Number of Sequence	Working Contents
(1)	Construction of diversion canal, (Discharge capacity is designed at 10 year frequency flood during the dry season)
(2)	Foundation excavation of left side
(3)	Foundation treatment of left side and Intake facilities
(4)	Embankment of left side

The following works will be carried out by discharging the flood water through the out-let, during the dry season.

(5)	Foundation excavation of right side
(6)	Foundation treatment of left side
(7)	Embankment of right side

The construction of the spill-way will be carried out during at the same period as the embankment works.

b) Layout of Construction Method

Although there are the two types of energy of electricity and fuel, the energy used for construction works was decided in from more economical and easy of operation and maintenance of the irrigation system in future.

There are two cases to secure the coarse aggregates for concrete, the field production and the purchase from existing crushing plants. Since the former will require a long distance transportation from the existing plant to the Project site, the latter will be selected for the construction of the both of Storage Dam and Diversion Dam by producting aggregates by a portable crushing plant (50 ton/hr class) after mining the rocks at the quarry sites around the Project Area.

The pilot holes shall be drilled before grouting in order to grasp the foundation conditions. After that, the grouting will be carried out appropriately according to the geological conditions.

It is reasonable that blanket grout holes be drilled by percussion type drilling machine. However, curtain grout holes shall be drilled by rotary type drilling machines in order to prevent the collapse of the holes and obtain effectiveness of grout injection.

The summary of embankment measures is as follows:

Zone	Thickness of Spreading	Number of Pass	Machine of Compaction
Impervious Zone	20 cm	8	Tamping Roller 15 ton
Semi-pervious Zone	30 cm	6	Vibratory Roller 8 ton
Pervious Zone	60 cm	5	-ditto-
Filter Zone	40 cm	4	Vibratory Roller 0.6 ton

The field moisture contents of embankment materials particularly impervious materials, are in dry side from the optimum moisture. Therefore, they shall be compacted with optimum moisture condition by adding water.

The spillway will be constructed during the same period in order to utilize the excavated materials for embankment of the dam.

4) Diversion Dam

a) Sequence of Construction Works

The sequence of Diversion Dam construction is shown in Fig. 5.1-3, Appendix.

Primary works cover the work at the right and the left abutments, and flood water will pass through the actual water rout during this construction period.

Secondary Works cover the construction of the right side spillway, and the flood water will pass through the left side of actual water rout during this construction period.

Tertiary Works cover the construction of the left side spillway, and the flood water will pass through the conduit pipe provided at the left side spillway by the second works during this construction period. The discharge capacity of conduit pipe is designed with 10- year frequency flood during the dry season.

Number of Sequence	Working Contents
(1)	Foundation excavation at the first step
(2)	Foundation treatment at the first step
(3)	Embankment and concrete works at the first step
(4)	Construction of diversion canal
(5)	Foundation excavation at the second step
(6)	Foundation treatment at the second step
(7)	Concrete works at the second step and conduit pipe

During the dry season, the following works will be carried out by discharging the flood water through the conduit pipe.

(8)	Foundation excavation at the third step
(9)	Foundation treatment at the third step
(10)	Concrete works and installation of gates at the third step

b) Outline of Construction Method

The supply of power source of construction and aggregates for concrete will be made in the same way as that for the storage dam.

The foundation treatments will be also carried out by the same construction methods.

The large size aggregates (max.60 m/m) and low slump concrete shall be used for mass concrete of spillway from the viewpoints of economy and quality control. And the concrete will be placed by the 180 ton-m tower crane.

5) Irrigation Facilities

The Project Area is divided into the following sub-areas.

Right Bank Sub-area: Mae Tha area, Mae Pung Left area and Mae Pung Right area

Mae Wa Sub-area

Sop Chang Sub-area

The Mae Chang Main Canal is located in the uppermost will be constructed in the same period as that of the first diversion dam. Since Mae Tha area is located far from the existing river and canals and it is significant that irrigation water be supplied to this area.

It is economical to supply the concrete aggregates from the existing crushing plant. The fuel energy will be useful for the canal system construction as compared with electricity. The embankment materials shall be compacted sufficiently with the careful control of moisture content, since the field moisture will be in dry side from the optimum moisture in the same state as the dam materials.

6) Construction Equipment

The major machinery and equipment for the construction mentioned perviously are listed in Table 5-1.

