
33.000	33.000	141.00
34.000	34.000	135.00
35.000	35.000	122.00
36.000	36.000	108.00
37.000	37.000	101.00
38.000	38.000	100.00
39.000	39.000	76.00
40.000	40.000	69.00
41.000	41.000	64.00
42.000	42.000	68.00
43.000	43.000	54.00
44.000	44.000	40.00
45.000	45.000	32.00
46.000	46.000	46.00
47.000	47.000	30.00
48.000	48.000	8.00
49.000	49.000	11.00
50.000	50.000	8.00
51.000	51.000	6.00
52.000	52.000	5.00
53.000	53.000	5.00
54.000	54.000	4.00
55.000	55.000	5.00
56.000	56.000	7.00
57.000	57.000	15.00
58.000	58.000	18.00
59.000	59.000	23.00
59.600	59.600	

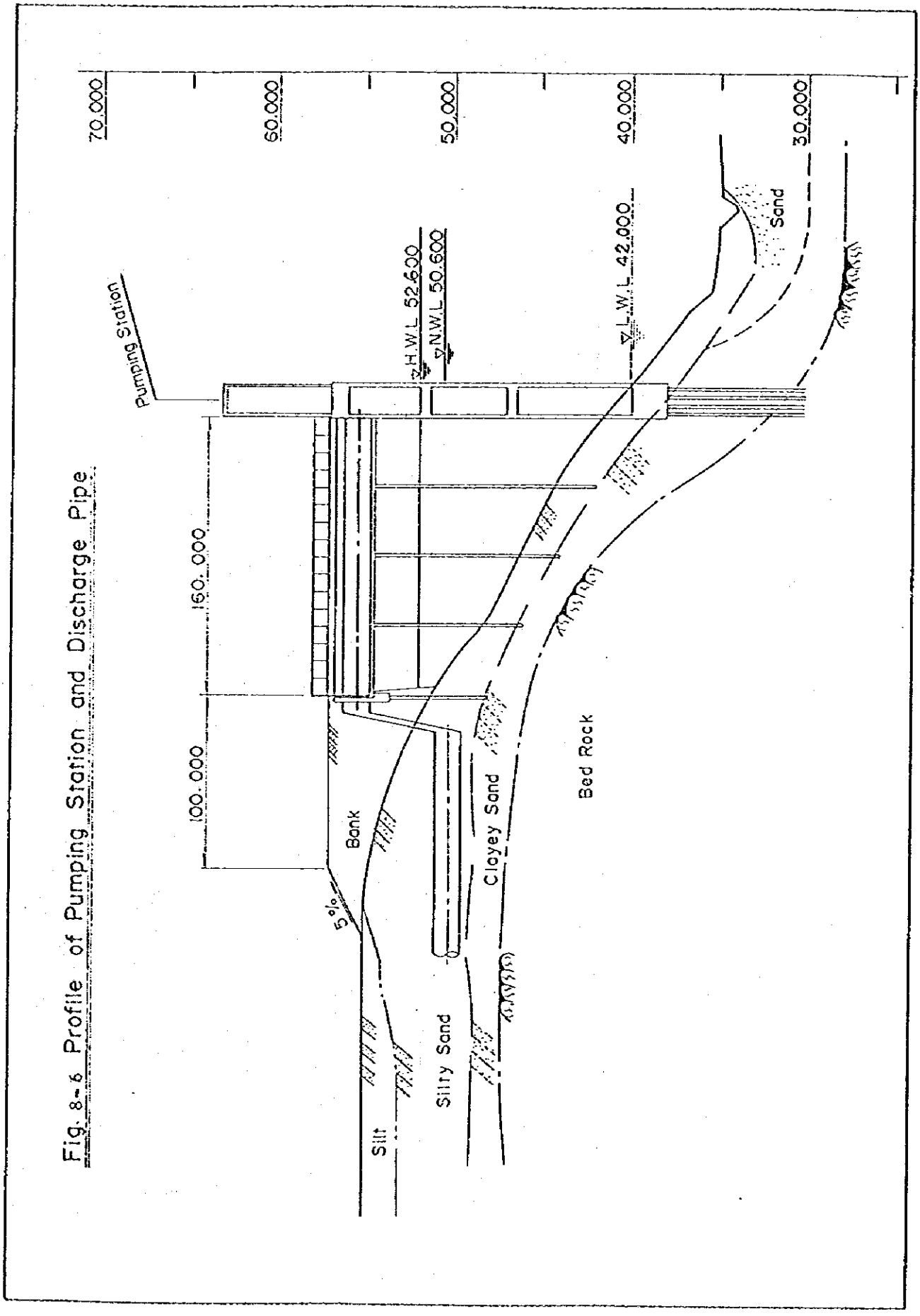


Fig. 8-6 Profile of Pumping Station and Discharge Pipe

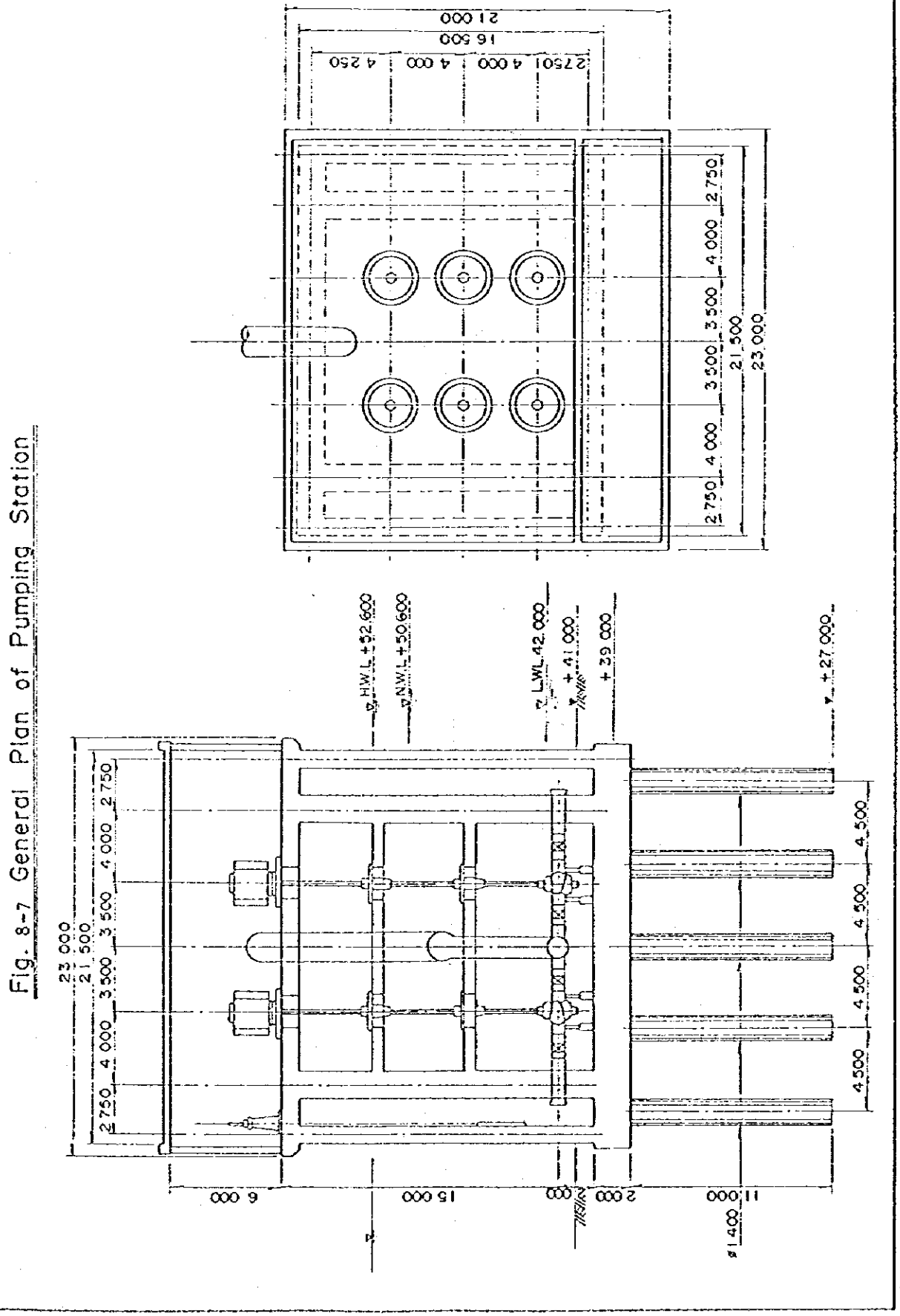


Fig. 8-7 General Plan of Pumping Station

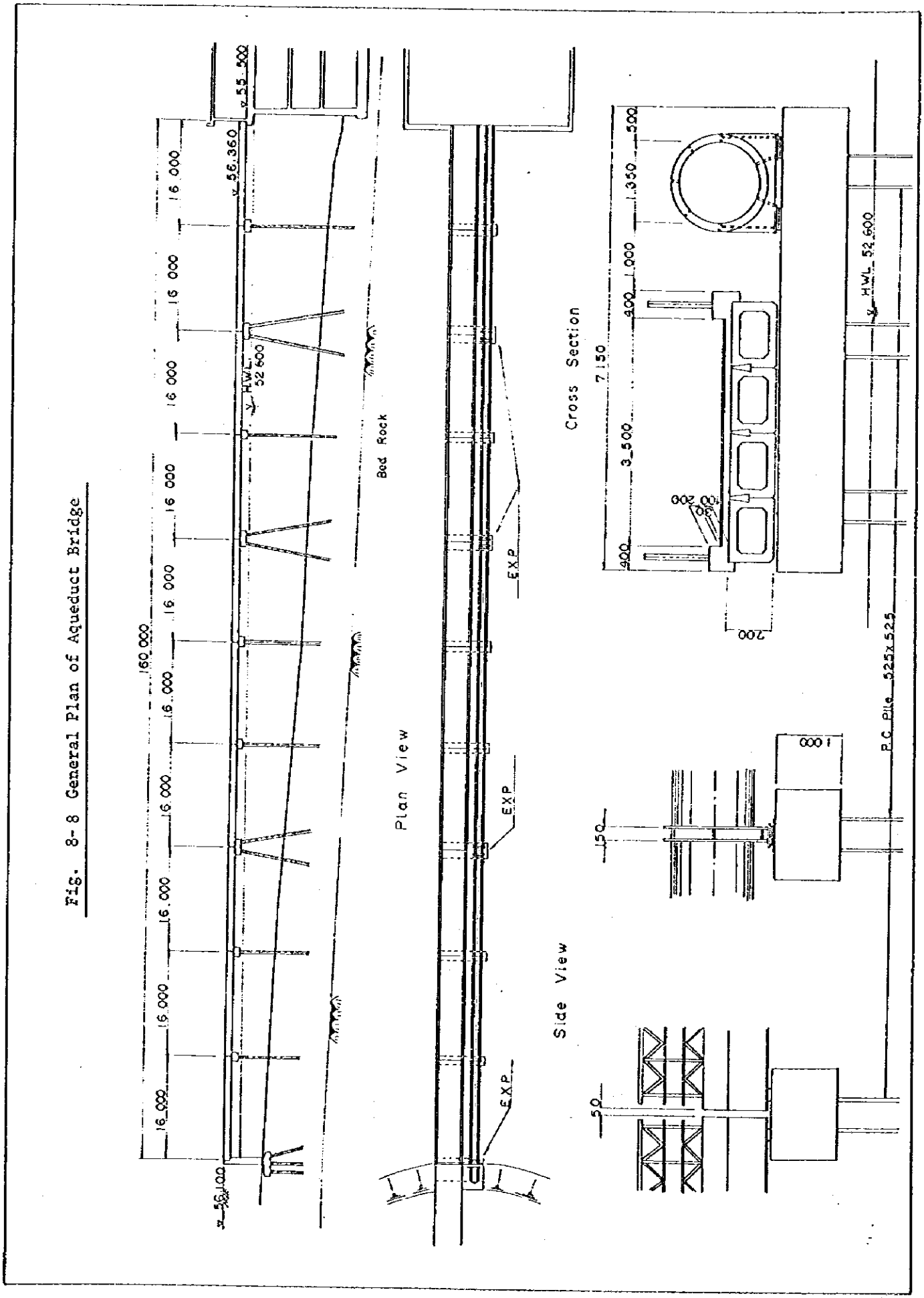


Fig. 8-8 General Plan of Aqueduct Bridge

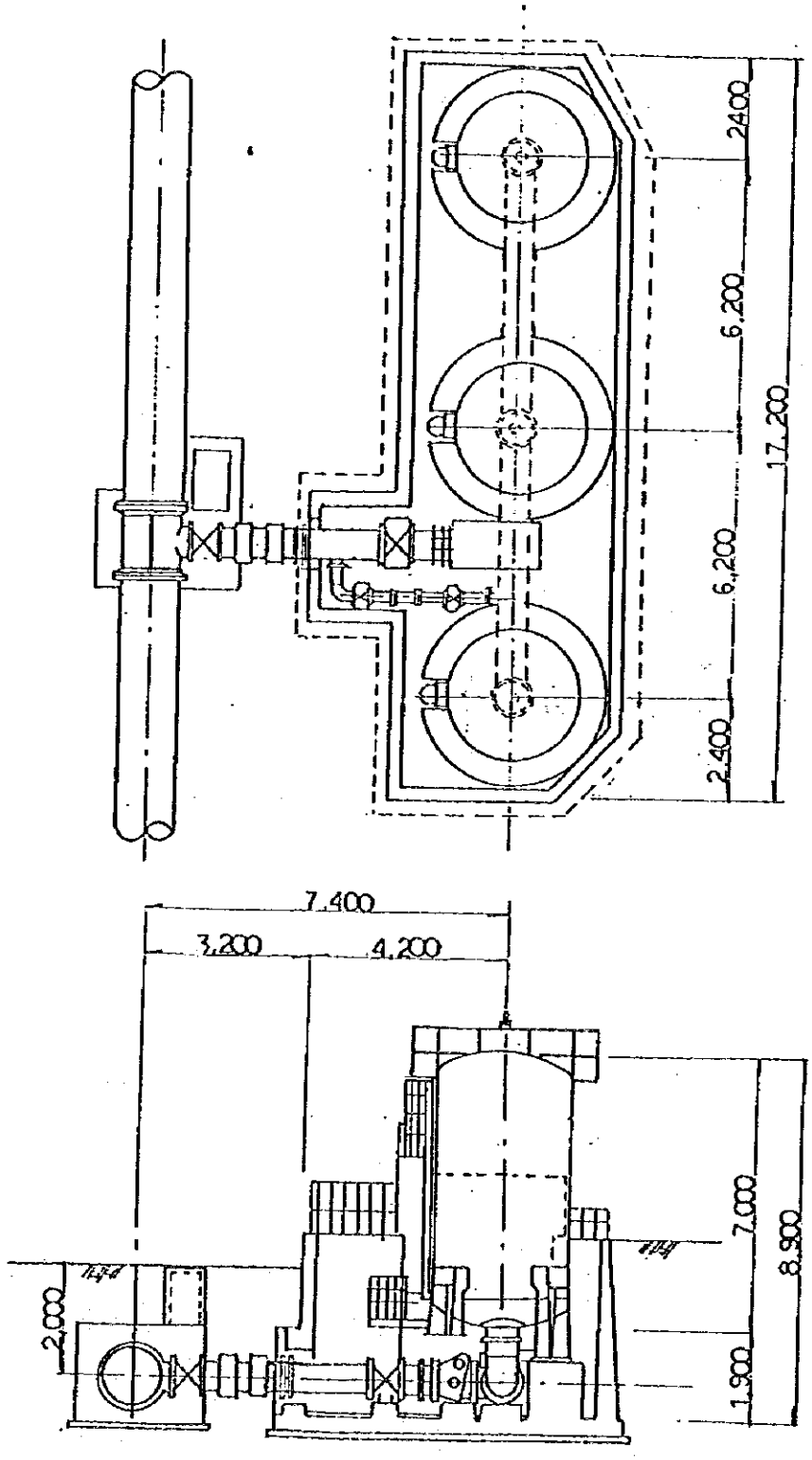


Fig. 8-9 General Plan of Air Chamber

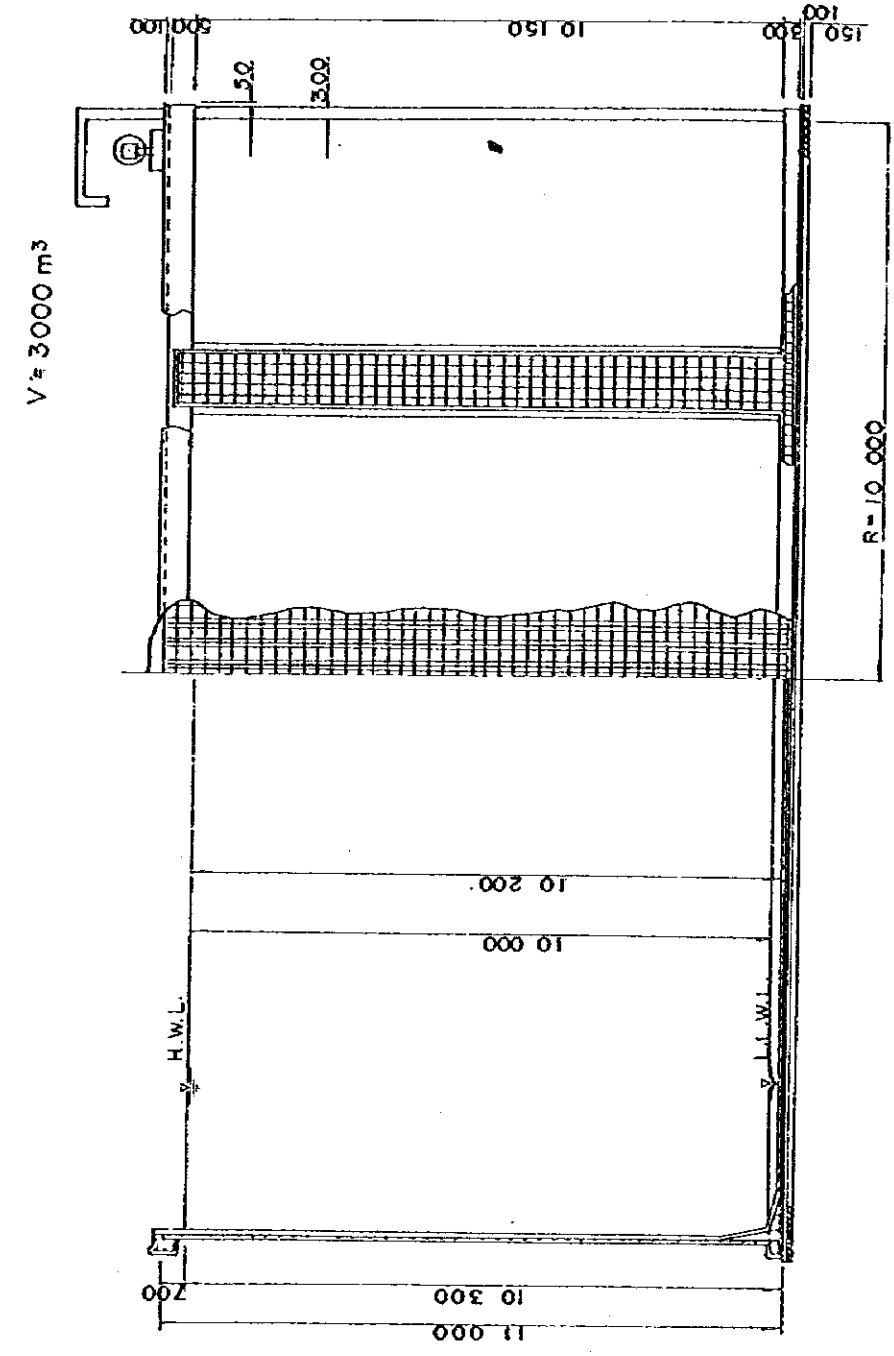


Fig.8-10 Standard Dimension of Head Tank

Fig. 8-11 General Plan of Reciving Well

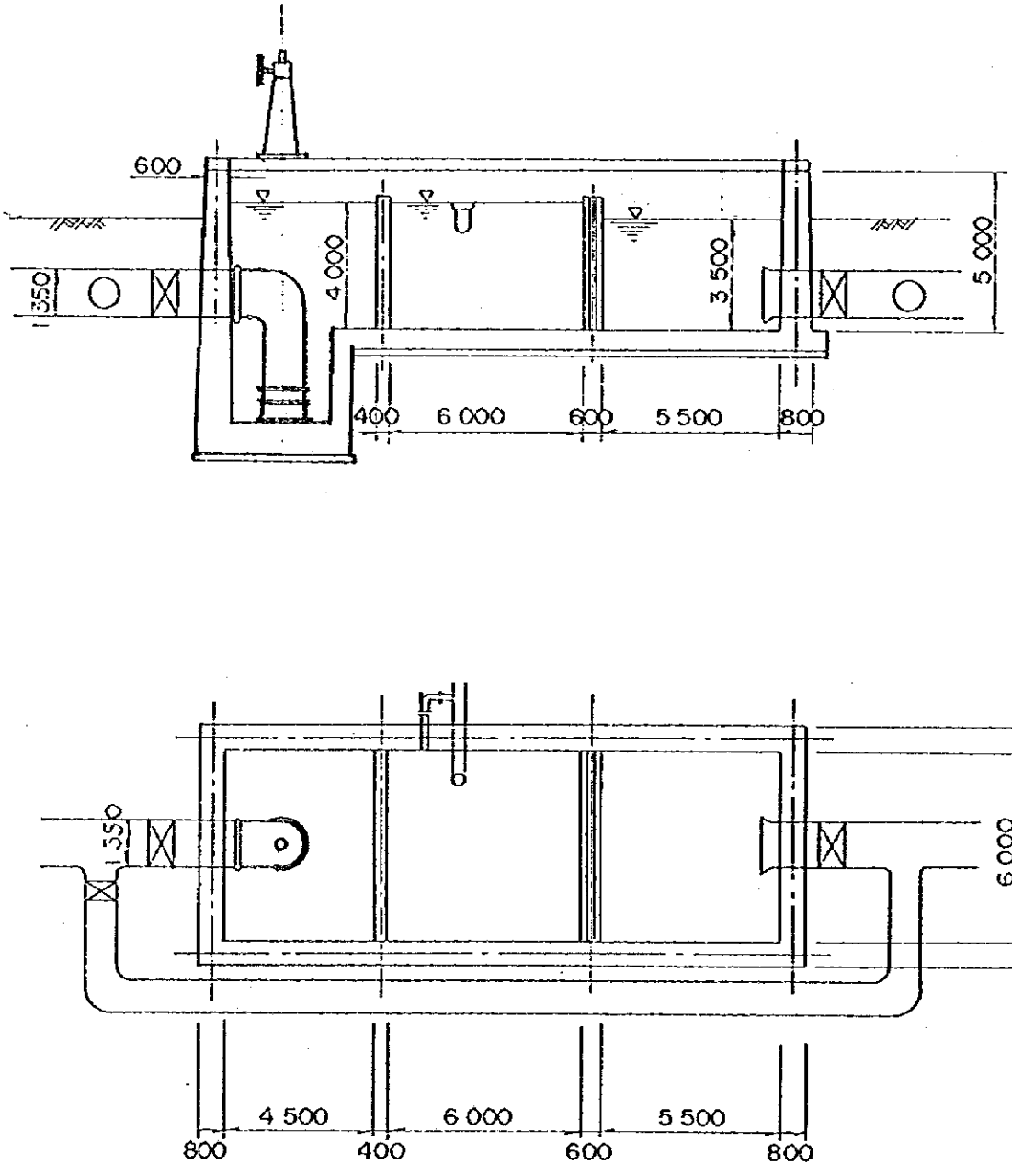


Fig. 9-1 Construction Schedule-A

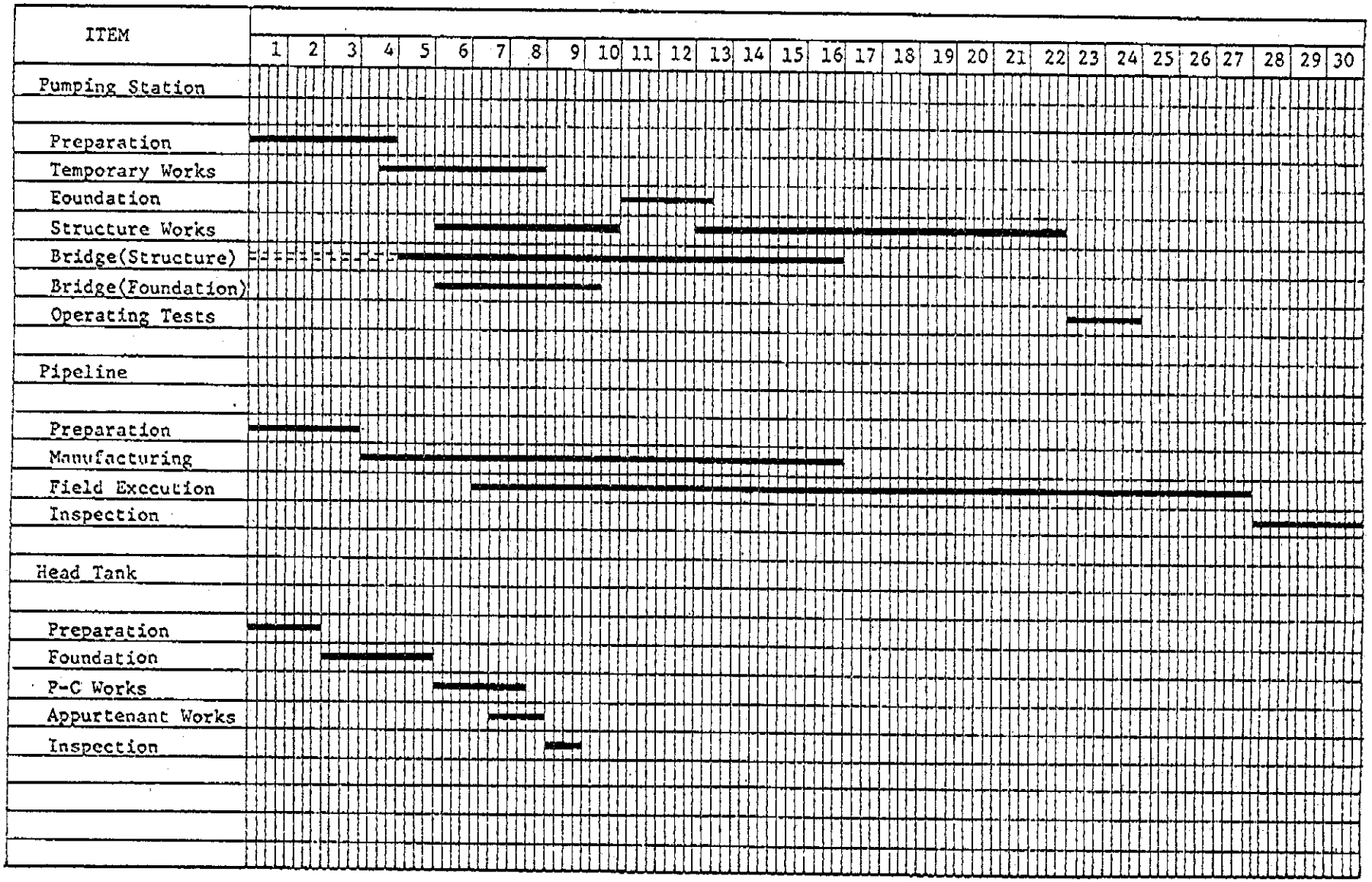


Fig.9-2 Construction Schedule-B

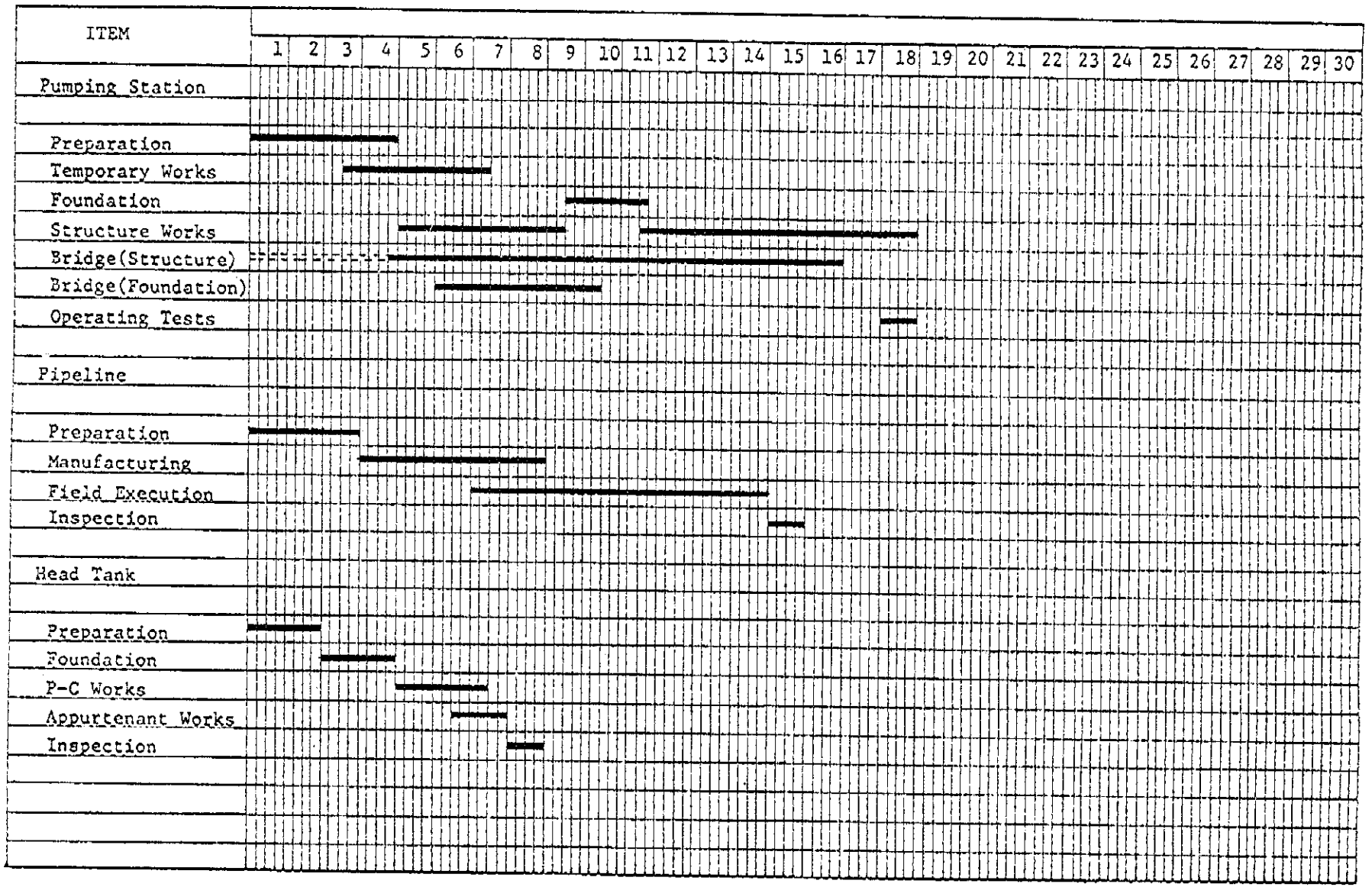
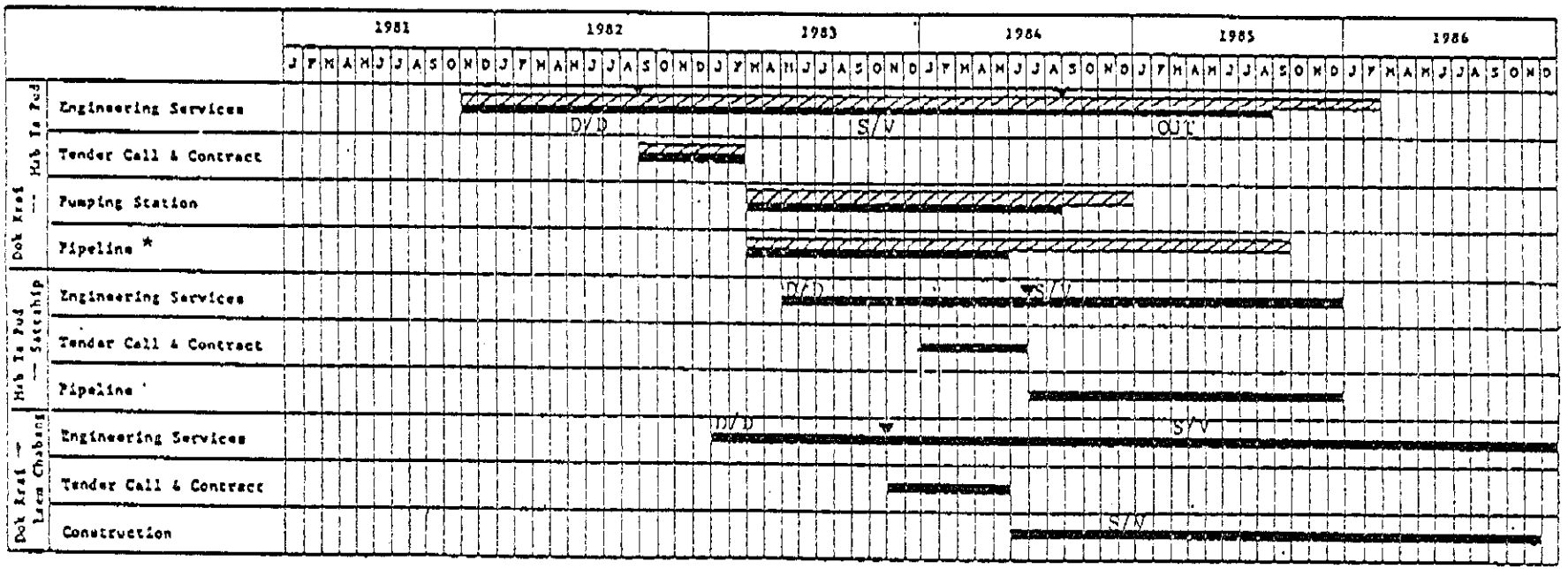


Fig. 9-3 Implementing Schedule



Legend: Schedule
Schedule

A D/D: Detailed Design
B S/V: Supervision
OJT: On the Job Training

Fig.12-1 General Plan of Water Supply System

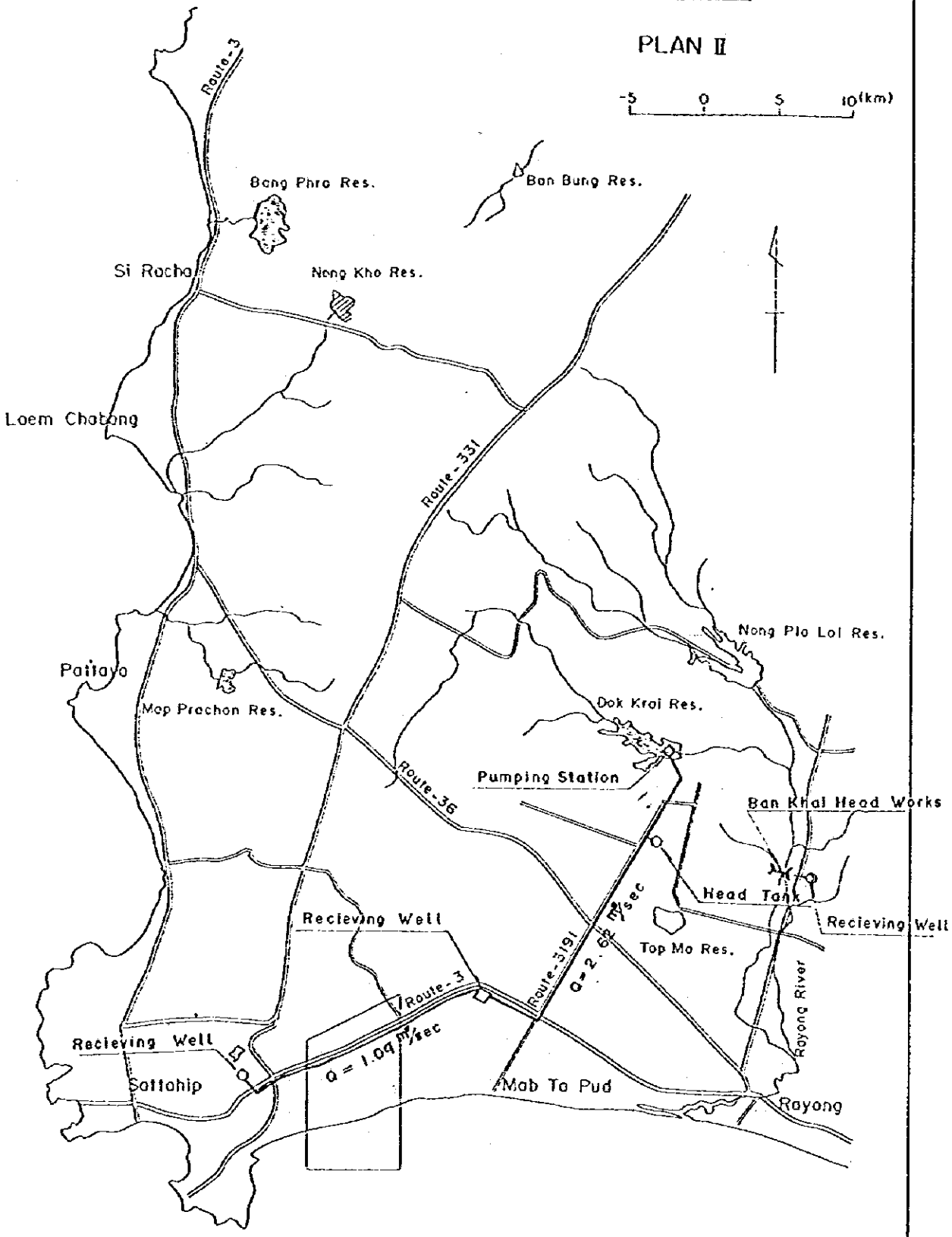


Fig. 12-2 General Plan of Pipeline from Dok Krai to Mab Ta Pud

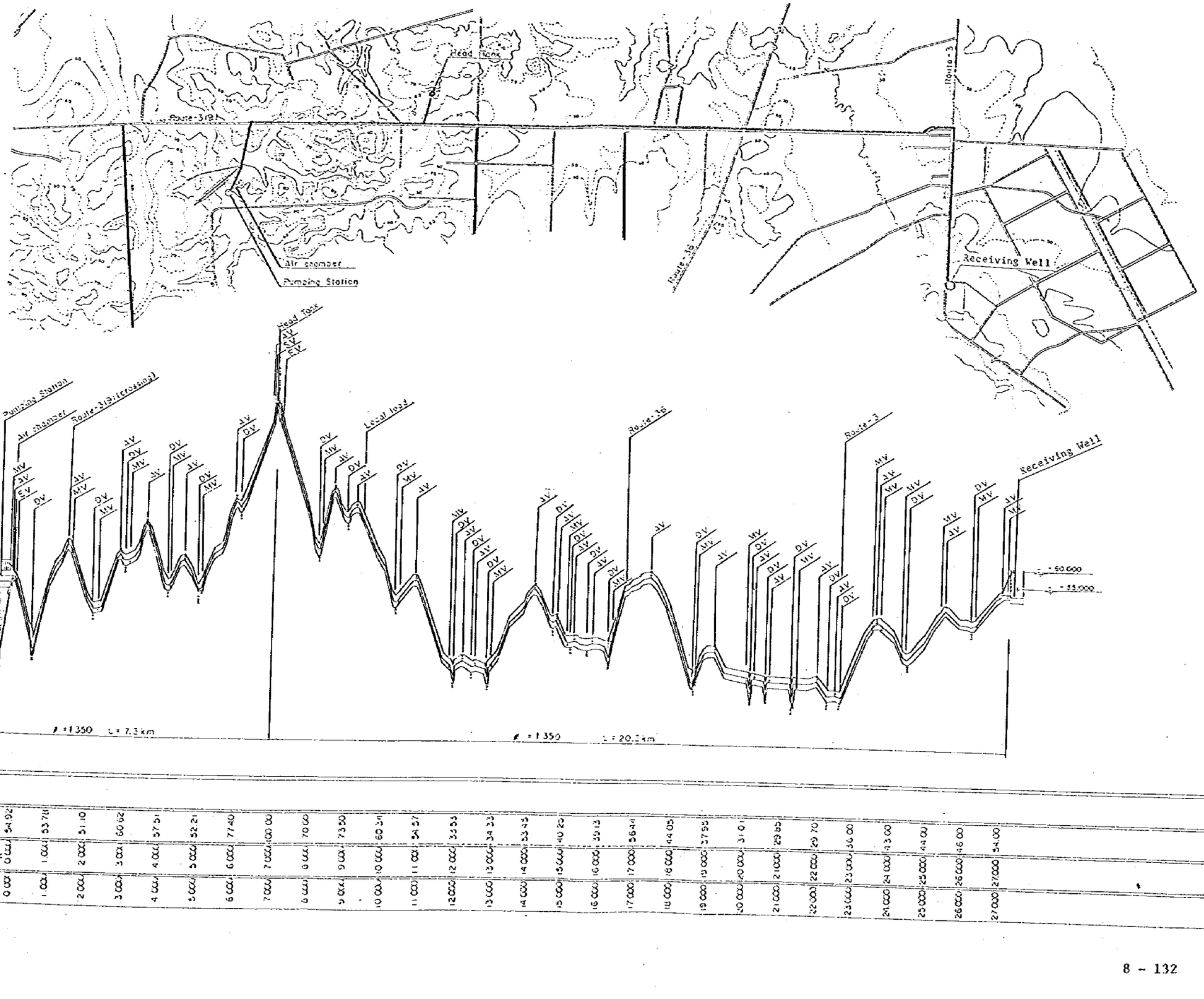
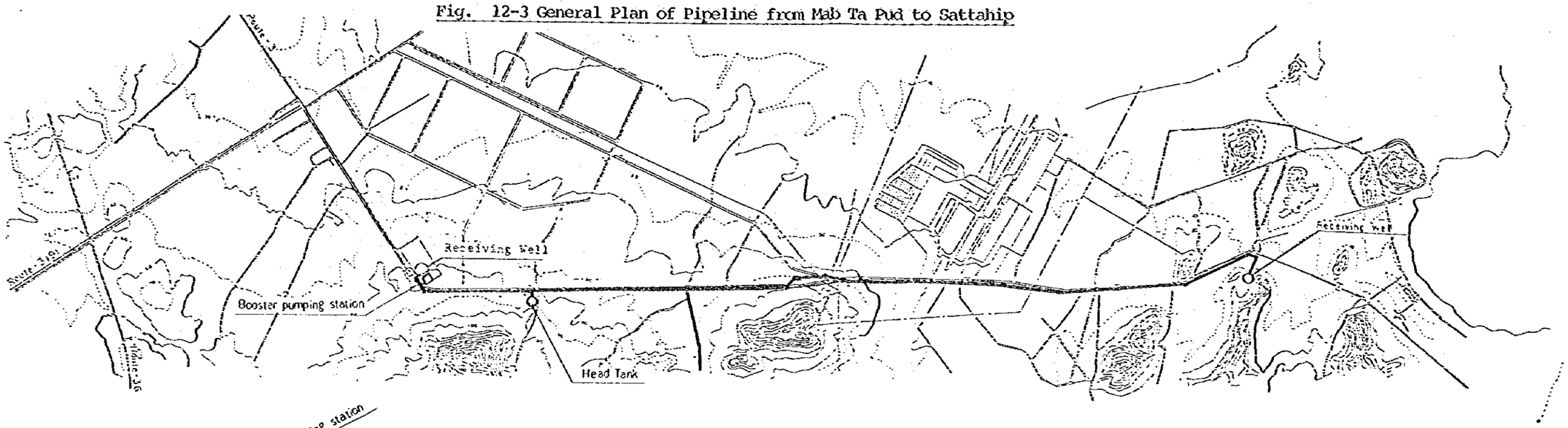
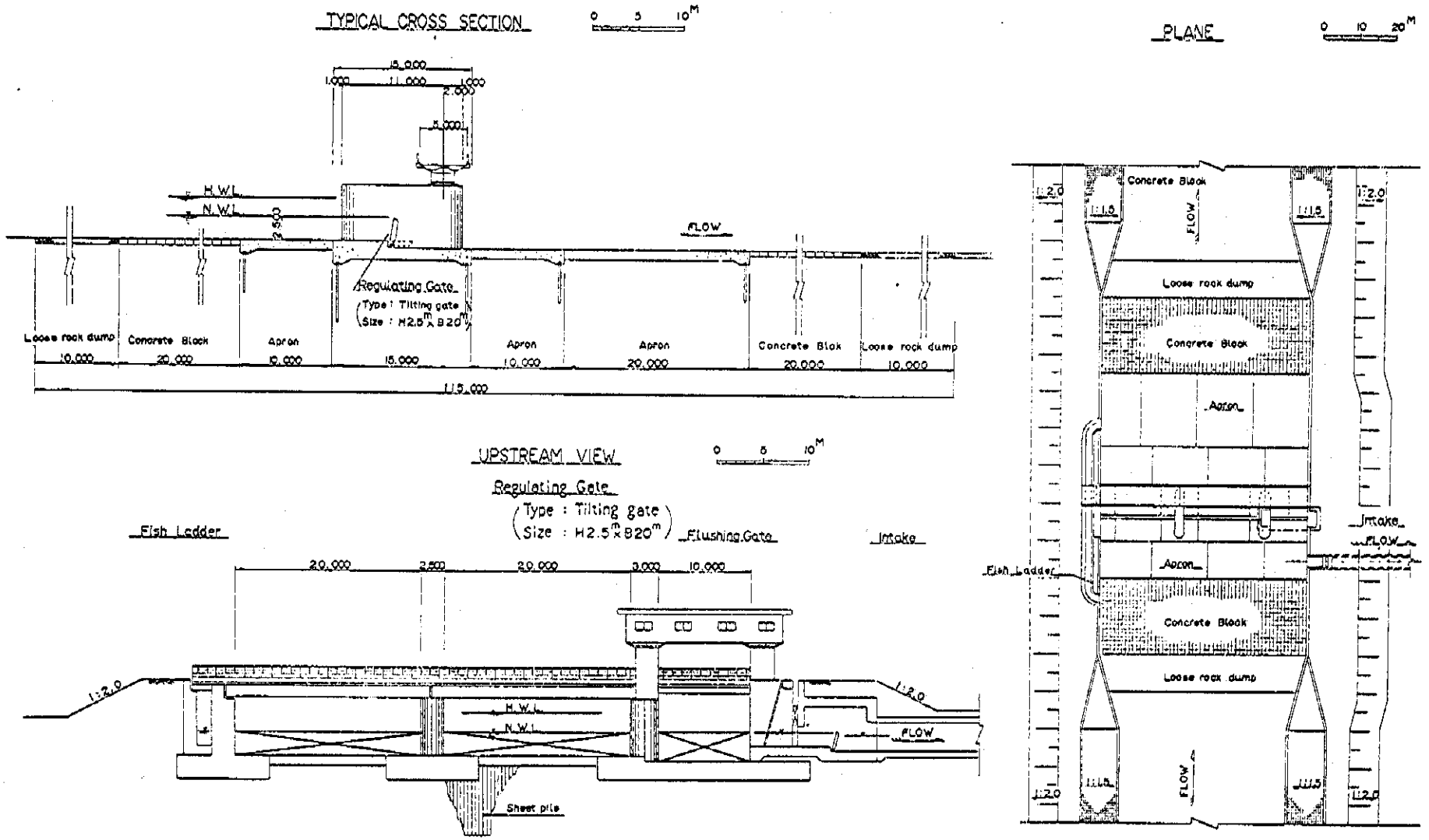


Fig. 12-3 General Plan of Pipeline from Mab Ta Pud to Sattahip



Station No.	Station Dist.	Profile
-5 000	-5.000	26.00
-4 000	-4.000	13.50
-3 000	-3.000	36.50
-2 000	-2.000	19.00
-1 000	-1.000	17.50
0 000	0.000	0.00
1 000	1.000	31.50
2 000	2.000	12.00
3 000	3.000	10.00
4 000	4.000	42.00
5 000	5.000	13.00
6 000	6.000	40.00
7 000	7.000	30.00
8 000	8.000	10.00
9 000	9.000	22.50
10 000	10.000	10.00
11 000	11.000	40.00
12 000	12.000	31.50
13 000	13.000	22.50
14 000	14.000	17.00
15 000	15.000	50.00
16 000	16.000	14.00
17 000	17.000	13.50
18 000	18.000	13.50
19 000	19.000	20.00
20 000	20.000	11.50
21 000	21.000	15.00
22 000	22.000	27.50

Fig.12-4 General Plan of Ban Khai Head Works



IX. IRRIGATION AND DRAINAGE

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1. PRESENT IRRIGATION AND DRAINAGE PRACTICE

Most of the area is rainfed area excepting the two areas, Bung Ton Chan and Khlong Yai Dam, where small diversion weirs have been constructed across the tributaries of the Rayong River. The actual irrigable area remains a few hectares because of lack of irrigation canals, although the officially proposed irrigable areas are 1,280 ha (8,000 rai) and 480 ha (3,000 rai), respectively. Supplementary irrigation for wet season paddy is practiced. These two areas are included in the Nong Pla Lai Project Area.

There exists Ban Khai irrigation project area of 4,800 ha on the down-stream reach adjacent to the Project Area. The diversion weir and the right and the left main irrigation canals were completed in 1960. In order to ensure not only wet season irrigation water supply, but also make possible the dry season irrigation, the Dok Krai Dam has been constructed in 1975. Land consolidation has not been performed yet. The canal density is low and most of the paddy fields are irrigated by plot to plot method. The crop area and the diverted water in Ban Khai Project are shown in Table 1-1 and Table 1-2, respectively, while the data of design diversion water is not available, the same cropping pattern and unit water demand as in the Nong Pla Lai area as shown in 2-2 Diversion Requirement is applied.

2. IRRIGATION SCHEME

2.1 PROJECT AREA

The project area consists of two areas namely Nong Pla Lai and Thap Ma.

The former lies on the left bank of the Rayong River, having an area of 8,360 ha (52,250 rai) in gross. It occupies the upper reach of the existing Ban Khai irrigation project area.

The present and proposed land use was studied. No land would be converted to paddy fields in future in due consideration of the limited irrigation water to be made available. 3,650 ha of paddy field out of 8,360 ha gross Project Area is proposed to be irrigated.

The latter, Thap Ma area lies on the right bank of lower reaches of the Rayong River along the Thap Ma River. As the development scheme of this area is not so ripe as in the former, the proposed paddy field of 6,400 ha is subject change by further study and in this study only water demand is estimated in proportion to the irrigable area.

2.2 DIVERSION WATER REQUIREMENT

2.2.1 Basic Concept

The diversion water requirement will be estimated by the following procedure. Crop consumptive use is the depth of water to meet the water loss through evapotranspiration; it is estimated from the climatic data and crop growing stage for each crop. The percolation is also taken into account for the paddy cropping. The water needed for land preparation is considered. The net water requirement will be given in the following formula.

Net Water Requirement = Crop Consumptive Use
+ Percolation
+ Water for Land Preparation

Net water requirement can be fully or partly met by rainfall. It is called effective rainfall. Net irrigation requirement is expressed in the following formula.

Net Irrigation Requirement = Net Water Requirement - Effective Rainfall

On and above the net irrigation requirement, additional water is needed to cover the losses incurred during conveyance and application to the field. Efficiency factors should be taken into consideration when estimating the diversion water requirment. It is given in the following formula.

Diversion Water Requirement = Net Irrigation Requirement/(Ec.Ef)

where Ec : Conveyance Efficiency
Ef : Field Efficiency

2.2.2 Crop Consumptive Use

Crop consumptive use is the depth of water consumed through evapotranspiration. It is affected by climate and crop growing stage. The effect of the climate is given by the reference crop evapotranspiration which is defined as the rate of evapotranspiration from a vast expansion of flat land covered with green grass of 8 to 15 cm uniform height. The effect of the crop growing stage is expressed in terms of crop coefficient which is obtained either empirically or experimentally.

Evapotranspiration

The estimate of evapotranspiration was made by applying the modified Penman method. The complete set of meteorological data required for computation were obtained from the records observed at Chonburi Station. The monthly mean for the year 1951 - 1975 is shown in Table 2-1. The estimated value of evapotranspiration for the Project is tabulated as follows.

EVAPOTRANSPIRATION (ET)

Month	mm/day	mm/month
April	6.0	180.0
May	5.0	155.0
June	5.0	150.0
July	4.7	145.7
August	4.5	139.5
September	4.0	120.0
October	4.1	127.1
November	4.8	144.0
December	5.2	161.2
January	5.2	161.2
February	5.5	154.0
March	6.1	189.1
Total or Mean	5.0	1,826.8

The estimated mean daily evapotranspiration ranges from 6.1 mm/day in March to 4.0 mm/day in September. The annual mean is 5.0 mm/day.

Crop Coefficient

The effect of crop characteristics on the relationship between evapotranspiration and crop's consumptive use is expressed in terms of crop coefficient. The crop coefficient of each crop varies with their growing stage. It is estimated from the actual measurement data by Irrigated Agriculture Section, RID, though some modifications were made for the growing period. The crop coefficient of each crop is shown below.

Crop Coefficient (Kc)

Month	Wet Season Paddy	Dry Season Paddy	Ground Nut
1st	1.0	1.0	0.55
2nd	1.2	1.25	1.0
3rd	1.35	1.35	0.65
4th	1.25	1.15	
5th	1.15		

2.2.3 Percolation

Percolation is affected largely by the soil features as well as the groundwater condition of the farm land. The rate of percolation is considered to be constant through the whole year, though the slight change in groundwater condition may take place in a long run. The soil features in the Area are generally sandy.

The rate of the percolation for the Project Area was determined on the basis of the measurements carried out at eight selected points in the Ban Khai project area which is located in a downstream reach adjacent to the Project Area where the soil features and the groundwater conditions can be considered to be quite similar to those of the Project Area. The measuring site of percolation is shown in Fig. 2-1 and the results obtained from the measurement are shown below.

Test Site No.	Percolation Rate mm/day
1	2.1
2	1.6
3	3.0
4	2.3
5	2.7
6	3.0
7	3.2
8	5.8
Mean	2.9

Above percolation rates are averages of the values obtained by two measurements at every site. The result shows that most of the soils have rather large percolation rate in comparison with that of the Central Plain because of the sandy soil texture. The percolation rate ranges from 1.6 mm/day to 5.8 mm/day with the mean value 2.9 mm/day. The percolation rate of 3.0 mm/day is adopted for the Project.

2.2.4 Water Requirement for Land Preparation

Water needed for land preparation should be considered for paddy cropping and those for preparatory work in upland cropping is also taken into account in addition to the crop consumptive use. The additional water requirement for land preparation is as follows.

Crop	Water Requirement (mm)
Paddy	200
Groundnut	60

The land preparation is carried out within one month for both paddy and groundnut according to the proposed cropping pattern.

2.2.5 Effective Rainfall

A part of the water requirement may be met by rainfall. A rate of effective rainfall to total rainfall depends on its amount, frequency and intensity. It varies from place to place and month to month. However, the relation between the monthly effective rainfall and the monthly rainfall was empirically established by RID. The factors of effective rainfall are as follows.

Monthly Rainfall (mm)	Factor of Effective Rainfall
0 - 10	0
10 - 100	0.80
100 - 200	0.70
200 - 250	0.60
250 - 300	0.55
300 up	0.50

The above factors are based on the long experience and found to give satisfactory result. The monthly effective rainfall estimated from the observed records at the station Ban Khai for the period from 1957 to 1980 is shown in Table 2-2.

2.2.6 Losses

A part of the irrigation water to be supplied to the field is lost during conveyance by seepage and evaporation. This loss is expressed in terms of water conveyance efficiency which is given in the following equation.

$$Ec = \frac{Wf}{Wd}$$

where Wf; water delivered to the field
Wd; water diverted from the river

As the main and lateral canals are planned to be lined with concrete under the Project, 0.9 is adopted for the conveyance efficiency.

A part of the irrigation water applied to the field is lost by surface runoff from the field and deep percolation below the root zone. Though, in case of paddy field, the

deep percolation is counted in the net irrigation water requirement, the loss caused by the seepage through the levee must be taken into account. Field efficiency is given in the following equation.

$$Ef = \frac{Ws}{Wf}$$

where Ws; net irrigation water requirement
Wf; water delivered to the field

The field efficiency varies with irrigation method and field condition. In this project, 0.7 is adopted for field efficiency.

2.2.7 Diversion Water Requirement

Based on the aforementioned conditions, case studies on the diversion water requirement were made for the proposed cropping pattern with the different rate of dry season cropping intensity. The cropping pattern studied are illustrated in Fig. 2-2. The monthly diversion water requirements for 24 years (1957-1980) in each case are shown in Table 2-3 to Table 2-6. The annual diversion water requirement necessary in 1978 which is adopted as the design drought year are listed as follows.

Case	Cropping Intensity (percent)	Diversion Water Requirement (MCM)		
		Nong Pla Lai (3,650 ha)	Ban Khai (4,800 ha)	Thap Ma (6,400 ha)
1	180	69.4	91.3	121.7
2	160	62.7	82.5	109.9
3	140	56.0	73.6	98.2
4	120	49.4	65.0	86.6

It is determined by the reservoir operation studies that the water allocation for irrigation corresponds to Case-1 with cropping intensity 180 percent.

3. DRAINAGE SCHEME

3.1 GENERAL

In most of the Nong Pla Lai area, drainage problems can be solved by constructing on-farm drainage canals which can drain directly into the adjacent tributaries of the Rayong River, excepting those low-lying area like the irrigation block number B-17, B-18, B-19, B-20, B-21 (Refer to Fig. 3-1), where a stream runs into the low-lying area from the hill outside the Project Area and bifurcate into the paddy field. The proposed drainage area is 21.3 Km^2 and the catchment area outside the Project Area is 14.9 Km^2. When water is supplied through the main irrigation canal, one main drainage canal would be necessary in this area.

As for the Thap Ma area, only the water demand is estimated and drainage scheme is subject to the further study.

3.2 ESTIMATE OF DESIGN DISCHARGE

For the estimate of design discharge, 10 year probable daily rainfall is taken in this study from the economic point of view. From the hydrological data processing, 135 mm/day is obtained for 10 year probable daily rainfall.

The unit area design discharge was obtained on the following presumption. The excess water caused by rainfall is immediately drained to the low-lying area. The water is stored in the low-lying area and discharged at the rate of design discharge capacity. It is roughly estimated that low-lying area occupies about half of the inside area and about one third of outside area, respectively, in the proposed drainage area.

The design drainage discharge is so decided as to keep the average inundation depth less than 20 cm. The unit design discharge is given in the following equation.

$$(R - Q)\frac{1}{A} = D$$

where R : 10 year probable daily rainfall 135 mm
Q : Unit design discharge
A : Ratio of low-lying area
D : allowable inundation depth 200 mm

Unit design discharge from outside of the Project Area.

$$(135 - Q)\frac{1}{1/3} = 200$$

$$Q = 68.3 \text{ mm/day}$$
$$= 0.791 \text{ m}^3/\text{sec/Km}^2$$

4. PHYSICAL PLANNING

4.1 IRRIGATION SYSTEM

4.1.1 General

In the Nong Pla Lai area, the irrigation water is planned to be diverted at the Ban Nong Bau Diversion Weir which will be constructed at the downstream of the confluence of the Nong Pla Lai River and the Khlong Yai. The main irrigation canal is aligned along the hillside on the left bank of the Rayong River. It will be lined with concrete and has an average slope 1/5,000 in general (1/3,000 slope in the downstream portion). The total length of the main irrigation canal is 46.2 Km. Twelve lateral canals with total length of 20 Km are planned. They will be also lined with concrete.

As the water demand only is studied in Thap Ma area, Physical Planning is not induded in this study.

4.1.2 Determination of Design Capacity

It is evident that the maximum diversion water requirement occurs during the last day of the land preparation for wet season paddy cropping. The unit water requirement for determination of canal design capacity is given in the following equation.

$$Q = \left[\frac{1}{N} d1 + \frac{N-1}{N} d2 \right] \times \frac{10^{-3} \times 10^{4}}{86,400 \times Ec \times Ef}$$

where
- Q : Unit design capacity (m^3/sec/ha)
- N : Number of days for land preparation (30 days)
- d1: Water depth for land preparation (200 mm)
- d2: Consumptive use (8.2 mm)
- Ec: Conveyance efficiency (0.9)
- Ef: Field efficiency (0.7)

$$Q = 0.00268 \ m^3/sec/ha$$

4.1.3 Irrigation Block

The irrigation area is planned to be divided into 25 irrigation blocks, in due consideration of the topographic conditions. Each irrigation block is commanded by one turnout on the main canal. The commanded area and the design discharge of each turnout is listed in Table 4-1

In the small irrigation blocks on the main irrigation canal, the irrigation water is to be diverted into the on-farm irrigation ditches from the turnout on the main irrigation canal. In the larger irrigation blocks and the blocks off the main irrigation canal, lateral canals are to be provided and irrigation water is to be diverted into the on-farm irrigation ditches through the lateral canals. The irrigation canal systems is shown in Fig. 3-1.

4.1.4 Irrigation Canal

Hydraulic Design

Hydraulic design was made on the basis of the Manning Formula. The roughness coefficient of 0.014 is adopted for the concrete lining and the maximum design velocity is controlled below 1.5 m/sec in order to secure the stable flow.

Bottom Width and Freeboard

The bottom width and the freeboard of the main canal will be determined as follows in accordance with the design discharge.

Discharge (m^3/sec)	Bottom Width (m)	Freeboard (m)
0 - 2.0	1.6	0.3
2.0 - 4.0	2.0	0.3
4.0 - 6.0	2.4	0.4
6.0 up	2.8	0.4

The freeboard of 0.15 m is taken for the lateral canal.

Embankment Slope

The embankment slopes for the main and the lateral canals are determined as follows.

	Inside Slope	Outside Slope
Main Canal	1 : 1.5	1 : 1.5
Lateral Canal	1 : 1.0	1 : 1.5

Lining

Both the main canal and the lateral canals are to be lined with concrete. The thickness of the lining is 7 cm on the main canal and 5 cm on the lateral canal, respectively.

Operation and Maintenance (O.M.) Road

One side of the embankment is used as O.M. Road. The width of the road is 5 m on the main canal and 3 m on the lateral canal, respectively.

The typical cross sections and the dimensions of the main irrigation canal and the lateral canal are shown in Fig. 4.1.

4.1.5 Appurtenant Structure

The major appurtenant structure to the irrigation canals are as follows.

Turnout

Turnouts will be provided at the diversion points from the main canal to the lateral canals or on-farm ditches. The structure should have a function of checking the amount of discharge. Generally, the constant head orifice will be provided.

Check Gate

Check gates will be installed at the downstream points of the turnout and at the points with the interval of every 2 Km along the canal in order to secure proper water level.

Spillway, Wasteway

Spillways and wasteways will be provided at the changing points of the design discharge and at the sites close to the syphons for the convenience of connectin to the river.

Syphone

Syphones will be provided where the irrigation canals cross the existing river channel. Reinforced concrete pipes will be used.

Bridge

Bridges will be provided at the points of road crossing. Reinforced concrete slab bridge will be adopted.

Culvert

Concrete pipe culverts will be installed at the points where small amount of drain discharge cross the irrigation canal.

4.2 DRAINAGE SYSTEMS

Earth canal is recommended for the drainage canal from the economic viewpoint. The alignment of the main drainage canal is so selected as to run through the lowest portion of the area. The catchment area and the design discharge are as follows.

Length (Km)	Catchment Area (Km^2) Inside	Outside	Discharge (m^3/sec)
0 - 3.05	21.3	14.9	20.4
3.05 - 6.45	6.0	14.9	14.2

Hydraulic design was made on the basis of the Manning Formula. The roughness coefficient of 0.035 is adopted for the earth canal. The embankment slope of the main drainage canal is 1:1.5. An O.M. road with width of 3.0 m is to be constructed along the canal. The standard cross section and the dimensions are shown in Fig. 4-1.

5. COST ESTIMATE AND CONSTRUCTION SCHEDULE

Estimated Work Volume

The work volume for the irrigation and drainage systems in Nong Pla Lai area is estimated as follows.

Facilities	Quantity
A. Irrigation Systems	
Diversion Weir	1
Main Irrigation Canal	46.2 Km
Lateral Canal	20.15 Km
B. Drainage Systems	
Drainage Canal	6.45 Km
C. Land Acquisition	
Irrigation Systems	291 ha
Drainage Sytems	14 ha

Cost Estimate

The construction cost will be estimated on the contract basis. The total project cost amounts to US$16.05 million and the foreign currency portion occupies 44 percent of the total construction cost. The details are shown in Tables 5-1 to 5-4.

Constructin Schedule

The project involves relatively large volume of civil works. The construction period depends on the work volume and the climate condition. The construction schedule was carefully studied and was discussed with RID. The construction schedule for the irrigation and drainage systems was decided as follows in accordance with that of the dam construction.

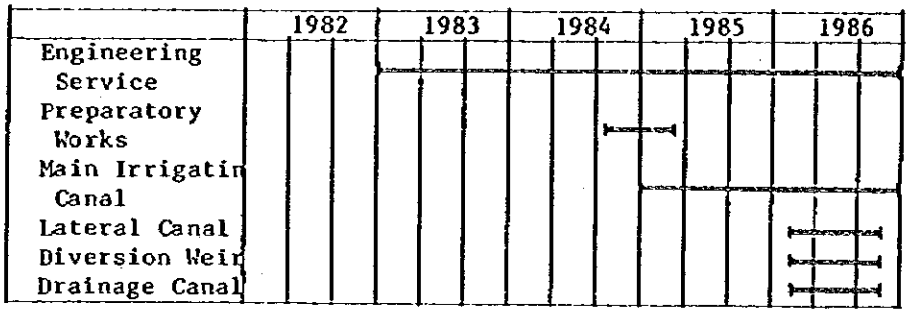


Table 1-1 Crop Area in Ban Khai Project

Unit: Rai

Wet Season		Dry Season								
Year	Paddy	Paddy	Ground Nut	Water Melon	Sweet Corn	Sweet Potato	Musk Melon	Cucumber	Egg Plant	Others
1975	29,950	4,600	305	200	-	50	-	3	-	-
1976	30,000	15,000	-	-	-	-	-	-	-	40
1977	30,000	3,500	180	80	-	200	-	2	-	-
1978	30,000	8,000	400	350	50	1,000	750	60	40	140
1979	30,000	10,000	1,000	1,000	500	1,250	2,800	150	150	300
1980	30,000	8,700	425	620	-	-	-	540	-	-

Table 1-2 Diverted Water in Ban Khai Project

Water Year	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Total
1968	-	-	-	-	-	-	-	-	-	3,892	2,255	2,512	-
1969	2,646	5,712	4,450	4,329	7,963	5,721	10,378	7,606	4,682	3,464	3,001	3,201	63,154
1970	5,433	3,501	3,501	4,781	5,917	6,968	9,858	8,340	2,534	2,303	3,917	1,577	58,610
1971	2,178	3,740	3,163	5,122	7,880	3,612	4,816	4,052	3,280	2,582	2,613	2,528	45,566
1972	3,061	3,771	4,651	5,095	4,407	4,108	5,114	5,236	2,001	2,329	1,909	3,765	45,447
1973	3,537	2,695	3,494	5,851	8,150	4,565	5,657	3,834	1,483	3,011	1,983	3,197	47,457
1974	2,561	1,752	2,388	5,263	8,476	8,393	1,780	1,528	626	1,369	1,950	4,410	40,596
1975	5,042	3,149	3,101	5,585	8,531	7,483	3,960	2,273	215	3,497	4,283	3,953	51,072
1976	3,704	1,636	3,003	5,609	3,898	818	5,886	1,914	313	2,276	3,696	3,432	36,185
1977	4,955	6,081	7,987	9,327	7,308	9,043	8,683	5,416	652	2,063	3,072	4,835	69,422
1978	5,572	2,784	1,052	6,290	7,164	4,813	6,023	6,535	1,215	3,699	6,343	7,093	58,583
1979	7,388	4,052	5,643	5,443	6,931	9,443	7,777	4,723	1,809	3,602	5,348	7,474	69,633
1980	3,347	5,026	5,529	6,109	5,216	6,223	9,204	-	-	-	-	-	-

Table 2-1 Meteorological Data used for Estimating Evapotranspiration

	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Air Temperature (°C)	29.6	29.3	28.9	28.6	28.3	27.9	27.3	26.7	25.8	25.9	27.4	28.8
Relating Humidity (%)	71.0	75.0	75.0	75.0	76.0	80.0	80.0	73.0	66.0	67.0	71.0	71.0
Wind Speed (Km/day)	210	194	233	217	214	174	164	204	217	210	230	233
Cloudiness (Oktas)	4.7	6.1	6.5	6.7	6.9	6.7	5.8	4.5	3.6	3.9	3.8	4.0

Table 2-2 Effective Rainfall

Unit: mm

YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1968	0.0	124.9	241.1	81.1	70.7	83.9	81.8	26.4	12.6	94.8	31.5	87.2	936.0
1969	43.0	156.6	63.5	103.6	123.1	143.7	146.6	63.6	0.0	57.5	127.6	66.2	1095.6
1970	133.6	148.1	143.7	75.2	121.1	121.7	81.7	75.5	129.4	0.0	12.9	27.2	1070.1
1971	58.6	139.5	45.3	52.6	128.1	149.7	125.2	0.0	33.2	0.0	0.0	8.2	740.5
1972	130.4	20.6	138.2	42.4	15.9	190.5	64.8	87.7	0.0	18.9	0.0	70.8	780.3
1973	30.8	175.6	139.1	78.6	94.4	164.5	120.0	79.4	17.8	0.0	26.7	27.7	954.6
1974	132.2	152.8	78.4	56.6	107.0	173.6	255.4	52.8	0.0	60.8	0.0	59.2	1128.8
1975	51.0	154.1	89.6	76.1	97.7	135.9	184.4	36.1	0.0	0.0	38.4	38.8	902.1
1976	70.6	144.3	27.8	26.7	159.1	121.4	155.8	34.2	0.0	19.5	0.0	8.1	767.5
1977	54.1	117.4	70.2	160.5	51.6	120.7	135.7	8.9	0.0	62.6	77.6	0.0	859.3
1978	57.6	113.8	141.7	127.3	75.9	134.8	80.7	16.8	0.0	0.0	44.8	8.4	801.8
1979	69.6	32.5	153.5	75.7	12.3	137.8	70.8	0.0	9.0	0.0	0.0	63.1	624.3
1980	79.9	44.4	140.8	105.5	130.6	101.4	127.7	44.9	0.0	0.0	15.2	32.0	822.4

Table 2-3 Water Demand of Nong Pla Lai Irrigation Area (Cropping Intensity 180%)

WATER YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1968	6.68	1.13	0.00	12.35	11.59	9.38	9.48	6.63	0.00	0.67	7.16	6.01	71.14
1969	5.33	0.88	0.51	10.33	8.56	5.92	5.72	5.55	0.00	1.45	2.30	6.98	53.59
1970	2.81	0.95	0.27	12.89	8.67	7.19	9.48	5.21	0.00	4.47	8.15	8.79	68.93
1971	4.87	1.01	0.56	14.92	8.26	5.57	6.96	7.40	0.00	4.47	8.84	9.67	72.58
1972	2.85	1.93	0.29	15.83	14.77	3.21	10.46	4.86	0.00	3.47	8.84	6.77	73.34
1973	5.72	0.74	0.29	12.58	10.22	4.72	7.26	5.10	0.00	4.47	7.42	8.77	67.33
1974	2.83	0.91	0.46	14.56	9.49	4.19	0.00	5.87	0.00	1.31	8.84	7.31	55.80
1975	5.10	0.90	0.43	12.80	10.02	6.37	3.53	6.35	0.00	4.47	6.80	8.25	65.09
1976	4.50	0.98	0.61	17.24	6.47	7.21	5.19	6.41	0.00	3.45	8.84	9.68	70.61
1977	5.00	1.18	0.49	5.23	12.70	7.25	6.35	7.14	0.00	1.27	4.70	10.05	61.43
1978	4.90	1.21	0.28	8.21	11.29	6.44	9.54	6.91	0.00	4.47	6.46	9.66	69.41
1979	4.53	1.84	0.25	12.84	14.97	6.26	10.12	7.40	0.00	4.47	8.84	7.13	78.69
1980	4.20	1.76	0.28	10.16	8.12	8.37	6.82	6.10	0.00	4.47	8.04	8.56	66.88

Table 2-4 Water Demand of Nong Pla Lai Irrigation Area (Cropping Intensity 160%)

WATER YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1968	5.00	0.84	0.00	12.35	11.59	9.38	9.48	6.63	0.00	0.50	5.37	4.50	65.71
1969	3.99	0.66	0.51	10.33	8.56	5.92	5.72	5.55	0.00	1.09	1.72	5.23	49.34
1970	2.10	0.71	0.27	12.89	8.67	7.19	9.48	5.21	0.00	3.35	6.11	6.59	62.63
1971	3.65	0.76	0.56	14.92	8.26	5.57	6.96	7.40	0.00	3.35	6.63	7.25	65.35
1972	2.14	1.45	0.29	15.83	14.77	3.21	10.46	4.86	0.00	2.60	6.63	5.08	67.36
1973	4.29	0.55	0.29	12.58	10.22	4.72	7.26	5.10	0.00	3.35	5.56	6.57	60.54
1974	2.12	0.68	0.46	14.56	9.49	4.19	0.00	5.87	0.00	0.98	6.63	5.48	50.49
1975	3.82	0.67	0.43	12.80	10.02	6.37	3.53	6.35	0.00	3.35	5.09	6.18	58.69
1976	3.37	0.73	0.61	17.24	6.47	7.21	5.19	6.41	0.00	2.58	6.63	7.25	63.74
1977	3.75	0.89	0.49	5.23	12.70	7.25	6.35	7.14	0.00	0.95	3.53	7.54	55.86
1978	3.67	0.91	0.28	8.21	11.29	6.44	9.54	6.91	0.00	3.35	4.84	7.24	62.73
1979	3.39	1.38	0.25	12.84	14.97	6.26	10.12	7.40	0.00	3.35	6.63	5.34	71.98
1980	3.15	1.32	0.28	10.16	8.12	8.37	6.82	6.10	0.00	3.35	6.03	6.42	60.12

Table 2-5 Water Demand of Nong Pla Lai Irrigation Area (Cropping Intensity 140%)

WATER YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1968	3.33	0.56	0.00	12.35	11.59	9.38	9.48	6.63	0.00	0.33	3.57	3.00	60.28
1969	2.65	0.44	0.51	10.33	8.56	5.92	5.72	5.55	0.00	0.72	1.14	3.48	45.09
1970	1.39	0.47	0.27	12.69	8.67	7.19	9.48	5.21	0.00	2.23	4.07	4.39	56.32
1971	2.42	0.50	0.56	14.92	8.26	5.57	6.96	7.40	0.00	2.23	4.41	4.83	58.12
1972	1.42	0.96	0.29	15.83	14.77	3.21	10.46	4.86	0.00	1.73	4.41	3.38	61.37
1973	2.85	0.36	0.29	12.58	10.22	4.72	7.26	5.10	0.00	2.23	3.70	4.38	53.75
1974	1.41	0.45	0.46	14.56	9.49	4.19	0.00	5.87	0.00	0.65	4.41	3.64	45.17
1975	2.54	0.45	0.43	12.81	10.02	6.37	3.53	6.35	0.00	2.23	3.39	4.12	52.30
1976	2.24	0.48	0.61	17.24	6.47	7.21	5.19	6.41	0.00	1.72	4.41	4.83	56.87
1977	2.49	0.59	0.49	5.23	12.70	7.25	6.35	7.14	0.00	0.63	2.34	5.02	50.29
1978	2.44	0.60	0.28	8.21	11.29	6.44	9.54	6.91	0.00	2.23	3.22	4.82	56.04
1979	2.25	0.91	0.25	12.84	14.97	6.26	10.12	7.40	0.00	2.23	4.41	3.56	65.26
1980	2.10	0.88	0.28	10.16	8.21	8.37	6.82	6.10	0.00	2.23	4.02	4.28	53.45

Table 2-6 Water Demand of Nong Pla Lai Irrigation Area (Cropping Intensity 120%)

WATER YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1968	1.67	0.28	0.00	12.35	11.59	9.38	9.48	6.63	0.00	0.17	1.79	1.50	54.89
1969	1.33	0.22	0.51	10.33	8.56	5.92	5.72	5.55	0.00	0.36	0.57	1.74	40.87
1970	0.70	0.23	0.27	12.89	8.67	7.19	9.48	5.21	0.00	1.11	2.04	2.20	50.05
1971	1.22	0.25	0.56	14.92	8.26	5.57	6.96	7.40	0.00	1.11	2.21	2.42	50.92
1972	0.71	0.48	0.29	15.83	14.77	3.21	10.46	4.86	0.00	0.86	2.21	1.69	55.42
1973	1.43	0.18	0.29	12.58	10.22	4.72	7.26	5.10	0.00	1.11	1.85	2.19	46.99
1974	0.71	0.22	0.46	14.56	9.48	4.19	0.00	5.87	0.00	0.32	2.21	1.82	39.90
1975	1.27	0.22	0.43	12.80	10.02	6.37	3.53	6.35	0.00	1.11	1.70	2.06	45.94
1976	1.12	0.24	0.61	17.24	6.47	7.21	5.19	6.41	0.00	0.86	2.21	2.42	50.02
1977	1.25	0.29	0.49	5.23	12.70	7.25	6.35	7.14	0.00	0.31	1.18	2.51	44.75
1978	1.22	0.30	0.28	8.21	11.29	6.44	9.54	6.91	0.00	1.11	1.61	2.41	49.38
1979	1.13	0.46	0.25	12.84	14.97	6.26	10.12	7.40	0.00	1.11	2.21	1.78	58.58
1980	1.05	0.44	0.28	10.16	8.12	8.37	6.82	6.10	0.00	1.11	2.01	2.14	46.65

Table 4-1 Area and Discharge of Turnout

Block No.	Area (ha)	Turnout	Discharge (m^3/sec)	Lateral
B-1	92	T-1	0.247	
B-2	86	T-2	0.230	
B-3	21	T-3	0.056	
B-4	20	T-4	0.054	
B-5	218	T-5	0.584	L-1
B-6	87	T-6	0.233	L-2
B-7	125	T-7	0.335	
B-8	166	T-8	0.445	
B-9	92	T-9	0.247	
B-10	122	T-10	0.327	
B-11	163	T-11	0.437	
B-12	115	T-12	0.308	
B-13	63	T-13	0.169	L-3
B-14	30	T-14	0.080	L-4
B-15	185	T-15	0.496	L-5
B-16	150	T-16	0.402	
B-17	148	T-17	0.397	L-6
B-18	83	T-18	0.222	L-7
B-19	137	T-19	0.367	
B-20	116	T-20	0.311	
B-21	749	T-21	2.007	L-8
B-22	68	T-22	0.182	L-9
B-23	194	T-23	0.520	L-10
B-24	165	T-24	0.442	L-11
B-25	260	T-25	0.697	L-12

Table 5-1 Financial Cost (Irrigation)

1US$ = 23¥ = ≒230

Item	Q'ty	Unit	Total Million US$		
			Total	F.C	L.C
1. Main Civil Works					
1.1 Diversion Weir	1	L.S	0.07	0.02	0.05
1.2 Main Canal	46.2	km	6.10	2.49	3.61
1.3 Lateral Canal	20.15	km	0.68	0.27	0.41
1.4 Drainage Canal	6.45	km	0.22	0.13	0.09
(Sub-Total)			(7.07)	(2.91)	(4.16)
2. Land Acquisition			0.41	-	0.41
2.1 Irrigation System	1,819	rai			
2.2 Drainage System	88	rai			
3. Engineering Service	1	L.S	1.79	1.56	0.23
4. Contingencies					
4.1 Physical Cont. (15%)	1	L.S	1.38	0.67	0.71
4.2 Price Cont.	1	L.S	5.14	1.61	3.53
Total			15.79	6.75	9.04
5. Interest during Construction (3%)	1	L.S	0.26	0.26	-
Grand Total			16.05	7.01	9.04

Table 5-2 Disbursement Schedule of Financial Cost (Irrigation)

1US$ = 23¥ = 230₹

Item	Total Million US$			1983		1984		1985		1986	
	Total	F.C	L.C	F.C	L.C	F.C	F.C.	F.C	F.C	F.C	F.C
1. Main Civil Works	7.07	2.91	4.16			0.19	0.28	1.15	1.66	1.57	2.22
2. Land Acquisition	0.41	-	0.41			-	0.16	-	0.25	-	-
2.1 Irrigation System											
2.2 Drainage System											
3. Engineering Service	1.79	1.56	0.23	0.65	0.09	0.37	0.04	0.27	0.05	0.27	0.05
4. Contingencies											
4.1 Physical Cont. (15%)	1.38	0.67	0.71	0.10	0.01	0.08	0.07	0.21	0.29	0.28	0.34
4.2 Price Cont.	5.14	1.61	3.53	0.11	0.03	0.14	0.22	0.51	1.29	0.85	1.99
Total	15.79	6.75	9.04	0.86	0.13	0.78	0.77	2.14	3.54	2.97	4.60
5. Interest during Construction (3%)	0.26	0.26	-	0.01	-	0.03	-	0.07	-	0.15	-
Grand Total	16.05	7.01	9.04	0.87	0.13	0.81	0.77	2.21	3.54	3.12	4.60

Table 5-3 Economic Cost (Irrigation)

1US$ = 23¥ = 230₩

Item	Q'ty	Unit	Total Million US$		
			Total	F.C	L.C
1. Main Civil Works					
1.1 Diversion Weir	1	L.S	0.07	0.02	0.03
1.2 Main Canal	46.2		4.75	2.49	2.26
1.3 Lateral Canal	20.15	km	0.53	0.27	0.26
1.4 Drainage Canal	6.45	km	0.19	0.13	0.06
(Sub-Total)			(5.52)	(2.91)	(2.61)
2. Land Acquisition					-
2.1 Irrigation System	1,819	rai			
2.2 Drainage System	88	rai			
3. Engineering Service	1	L.S	1.79	1.56	0.23
4. Contingencies					
4.1 Physical Cont. (15%)	1	L.S	1.09	0.67	0.42
Total			8.40	5.14	3.26

Table 5-4 Disbursement Schedule of Economic Cost (Irrigation)

1US$ = 23¥ = ₩230

Item	Total Million US$			1983		1984		1985		1986	
	Total	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C
1. Main Civil Works	5.52	2.91	2.61			0.19	0.17	1.15	1.04	1.57	1.40
2. Land Acquisition			-				-		-		
2.1 Irrigation System											
2.2 Drainage System											
3. Engineering Service	1.79	1.56	0.23	0.65	0.09	0.37	0.04	0.27	0.05	0.27	0.05
4. Contingencies											
4.1 Physical Cont. (15%)	1.09	0.67	0.42	0.10	0.01	0.08	0.03	0.21	0.16	0.28	0.22
Total	8.40	5.14	3.26	0.75	0.10	0.64	0.24	1.63	1.25	2.12	1.67

Fig. 2-1 Measuring Site of Percolation

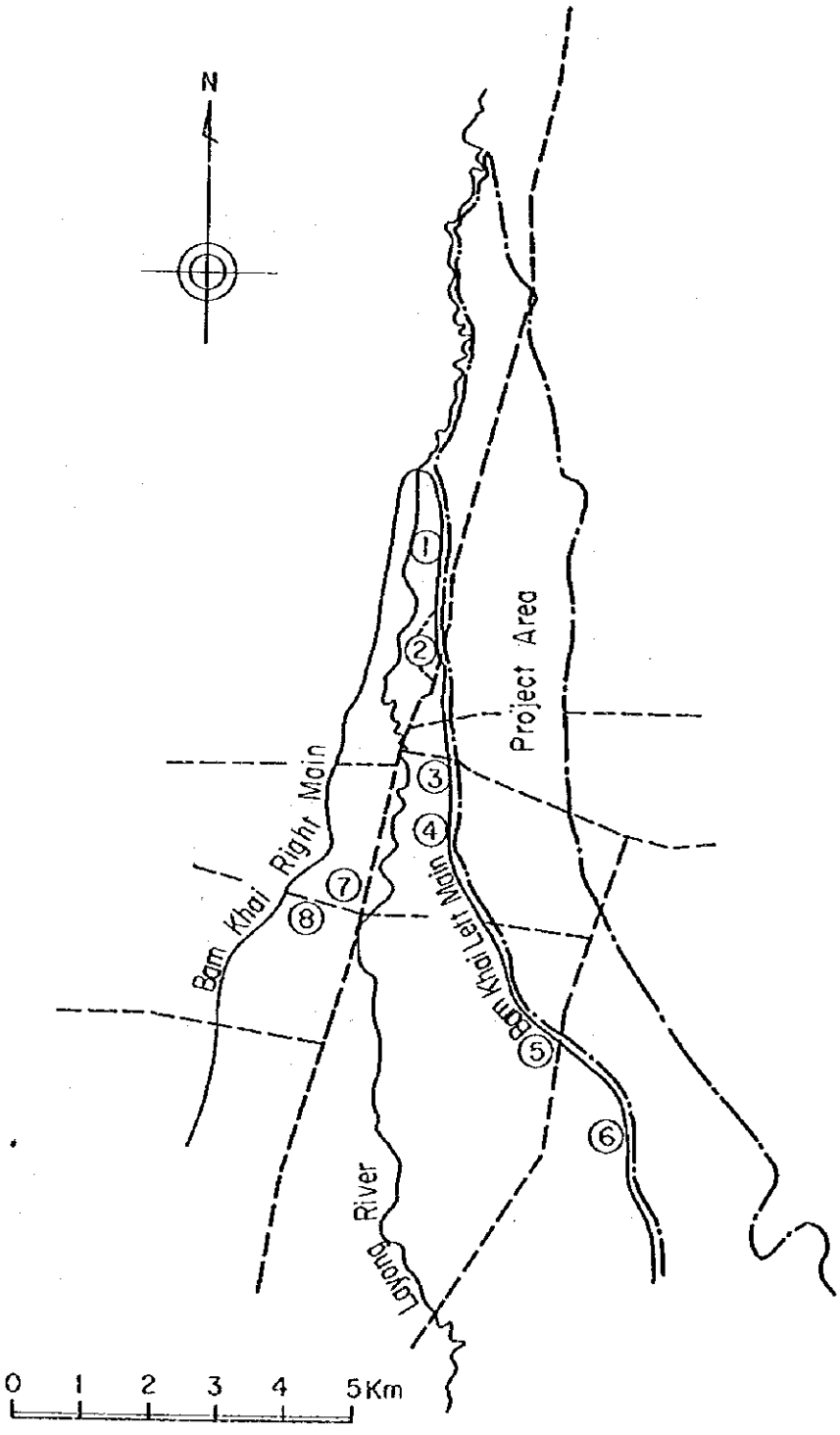


Fig. 2-2 Proposed Cropping Pattern

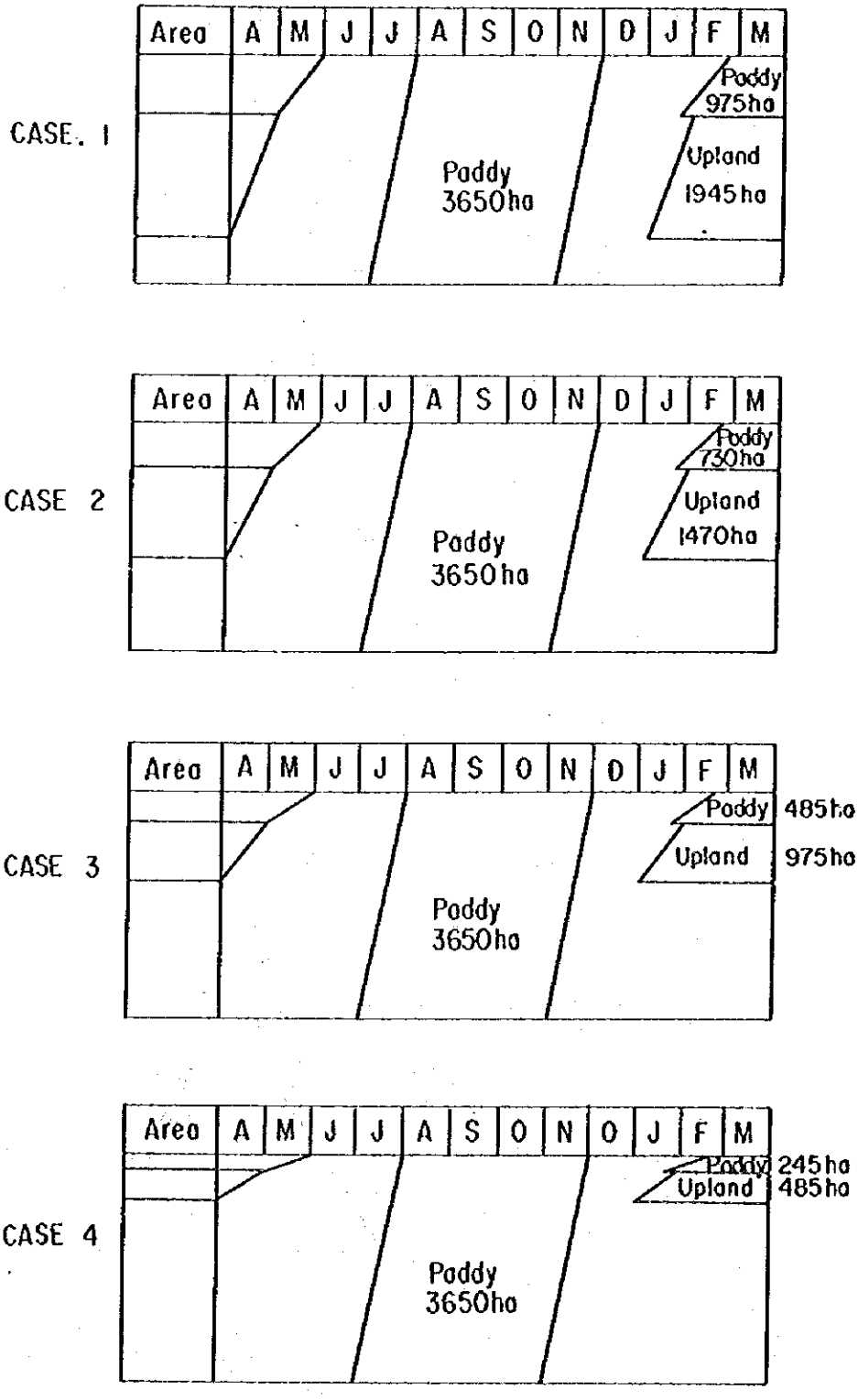


Fig. 3-1 General Plan of Irrigation and Drainage System

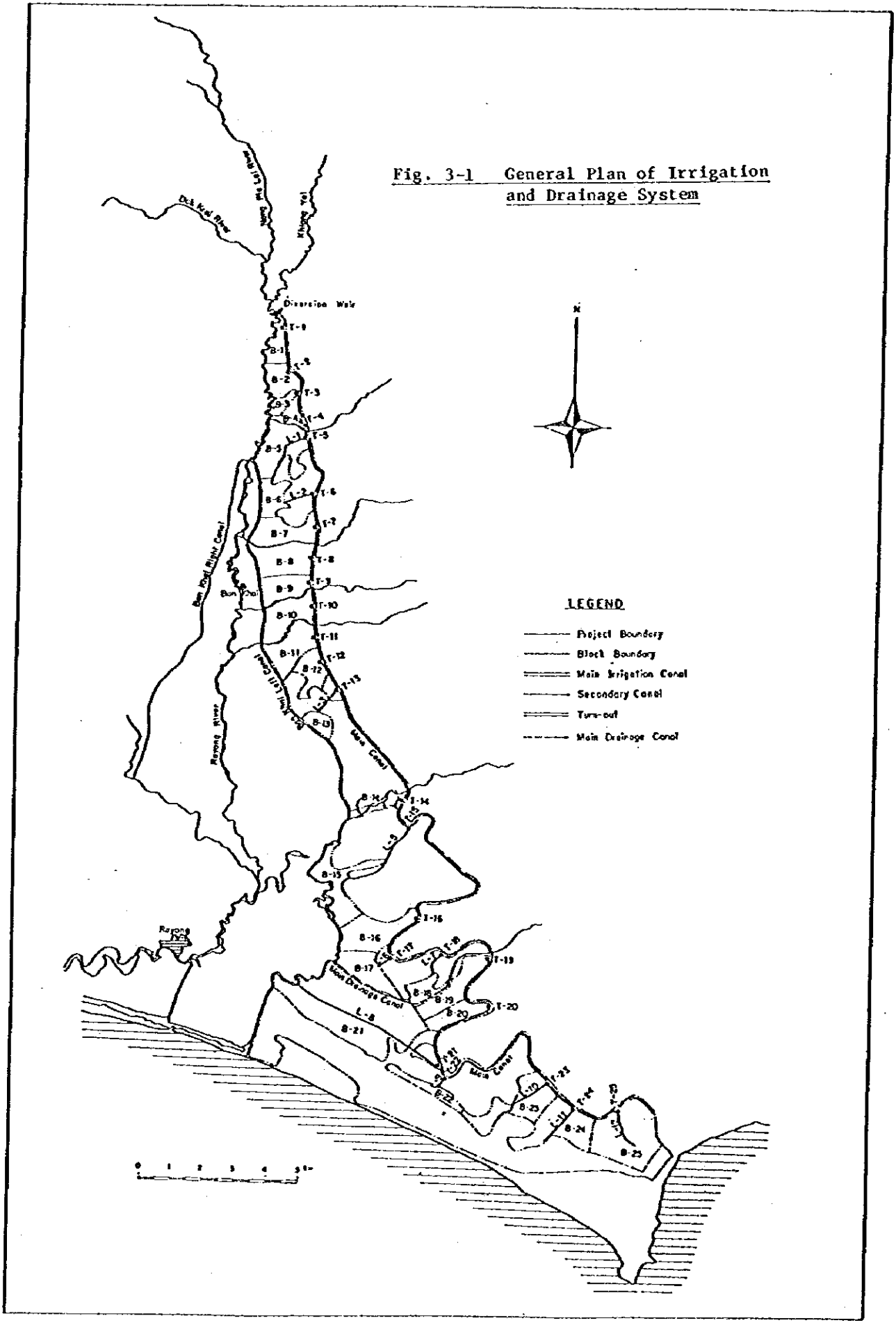


Fig. 4-1 Longitudinal Profile of Main Irrigation Canal

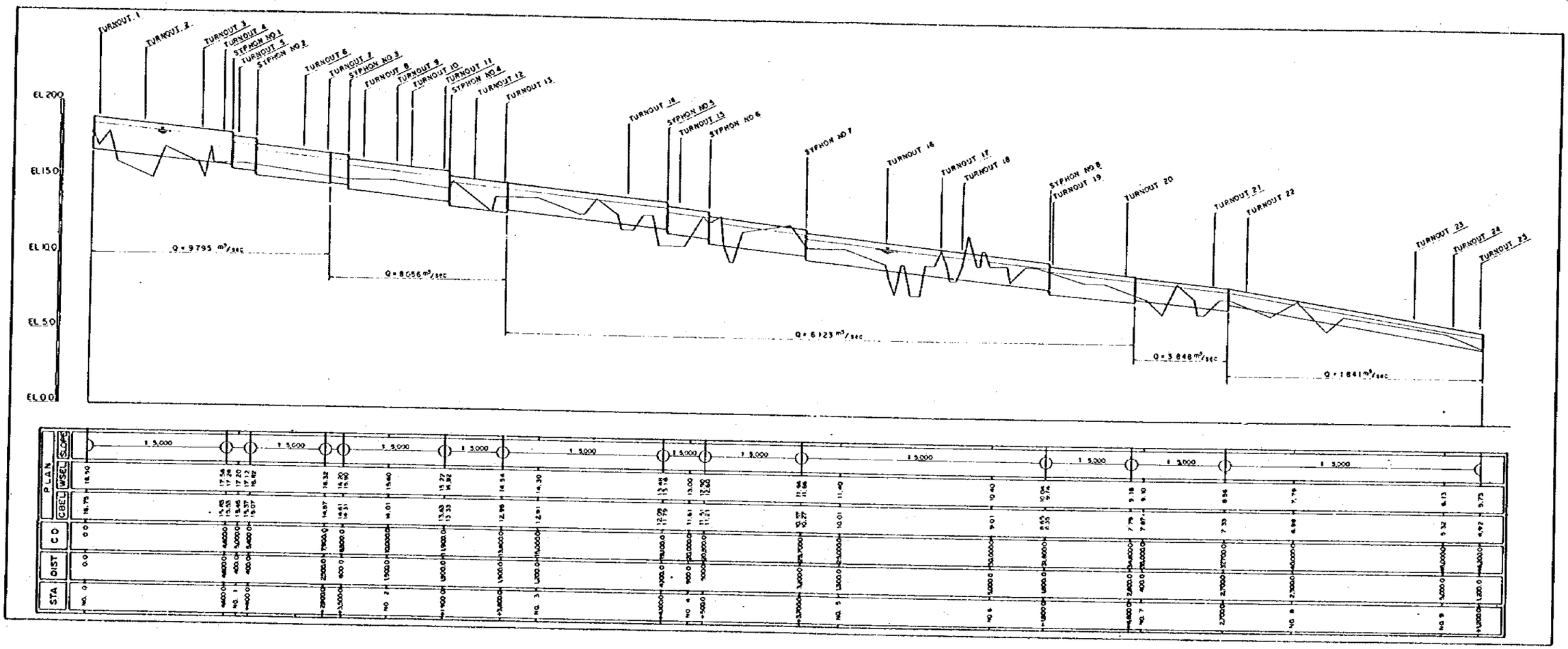
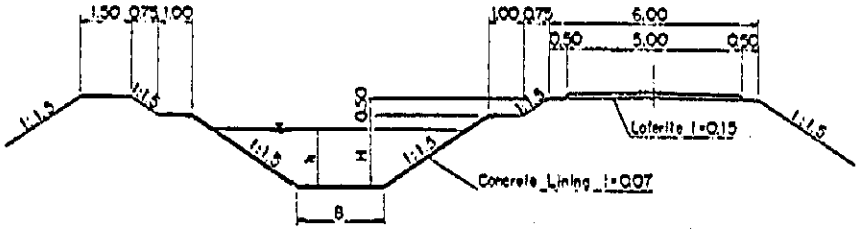


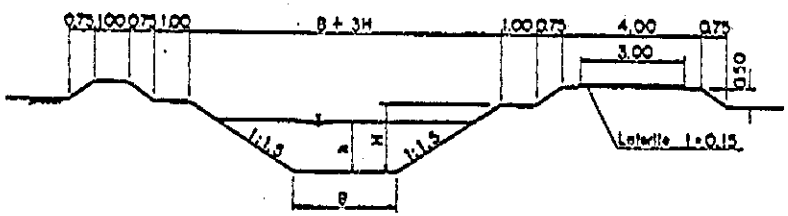
Fig. 4-2 Standard Cross Section and Dimension of Irrigation and Drainage Canals



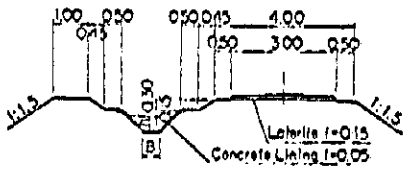
Standard Cross Section of Main Canal

Dimension Table of Main Canal

Length (km)	Discharge (m³/sec)	Slope	h (m)	B (m)	H (m)
7.9	9.795	1/5,000	1.75	2.80	2.15
5.9	8.056	1/5,000	1.59	2.80	1.99
20.6	6.123	1/5,000	1.39	2.80	1.79
3.1	3.848	1/5,000	1.23	2.00	1.53
6.5	1.841	1/3,000	0.81	1.60	1.11



Standard Cross Section of Drainage Canal



Standard Cross Section of Secondary Canal

Dimension Table of Secondary Canal

Lateral No.	Length (km)	Discharge (m³/sec)	Slope	h (m)	B (m)
L-1	1.75	0.584	1/600	0.45	0.50
L-2	0.80	0.233	1/800	0.40	0.40
L-3	1.05	0.169	1/500	0.30	0.40
L-4	0.40	0.080	1/800	0.25	0.30
L-5	3.35	0.496	1/500	0.40	0.50
L-6	0.60	0.397	1/800	0.40	0.50
L-7	1.00	0.222	1/800	0.35	0.40
L-8	5.35	2.007	1/1,200	0.90	1.00
L-9	0.45	0.182	1/800	0.35	0.40
L-10	2.10	0.520	1/800	0.50	0.50
L-11	1.65	0.442	1/800	0.50	0.50
L-12	1.65	0.697	1/600	0.50	0.60

Dimension Table of Drainage Canal

Length (km)	Discharge (m³/sec)	Slope	h (m)	B (m)	H (m)
3.40	14.2	1/700	1.80	4.0	2.20
3.05	20.4	1/1,000	2.03	6.0	2.50

X . PROJECT ECONOMY

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1. ECONOMIC EVALUATION

1.1 ECONOMIC COST ESTIMATION

Based on the preliminary designs, the economic construction cost was estimated in such a manner that all taxes, insurance cost, and compensation have been deducted. Estimation of costs required for equipment and engineering services, which are to be procured by international competitive bidding, is based on the international price levels. As to the labor cost, 70% of unskilled labor cost and 100% of skilled labor cost of the financial estimation has been adopted. Financial price has been adopted for the engineering service. Physical contingency of 10% and 15% has been considered for the water transmission system and other sectors, respectivelt. No price contingency is included. All economic prices shown are in February, 1981 fixed price.

Nong Pla Lai Sub-Project

For pipeline, three routes of Dok Krai - Mab Ta Pud, Mab Ta Pud - Sattahip, and Dok Krai - Laen Chabang are adopted as base case. The economic costs of Nong Pla Lai Sub-Project are shown below:

1) Construction Cost

The total economic construction cost is estimated to be 140.36 million US$, which can be classified by work item as follows:

Work Item	Cost (million US$)
Nong Pla Lai Dam	35.58
Water Transmission System	92.79
Irrigation and Drainage System	8.40
Land Consolidation	3.59
Total	140.36

Annual disbursement of the cost is presented in Tables 1-1 and 1-2 by work item.

2) Cost Allocation of Dam Construction Cost

The dam construction cost has been allocated by means of "Separable Cost - Remaining Benefit Method", as shown below:

Sector	Cost (million US$)
Flood Control	4.91
Industrial and Municipal Water	21.35
Irrigation	9.32
Total	35.58

3) Cost Estimate by Sector

Based on the above allocation of the dam construction cost, the total project economic cost can be further classified by each sector as follows:

Sector	Cost (million US$)
Flood Control	4.91
Water Transmission System	114.14
Irrigation	21.31
Total	140.36

4) Operation and Maintenance Cost

Operation and maintenance cost of Nong Pla Lai Dam and irrigation system is estimated to be 0.18 and 0.08 million US$ per year, respectively.

For pipeline (Dok Krai -- Mab Ta Pud -- Sattahip, Dok Krai -- Laem Chabang), operation and maintenance cost is estimated to be 1.41 million US$ at full operation. This cost mainly consists of electricity cost of motors for pumping up the water.

Ban Bung Sub-Project

1) Construction Cost

The economic cost of Ban Bung Sub-Project which consists of only Ban Bung Dam is estimated at 14.23 million US$, whose annual disbursement is given in Table 1-1.

2) Allocation of Dam Construction Cost

In the same method as the Nong Pla Lai dam, the construction cost of Ban Bung dam can be allocated as follows;

Sector	Cost (million US$)
Flood Control	0.28
Industrial and Municipal Water	13.95
Total	14.23

3) Operation and Maintenance Cost

Operation and maintenance cost of Ban Bung Dam is estimated to be 0.10 million US$ per year.

1.2 BENEFIT ESTIMATION

Value of Municipal and Industrial Water

Economic value has to be assigned to municipal and industrial water developed by the project to estimate the project benefit, although it is quite difficult to quantify the value in monetary terms.

In this study, the unit water value is assumed to be 5.0 ฿/m^3 for Nong Pla Lai sub-project and 7.0 ฿/m^3 for Bang Bung Dam Sub-Project, which has been arrived at from the unit cost estimated under the condition that the cost covers all the capital cost including an interest of 9% per annum/1 and OM cost.

Nong Pla Lai Sub-Project

1) Municipal and Industrial Water

The direct benefit is calculated by multiplying the unit value with the water consumption volume.

Table 1-3 shows the annual water demand and benefit based on the water consumption volume by each year that has been already studied in Section 2.2 of Water Resources Development in Supporting Report.

The benefit for industrial and municipal water will be estimated to be 17.36 million US$/year in full operation stage in 1995 and thereafter.

2) Irrigation Benefit

The water developed by the proposed Nong Pla Lai dam would be put to use for increment of paddy and groundnuts production. After the completion of the project, paddy production in a wet season will be much more assured than the present, and it will become possible to newly produce paddy and groundnuts in a dry season in areas of 975 ha and 1,945 ha, respectively.

Irrigation benefit is defined as an increase of net production value under the with- and without-the-project conditions. The net production value without the project would remain at approximately 41.32 million/B (1.80 million US$). On the other hand, the net projection value with the project will reach 120.36 million/B in a year (5.23 million US$), as detailed in Tables 1-4 to 1-6.

Note /1 This rate is generally applied to the loan of international banking facilities such as IBRD and ADB.

The benefit in the year 1993 (at the time the benefit comes up to full value) turns to be 79.04 million ฿ (3.44 million US$). Assuming that the volume of water supply is 69.4 MCM, the benefit will be 1.14 ฿/m^3 (0.05 US$/$m^3$).

3) Flood control

The economic benefit by the flood control is as stated before, 6.2 milion ฿ (0.27 million US$) on the annual average.

Ban Bung Sub-Project

1) Industrial and Municipal Water

The direct benefit will be estimated by multiplying the water value with volume of supplied water.

Table 1-7 shows the annual water supply and benefit.

The benefit for industrial and municipal water will be 2.04 million US$/year after 2000.

2) Flood Control

The economic benefit by the flood control is 0.32 million ฿ (0.01 million US$) on the annual average.

Indirect Benefit

1) Promotion of industrial development

Major industrial projects such as gas separation & petrochemical plant, soda ash plant, chemical fertilizer plant, sponge iron plant, industrial estate, deep sea port, etc. are planned to be implemented in the East Coast area in the future. This project will supply essential industrial water to these industrial projects, and will promote industrial development in this area.

2) Improvement of living standard

The population subject to new supply of municipal water by two sub-projects would total 250,000 to 300,000 persons, with expected per capita consumption of 320 l/day by 1993.

The present per capita water consumption of 220 l/day, therefore, would be enhanced by 100 l/day which is a substantial amount resultant to the improvement of living in the future.

Furthermore, the pervasion of waterworks being very limited in Ban Bung area, the supply is so unstable that the houses receiving the service have to have their own rain catcher and/or tank.

In the drought period of 1979-80, water tank lorries carried water to inhabitants almost daily. In the severest condition of drought days, the people themselves would go over to the water purification plant to dare unauthorized tapping. Stabilizing water supply to such area would undoubtedly bring about the betterment of the inhabitants' well-being.

3) Land enhancement by flood control

The mitigation of flood in the area will bring about more effective use of land in the future.

1.3 ECONOMIC EVALUATION

Evaluation of the project was made by means of calculating Internal Rate of Return on the basis of the estimated benefit and economic cost.

Nong Pla Lai Sub-Project

The Internal Rate of Return (IRR) of the Nong Pla Lai Sub-Project is calculated at 10.5%.

Internal Rate of Return has been further calculated for each sector based on cost estimate by sector which results in the following percentages.

Sector		IRR (%)
Industrial and Municipal Water	:	10.4
Irrigation	:	12.1
Flood Control	:	3.5
The Project	:	10.5

Ban Bung Sub-Project

From the economic cost and benefit calculated previously, the relation between cost and benefit of the industrial & municipal water supply at dam site and flood control are studied. The IRR of each sector is as follows;

Sector		IRR (%)
Industrial and Municipal Water	:	8.3
Flood Control	:	2.9
The Project	:	8.2

1.4 SENSITIVITY ANALYSIS

Sensitivity analysis to identify the IRR's change in response to the changes of factors such as construction cost, and delay of water demand has been done. Changing factors of each case and the results of IRR calculation are shown in Tables 1-8 and 1-9.

Nong Pla Lai Sub-Project

1) Construction cost

In response to 10% and 20% increase of construction cost, IRR would decrease to 9.5% and 8.7%, respectively.

2) Delay of Water Demand by 10 years

In case that the occurrence of water demand is assumed to be delayed by 10 years from the year 1995, benefit would decrease according to the delay. Consequently, IRR would be 8.6%, which is 1.9% less than the base case. Careful planning is therefore necessary to avoid providing a possible over-capacity beyond the actual water demand in this case.

Ban Bung Sub-Project

1) Construction cost

In response to 10% and 20% increase of construction cost, IRR would decrease to 7.6% and 7.0%, respectively.

2) Delay of Water Demand by 10 years

In case that the occurrence of water demand is assumed to be delayed by 10 years from the year 2000, benefit would decrease according to the delay. Consequently, IRR would be 7.0%, which is 1.2% less than the base case.

2. FINANCIAL EVALUATION

2.1 FINANCIAL BACKGROUND OF THE PROJECT

In Thailand, Royal Irrigation Department is in charge of the construction of dam and irrigation system financed by national budget, but as a matter of custom, the collection of water tariff from farmers or land-owners for the irrigation water supply service is not carried out. The collection of water tariff is opposed by the National Assembly for the reason that the farmers do still not have the solvency, and present situation seems unlikely to be changed in the near future. Therefore, financial analysis for the development of irrigation water system is impossible.

On the other hand, the collection of water tariff for industrial and municipal water is put into practice. Therefore, the financial analysis of the pipeline and dam can afford to be discussed.

2.2 WATER TARIFF

2.2.1 Basic Conditions

Water tariff has to be determined to estimate the revenue from the project. Concerning the water tariff provided from Nong Pla Lai Dam and Ban Bung Dam, the three conditions below should be taken into account.

1) Present water tariff

2) All the construction cost and operation and maintenance cost should be covered, or 10% of the construction cost and all the OM cost should be covered.

3) The water tariff should not exceed 5% of the household income of the people in these provinces.

The latter part of the condition 2) and the condition 3) are taken from "Village Water Supply" World Bank Paper, March 1976.

In this project, the above three conditions need be taken into account and reflected upon the setting up of the water tariff.

Present Water Tariff

As is shown in Table 2-1, for the present water tariff, 2 - 3 B/m^3 in Chonburi province and 2 - 4 B/m^3 in Rayong province are adopted, respectively.

For both provinces, PWWA adopts 2 B/m^3 and Local Authority adopts 2 - 4 B/m^3.

According to PWWA Regional 1 office, which covers the five eastern provinces, the present water tariff of 2 B/m^3 does not even cover the OM cost, so that it is out of the question to cover the construction cost of a new development. 5 - 7 B/m^3 can be considered as the appropriate water tariff.

Water Supply Cost

In this project, the water supply cost estimated from the construction cost of Nong Pla Lai Dam and the pipeline, and OM cost, results as followings.

Water Cost (B/m^3)

	Receiving Well	Distribution	User
Interest rate: 3%			
Covering all the construction cost and OM cost			
Industrial	2.98	-	2.98
Municipal	2.98	2.50	5.48
Covering 10% of the construction cost and all the OM cost			
Industrial	1.56	-	1.56
Municipal	1.56	2.50	4.06
Interest rate: 9%			
Covering all the construction cost and OM cost			
Industrial	5.00	-	5.00
Municipal	5.00	2.50	7.50
Covering 10% of the construction cost and all the OM cost			
Industrial	3.55	-	3.55
Municipal	3.55	2.50	6.05

Note: The distribution cost is assumed to be 2.50 B/m^3.

Per Capita Household Income (Current price)

Per capita income in the central area has been studied as given below to estimate the per capita household income in the project area.

	Per capita GNP	Household income (Central area)		Per capita household income (Central Area)	
		MA	MA - SD	MA	MA - SD
75	7.132	39.852	32.217	7.814	6.317
78	10.502	58.730*	47.580*	11.520	9.310*
81	15.490*	86.560*	67.970*	16.970*	13.720*

Notice: * ..... Estimation
MA ..... Municipal area
MA - SD ..... Area between municipal area and sanitary district

Source: Per capita GNP ..... Monthly bulletin, Bank of Thailand
Household income ..... Income, Consumption and Poverty in Thailand 1962/63 to 1975/76

It is assumed that Chonburi province is almost equal to MA - SD in Central area, and Rayong province is almost equal to 56% of Chonburi province. The per capita household income in these two provinces in 1981 are as follows:

Chonburi province	13,720 ฿ (597 US$)
Rayong province	7,683 ฿ (334 US$)

Per Capita Water Consumption Volume

In this report, per capita water consumption rate of 349 l/day in Chonburi province and 220 l/day in Rayang province are used for the estimation of water demand in these two provinces. These rates include not only domestic use but also factory and office uses. When only domestic use is considered, it seems to be appropriate that per capita water consumption rate should decrease to 150 l/day in Chonburi and Rayong.

Consequently, upper limits of water tariff to cover 5% of household income in these two provinces are estimated to be as follows:

Chon Buri : $13{,}720^{B} \times 0.05/365 \text{ day}/150^{l} \times 1000 = 12.5 ฿/m^3$ (0.543 US$/m^3$)

Rayong : $7{,}683^{B} \times 0.05/365 \text{ day}/150^{l} \times 1000 = 7.0 ฿/m^3$ (0.304 US$/m^3$)

Namely, it is needed that tariff of domestic water supplied from Nong Pla Lai Dam should be below 7.0 ฿/m^3.

2.2.2 Set-up of Water Tariff

To set up the water tariff, it is desirable that the results of the above study should be entirely fulfilled.

Foreign capital sources and their loan conditions for this project are expected as follows.

	Interest rate	Term of repayment	Grace period
OECF	3.00%	30 years	10 years
IBRD	9.25	20	5
ADB	9.25	20	5

Foreign capital source for this project is not decided yet, but for the calculation of water cost, it seems to be safer to presuppose IBRD or ADB that requires stricter conditions, as a loan source. Though the interest rate of loan from IBRD and ADB sometimes fluctuates according to the raising conditions of the money source, it is fixed at 9% in this project.

Considering all these results, the case which covers 10% of construction cost and all the OM cost with interest rate of 9% seems to fulfill all these conditions. The water tariff is assumed to be as follows:

	Receiving Well	User
Industrial	3.5 B/m^3 (0.152 US$/$m^3$)	3.5 B/m^3 (0.152 US$/$m^3$)
Municipal	3.5 B/m^3 (0.152 US$/$m^3$)	6.0 B/m^3 (0.261 US$/$m^3$)

So, we set up the above data as the water tariff in this project. But, tariff structure should be reconsidered by Government of Thailand before the commencement of the operation.

2.3 FINANCIAL PROJECTIONS

For the financial analysis of industrail and municipal water supply system, financial projections are set up as follows.

Nong Pla Lai Sub-Project

1) Total Capital Requirement

According to the cost allocation, the construction cost of the dam for industrial and municipal water supply claims 60% of the construction cost of Nong Pla Lai Dam. The construction cost of the pipeline includes the routes of Dok Krai -Mab Ta Pud - Sattahip, and Dok krai - Laem Chabang. The total capital requirement will be 175.31 million US$, with 61.1% (102.89 million US$) of foreign portion and 38.9% (65.97 million US$) of local portion, as summarized below.

		Foreign Currency	Local Currency	Total
Dam (for ind.)	(mil. US$)	17.91	22.02	39.93
Pipeline	(mil. US$)	88.37	47.01	135.38
Total	(mil. US$)	106.28	69.03	175.31

The annual disbursement of the total financial project cost is presented in Table 2-2.

2) Water Tariff

The water tariff is set up at 3.5 B/m^3 (0.152 US$/$m^3$) for both industrial and municipal water. This tariff has been determined through the considerations of capital cost recovery and the houshold income, as studied in details.

3) Depreciation and Operation and Maintenance Cost

37 years will be adopted as an average depreciation period of dam and pipeline. Operation and maintenance cost is shown below at the time of full operation (after 1994.)

Dan	180,000 US$/year
Pipeline	1,410,000 US$/year

4) Loan Condition of Foreign Capital

The loan condition of foreign capital is assumed as below.

Interest rate	:	3%
Term of repayment	:	30 years
Grace period	:	10 years

Note; The conditions above are of the case of OECF.

Ban Bung Sub-Project

1) Total Capital Requirement

The construction cost of Ban Bung dam is allocated by 98% to the sector of industrial and municipal water supply. The total capital requirement for this sector is estimated at 23.12 million US$, which is composed of 12.22 million US$ of foreign currency (52.8%) and 10.9 million US$ of local currency (47.2%). The annual disbursement of the total financial project cost is presented in Table 2-2.

2) Water Tariff

The water tariff is set up, same as Nong Pla Lai Sub-Project, at 3.5 ฿/m^3 (0.152 US$/$m^3$) for both industrial and municipal water. This tariff has been determined through the considerations of capital cost recovery and the houshold income, as studied in details.

3) Depreciation and Operation and Maintenance Cost

37 years will be adopted as an average depreciation period of dam and pipeline. Operation and maintenance cost is 100,000 US$/year at the time of full operation (after 2000).

4) Loan Condition of Foreign Capital

The loan condition of foreign capital is assumed to be same as Nong Pla Lai Sub-Project.

2.4 FINANCIAL ANALYSIS

Nong Pla Lai Sub-Project

1) Income statement

Tables 2-3-(1) and (2) show the income statement based on the financial conditions. The revenue will accrue from 1984 when water supply is to be started. From 1987 both interest and depreciation will start to be counted so that the profit will show a sharp decrease but thereafter it will gradually continue to increase. As the repayment of foreign currency will end by 2023, from 2024 annual profit will constantly be 7.21 million US$.

2) IRR Calculation

The calculation of Internal Rate of Return based on the Cash Flow (see Table 2-4) would be shown below.

IRR = 4.9%

Therefore, for Nong Pla Lai dam (for municipality and industry) and the pipeline, it is desirable to induce the capital with an interest rate of 4.9% or less.

Ban Bung Sub-Project

1) Income statement

Tables 2-5-(1) and (2), show the income statement based on the financial. The revenue will accrue from 1987 when water supply is to be started. From 1990 both interest and depreciation will start to be counted so that the profit will show a sharp decrease but thereafter it will gradually continue to increase. As the repayment of foreign currency will end by 2017, from 2018 annual profit will constantly be 0.25 million US$.

2) IRR Calculation

The financial IRR of Ban Bung Sub-Project is calculated to be 1.8% (see Table 2-6).

2.5 SENSITIVITY ANALYSIS

In the sensitivity analysis, it has been studied how a change in each single factor, namely water tariff, construction cost and water demand will affect IRR. Tariff factor is especially affective to IRR.

Sensitivity analyses for Nong Pla Lai and Ban Bung Sub-Projects are summarized in Tables 2-7 and 2-8.

Table 1-1 Annual Disbursement of the Economic Project Cost

Unit : million US$

Item	Total			1982		1983		1984		1985		1986	
	L.C.	F.C.	Total	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.
I. Nong Pla Lai Sub-Project													
1. Nong Pla Lai Dam	13.62	21.96	35.58	-	-	1.28	2.19	3.90	3.05	6.24	10.84	2.20	5.88
2. Water Transmission System*	27.55	65.24	92.79	0.21	1.42	7.45	21.29	4.58	14.59	8.42	16.70	6.89	11.24
3. Irrigation and Drainage System	3.26	5.14	8.40	-	-	0.10	0.75	0.24	0.64	1.25	1.63	1.67	2.21
Sub-Total (1-3)	44.43	92.34	136.77	0.21	1.42	8.83	24.23	8.72	18.28	15.91	29.17	10.76	19.24
II. Ban Bung Sub-Project	4.86	9.37	14.23	-	-	0.55	1.81	1.31	1.51	2.25	4.50	0.75	1.55
Total	49.29	101.71	151.00	0.21	1.42	9.38	26.04	10.03	19.79	18.16	33.67	11.51	20.79

NOTE * : This cost covers the pipeline route of Dok Krai - Mab Ta Pud, Mab Ta Pud - Sattahip and Dok Krai - Laem Chabang

Table 1-2 Economic Cost of Land Consolidation of Nong Pla Lai Irrigation Area

Unit in million US$

	Total	1985	1986	1987	1988
1. Base Cost	3.00	0.35	1.00	1.00	0.65
2. Engineering Service	0.12	0.01	0.04	0.04	0.03
3. Compensation	-	-	-	-	-
4. Contingency	0.47	0.04	0.17	0.17	0.09
5. Total	3.59	0.40	1.21	1.21	0.77

Table 1-3 Water Supply and Benefit (Nong Pla Lai Sub-Project)

Year	Water Supply (MCM)	Benefit (1,000 US$)
1984	6.2	1,345
1985	16.7	3,624
1986	22.8	4,948
1987	50.2	10,893
1988	51.0	11,067
1989	51.8	11,241
1990	66.5	14,431
1991	67.5	14,648
1992	68.3	14,821
1993	69.4	15,060
1994	70.3	15,255
1995	80.0	17,360
1996		
1997		
1998		
1999		
2000		
2031	80.0	17,360

Table 1-4 Agricultural Production by Crop

	Production Volume (T/ha)	Economic Price (฿/T)	Production (฿/ha)	Cost (฿/ha)	Net Production (฿/ha)
Without Project					
Wet Season					
Paddy (L.V.)					
Present (1981)	1.44	5,500	7,700	2,278	5,422
Future (1992)	2.00	6,700	13,400	2,639	10,761
With Project (1992)					
Wet Season					
Paddy (H.Y.V.)	4.00	6,700	26,800	7,342	19,458
Dry Season					
Paddy (H.Y.V.)	4.50	6,700	30,150	8,671	21,479
Groundnuts	1.90	13,020	24,738	10,146	14,592

Table 1-5 Agricultural Net Production by Crop
(Cropping Intensity 180%)

	Plant Area (ha)	NP per ha (฿/ha)	Gross Production (1,000฿)
Without Project			
Wet Season			
Paddy (L.V.)			
Present (1981)	3,840	5,422	20,820
Future (1992)	3,840	10,761	41,322
With Project (1992)			
Wet Season			
Paddy (H.Y.V.)	3,650	19,458	71,022
Dry Season			
Paddy (H.Y.V.)	975	21,497	20,960
Groundnuts	1,945	14,592	28,381

Table 1-6 Price Structure of Rice/Paddy at Constant 1981 Prices

	1981		1990	
	Financial	Economic	Financial	Economic
Export price, 5% br.				
FOB Bangkok (US$/ton) /1	510	510	622	622
(B/ton)	10,200	10,200	12,444	12,444
Grade differential (86%) /2	8,770	8,770	10,700	10,700
Rice premium	1,000		1,220	
Export duty	440		540	
Municipal tax	15		18	
Reserve requirement loss	845		1,030	
Exporter's margin /3	440	305	536	370
Wholesaler's margin /3	210	145	256	177
Ex-mill price of rice	5,820	8,320	7,100	10,153
Ex-mill price of paddy	4,190	5,990	5,110	7,310
Tax	90		110	
Miller's margin /4	350	250	430	310
Input price of paddy at mill	3,750	5,740	4,570	7,000
Middleman's margin /3	350	240	430	300
Farm gate price of paddy	3,400	5,500	4,140	6,700

/1 : The World Bank prospect.
/2 : Average of exported white rice excluding parboiled rice over previous five years.
/3 : Conversion factor 0.69 is applied.
/4 : Conversion factor 0.72 is applied.

Table 1-7 Water Supply and Benefit
(Ban Bung)

	Water Supply (MCM)	Benefit (1,000 US$)
1987	1.8	547
88	2.3	699
89	2.7	821
90	3.1	942
91	3.3	1,003
92	3.6	1,094
93	4.0	1,216
94	4.3	1,307
95	4.7	1,429
96	5.1	1,550
97	5.5	1,672
98	5.9	1,794
99	6.3	1,915
2000	6.7	2,037
|	|	|
2031	6.7	2,037

Table 1-8 Sensitivity Analysis of Industrial and Municipal Water for Nong Pla Lai Sub-Project (Economic)

	Construction cost	Delay of Water Demand	IRR (%)
Base case			10.5
Case 1	10% up		9.5
Case 2	20% up		8.7
Case 3		10 years	8.6

Table 1-9 Sensitivity Analysis of Industrial and Municipal Water for Ban Bung Sub-Project (Economic)

	Construction cost	Delay of Water Demand	IRR (%)
Base case			8.2
Case 1	10% up		7.6
Case 2	20% up		7.0
Case 3		10 years	7.0

Table 2-1 Water Consumption in Chon Buri & Rayong PWWA System and Other Local Systems

Province	Water Works	Consumption m^3/year				Fare
		1977	1978	1979	1980	฿/m^3
Chonburi	Chonburi	10,858,727	11,478,293	11,610,306	12,033,720	2
	Panat Nikhom	390,264	414,566	263,677	264,019	2
	Ban Bung	141,593	105,129	120,603	85,367	2
	Na Klua	219,170	302,699	226,975	295,010	2
	Ao Udom *	n.a.	195,128	117,849	194,400	2
	Nong Yai*	n.a.	13,811	14,734	22,000	3
	Pan Thong*	n.a.	55,869	36,716	43,200	3
	Tambon Mie*	-	-	30,940	36,000	3
Rayong	Rayong	1,297,580	1,548,695	1,337,485	n.a.	2
	Prasae	-	-	39,125	155,594	2
	Pluak Daeng*	n.a.	11,614	15,082	14,680	3
	Ban Khai*	n.a.	23,873	25,495	27,152	3
	Ban Chang*	n.a.	61,249	51,267	61,883	4
	Ban Khuen*	n.a.	124,637	134,861	142,723	2

Note: * Operated by the local authority, others by PWA

Source: PWA

Table 2-2 Annual Disbursement of the Financial Project Cost

Unit : million US$

Item	Total			1982		1983		1984		1985		1986	
	L.C.	F.C.	Total	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.
I. Nong Pla Lai Sub-Project													
1. Nong Pla Lai Dam	36.70	29.85	66.55	-	-	3.42	2.54	10.43	3.83	16.37	14.56	6.48	8.92
2. Water Transmission System*	47.01	88.37	135.38	0.24	1.54	9.84	25.25	7.73	19.36	15.17	24.21	14.03	18.01
3. Irrigation and Drainage System	9.04	7.01	16.05	-	-	0.13	0.87	0.77	0.81	3.54	2.21	4.60	3.12
Sub-Total (1-3)	92.75	125.23	217.98	0.24	1.54	13.39	28.66	18.93	24.00	35.08	40.98	25.11	30.05
II. Ban Bung Sub-Project	11.12	12.47	23.59	-	-	1.02	2.09	2.55	1.92	5.52	6.08	2.03	2.38
Total	103.87	137.70	241.57	0.24	1.54	14.41	30.75	21.48	25.92	40.60	47.06	27.14	32.43

NOTE * : This cost covers the pipeline route of Dok Krai - Mab Ta Pud, Mab Ta Pud - Sattahip and Dok Krai - Laem Chabang

Table 2-3-(1) Income Statement for Industrial and Municipal Use (Nong Pla Lai Sub-Project) (1)

(Unit: 1000 Doller)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1. REVENUE	0.0	0.0	942.4	2538.4	3404.8	7630.4	7752.0	7873.6	10108.0	10260.0
WATER COMSUMPTION (1)	0.0	0.0	6.2	16.7	22.4	50.2	51.0	51.8	66.5	67.5
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	0.0	0.0	140.0	650.0	1040.0	1230.0	7465.8	7475.8	7775.8	7785.8
1) OPERATING & MAINTENANCE	0.0	0.0	140.0	650.0	1040.0	1230.0	1240.0	1250.0	1550.0	1560.0
2) INTEREST	0.0	0.0	0.0	0.0	0.0	0.0	2862.6	2862.6	2862.6	2862.6
ON LONG TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	2862.6	2862.6	2862.6	2862.6
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	0.0	0.0	0.0	0.0	0.0	0.0	3363.3	3363.3	3363.3	3363.3
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	0.0	0.0	802.4	1888.4	2364.8	6400.4	286.2	397.8	2332.2	2474.2

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. REVENUE	10381.6	10548.8	10685.6	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0
WATER COMSUMPTION (1)	68.3	69.4	70.3	80.0	80.0	80.0	80.0	80.0	80.0	80.0
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	7815.8	7805.8	7813.8	7780.3	7723.2	7637.6	7531.6	7425.6	7319.5	7213.5
1) OPERATING & MAINTENANCE	1590.0	1580.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
2) INTEREST	2862.6	2862.6	2860.6	2827.0	2770.0	2684.4	2578.3	2472.3	2366.3	2260.3
ON LONG TERM DEPOSIT	2862.6	2862.6	2860.6	2827.0	2770.0	2684.4	2578.3	2472.3	2366.3	2260.3
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	2565.8	2743.0	2871.8	4379.7	4436.8	4522.4	4628.4	4734.4	4840.5	4946.5

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. REVENUE	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0
WATER COMSUMPTION (1)	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	7107.5	7001.5	6895.5	6789.4	6683.4	6577.4	6471.4	6365.4	6259.3	6153.3
1) OPERATING & MAINTENANCE	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
2) INTEREST	2154.3	2048.2	1942.2	1836.2	1730.2	1624.1	1518.1	1412.1	1306.1	1200.1
ON LONG TERM DEPOSIT	2154.3	2048.2	1942.2	1836.2	1730.2	1624.1	1518.1	1412.1	1306.1	1200.1
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	5052.5	5158.5	5264.5	5370.6	5476.6	5582.6	5688.6	5794.6	5900.7	6006.7

Table 2-3-(2) Income Statement for Industrial and Municipal Use (Nong Pla Lai Sub-Project) (2)

(UNIT: 1000 DOLLAR)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1. REVENUE										
WATER COMSUMPTION (1)	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0
WATER COMSUMPTION (2)	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
WATER RATE (1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST										
1) OPERATING & MAINTENANCE	6047.3	5941.3	5835.2	5729.2	5623.2	5517.2	5411.2	5305.1	5199.1	5095.1
2) INTEREST	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
ON LONG TERM DEPOSIT	1094.0	988.0	882.0	776.0	670.0	563.9	457.9	351.9	245.9	141.8
ON SHORT TERM DEPOSIT	1094.0	988.0	882.0	776.0	670.0	563.9	457.9	351.9	245.9	141.8
3) DEPRECIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) OTHERS	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	6112.7	6218.7	6324.8	6430.8	6536.8	6642.8	6748.8	6854.9	6960.9	7064.9

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1. REVENUE										
WATER COMSUMPTION (1)	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0
WATER COMSUMPTION (2)	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
WATER RATE (1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST										
1) OPERATING & MAINTENANCE	5022.6	4973.7	4953.2	4953.2	4953.2	4953.2	4953.2	4953.2	4953.2	4953.2
2) INTEREST	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
ON LONG TERM DEPOSIT	69.4	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ON SHORT TERM DEPOSIT	69.4	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) OTHERS	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	7137.4	7186.3	7206.7	7206.7	7206.7	7206.7	7206.7	7206.7	7206.7	7206.7

Table 2-4 Cash Flow of Nong Pla Lai Sub-Project

Unit : 1000 US$

YEAR	CAPITAL COST	REVENUE	OPE. & TAX	BENEFIT
1982	1752.4	0.0	0.0	0.0
1983	37980.4	0.0	0.0	0.0
1984	33811.6	942.4	140.0	802.4
1985	53986.1	2538.4	650.0	1888.4
1986	37281.4	3404.8	1040.0	2364.8
1987	0.0	7630.4	1230.0	6400.4
1988	0.0	7752.0	1240.0	6512.0
1989	0.0	7873.6	1250.0	6623.6
1990	0.0	10108.0	1550.0	8558.0
1991	0.0	10260.0	1560.0	8700.0
1992	0.0	10381.6	1590.0	8791.6
1993	0.0	10548.8	1580.0	8968.8
1994	0.0	10685.6	1590.0	9095.6
1995	0.0	12160.0	1590.0	10570.0
2031	0.0	12160.0	1590.0	10570.0

Table 2-5-(1) Income Statement for Industrial and Municipal Use (Ban Bung Sub-Project) (1)

(Unit: 1000 Doller)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1. REVENUE										
WATER COMSUMPTION (1)	0.0	0.0	0.0	0.0	0.0	273.6	349.6	410.4	471.2	501.6
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	1.8	2.3	2.7	3.1	3.3
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST										
1) OPERATING & MAINTENANCE	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	1162.0	1162.0
2) INTEREST	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0
ON LONG TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	425.0	425.0
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	425.0	425.0
3) DEPRECIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	637.1	637.1
3. PROFIT	0.0	0.0	0.0	0.0	0.0	173.6	249.6	310.4	-690.8	-660.4

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. REVENUE										
WATER COMSUMPTION (1)	547.2	608.0	653.6	714.4	775.2	836.0	896.8	957.6	1018.4	1018.4
WATER COMSUMPTION (2)	3.6	4.0	4.3	4.7	5.1	5.5	5.9	6.3	6.7	6.7
WATER RATE (1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
1) OPERATING & MAINTENANCE	1162.0	1162.0	1162.0	1158.3	1151.2	1133.9	1112.6	1091.4	1070.1	1048.9
2) INTEREST	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ON LONG TERM DEPOSIT	425.0	425.0	425.0	421.2	414.1	396.8	375.5	354.3	333.0	311.8
ON SHORT TERM DEPOSIT	425.0	425.0	425.0	421.2	414.1	396.8	375.5	354.3	333.0	311.8
3) DEPRECIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) OTHERS	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1
3. PROFIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	-614.8	-554.0	-508.4	-443.9	-376.0	-297.9	-215.8	-133.8	-51.7	-30.5

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. REVENUE										
WATER COMSUMPTION (1)	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4
WATER COMSUMPTION (2)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
WATER RATE (1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
1) OPERATING & MAINTENANCE	1027.6	1006.4	985.1	963.9	942.6	921.4	900.1	878.9	857.7	836.4
2) INTEREST	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ON LONG TERM DEPOSIT	290.5	269.3	248.0	226.8	205.6	184.3	163.1	141.8	120.6	99.3
ON SHORT TERM DEPOSIT	290.5	269.3	248.0	226.8	205.6	184.3	163.1	141.8	120.6	99.3
3) DEPRECIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) OTHERS	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1
3. PROFIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	-9.2	12.0	33.3	54.5	75.8	97.0	118.3	139.5	160.7	182.0

Table 2-5-(2) Income Statement for Industrial and Municipal Use (Ban Bung Sub-Project) (2)

(UNIT: 1000 DOLLAR)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1. REVENUE										
WATER COMSUMPTION (1)	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4
WATER COMSUMPTION (2)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
WATER RATE (1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
1) ORERATING & MAINTENANCE	815.2	793.9	772.7	755.2	741.0	737.1	737.1	737.1	737.1	737.1
2) INTEREST	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ON LONG TERM DEPOSIT	78.1	56.8	35.6	18.1	3.9	0.0	0.0	0.0	0.0	0.0
ON SHURT TERM DEPOSIT	78.1	56.8	35.6	18.1	3.9	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) OTHERS	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1
3. PROFIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	203.2	224.5	245.7	263.2	277.4	281.3	281.3	281.3	281.3	281.3

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1. REVENUE										
WATER COMSUMPTION (1)	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4
WATER COMSUMPTION (2)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
WATER RATE (1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
1) ORERATING & MAINTENANCE	737.1	737.1	737.1	737.1	737.1	737.1	737.1	737.1	737.1	737.1
2) INTEREST	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ON LONG TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4) OTHERS	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1
3. PROFIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	281.3	281.3	281.3	281.3	281.3	281.3	281.3	281.3	281.3	281.3

Table 2-6 Cash Flow of Ban Bung Sub-Project

Unit : 1000 US$

YEAR	CAPITAL COST	REVENUE	OPE. & TAX	BENEFIT
1982	0.0	0.0	0.0	0.0
1983	3076.9	0.0	0.0	0.0
1984	4398.3	0.0	0.0	0.0
1985	11413.1	0.0	0.0	0.0
1986	4204.1	0.0	0.0	0.0
1987	0.0	273.6	100.0	173.6
1988	0.0	349.6	100.0	249.6
1989	0.0	410.4	100.0	310.4
1990	0.0	471.2	100.0	371.2
1991	0.0	501.6	100.0	401.6
1992	0.0	547.2	100.0	447.2
1993	0.0	608.0	100.0	508.0
1994	0.0	653.6	100.0	553.6
1995	0.0	714.4	100.0	614.4
1996	0.0	775.2	100.0	675.2
1997	0.0	836.0	100.0	736.0
1998	0.0	896.8	100.0	796.8
1999	0.0	957.6	100.0	857.6
2000	0.0	1018.4	100.0	918.4
2031	0.0	1018.4	100.0	918.4

Table 2-7 Sensitivity Analysis of Industrial and Municipal Water for Nong Pla Lai Sub-Project (Financial)

	Water tariff ($US\$/m^3$)	Construction cost	Delay of Water Demand	IRR (%)
Base case	0.152			4.9
Case 1-1	0.066			-
1-2	0.130			3.7
1-3	0.218			7.2
Case 2-1		10% up		4.3
2-2		20% up		3.5
Case 3-1			10 years	3.8

Table 2-8 Sensitivity Analysis of Industrial and Municipal Water for Ban Bung Sub-Project (Financial)

	Water tariff ($US\$/m^3$)	Construction cost	Delay of Water Demand	IRR (%)
Base case	0.152			1.8
Case 1-1	0.174			2.3
1-2	0.218			3.3
1-3	0.304			5.4
Case 2-1		10% up		1.4
2-2		20% up		1.0
Case 3-1			10 years	1.2