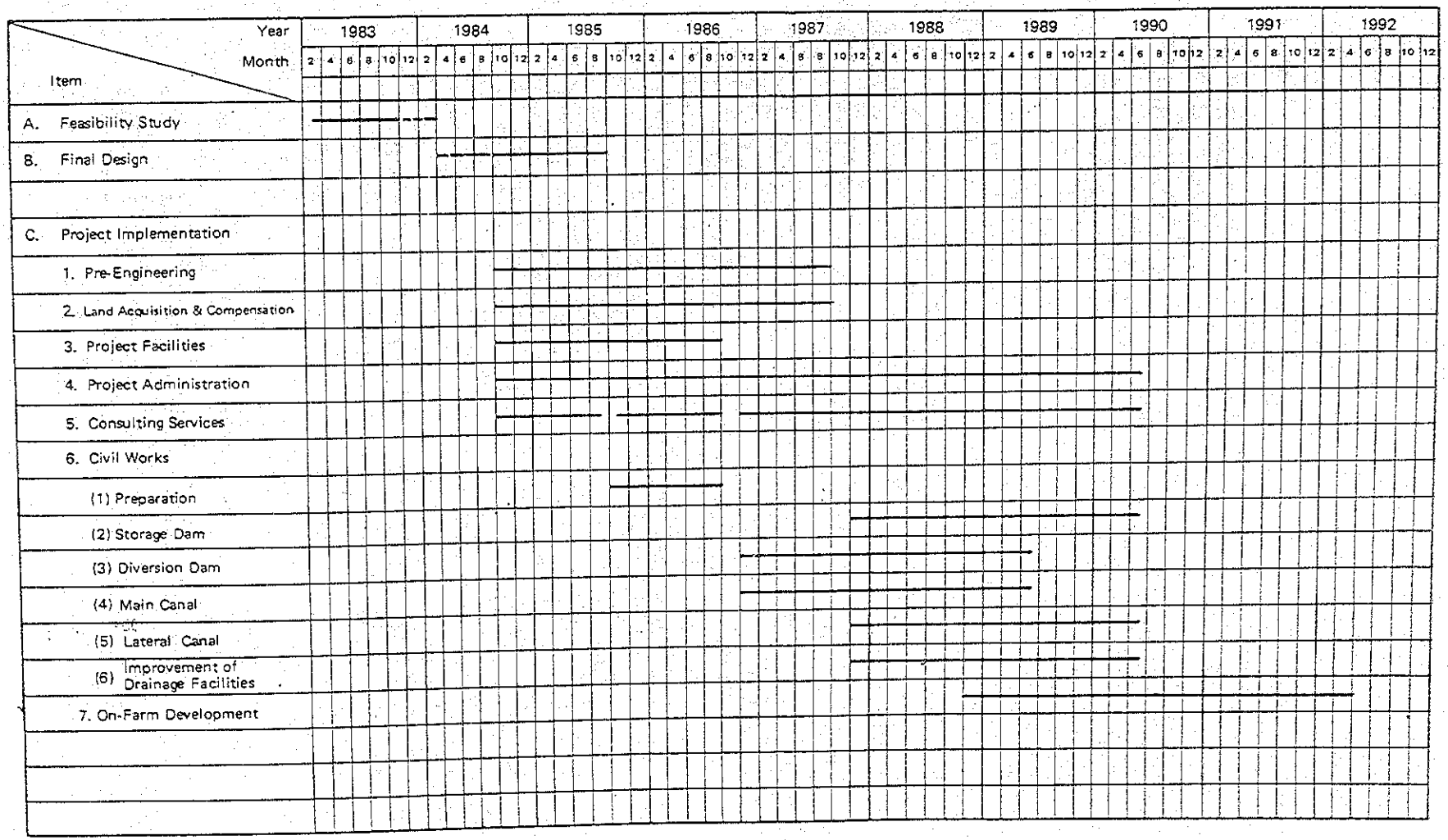
5.2.3. Construction Schedule

The implementation program for the Project is shown in Fig. 5-2.

Table 5.1. List of Major Construction Equipment

Description			Maximum Number			
			Storage Dam A	Diversion Dam C	Diversion Dam D	Canal System
Bulldozers	11 ton	110 ps	2	1	1	7
"	21	220 "	6	3	3	4
"	32	320 "	4	-	-	-
Fronted loaders	1.2 m^3	76 ps	1	1	1	-
"	1.8 "	160 "	-	2	2	-
"	2.2 "	200 "	8	-	-	-
Backhoes	0.4 m^3	92 ps	-	-	-	5
"	0.8 "	137 "	1	1	1	2
Dump trucks	11 ton	320 ps	40	9	9	4
"	18 "	230 "	14	-	-	-
Motor scrapers	11 m^3	210 ps x 2	-	3	1	1
Tired rollers	20 ton	100 ps	-	-	-	3
Tamping rollers	15 ton		2	1	1	-
Vibratory rollers	8 ton	86 ps	4	-	-	-
"	0.6	6 "	2	2	2	-
Motor graders	37 m	126 ps	1	1	1	1
Boring machines	5.5 KW		8	8	6	-
Grouting pumps	7.5 KW		10	8	6	-
Grouting mixers	200 x 2	2.2 KW	10	8	6	-
Aggregate production plants	50 ton/H	85 KW	1	1	1	-
Concrete plants	0.75m^3 x 2	15 KW	1	1	1	-
Portable concrete plants	0.5m^3		-	-	-	2
Agitator trucks	3.0 m^3	195 ps	2	2	2	3
Tower cranes	180 ton	88.5 KW	-	1	1	-
Truck cranes	10 ton	230 ps	1	1	1	-
Water tank trucks	6,000	160 ps	1	1	1	3
Crawler drills	10 m^3/min		4	1	1	-
Air compressors	110 ps		4	1	1	1
Leg drills	2.8 m^3/min		4	3	3	3

Fig. 5-2 IMPLEMENTATION PROGRAMME FOR THE PROJECT



Description		Maximum Number of Unit			
		Storage Dam A	Diversion Dam C	Diversion Dam D	Canal System
Pic hammer	1.1 m^3/min	8	4	4	4
Generator	50 KWA 70 ps	-	-	-	2
Motor drive winch	7.5 KW	-	1	1	-
Rammer	80 kg 4 ps	4	2	2	4
Truck	6 ton 170 ps	1	1	1	1

5.3. Operation and Maintenance of the Project

5.3.1. Executing Agency and Organization

The Project, after completion of physical works, will be transferred in its administration to the Region II Office of the RID. It is recommended, however, to establish a new organization, the so-called Irrigation System Office, for carrying out the operation and maintenance of the irrigation system of the Project, which will ensure the high cropping intensity throughout the year by systematic and functional operation of both a storage dam and a diversion dam playing a vitally important role as mainstays of the Project.

A chief of this proposed office will be positioned under the control of the Region II Office of the RID, staffing with powerful Project Engineer, officials for administration section, engineering section, operation and maintenance section, mechanical section and agricultural service section.

The Irrigation System Office controls the two dam O & M Offices, storage dam O & M Office and diversion dam O & M Office and the five zone Offices, Zones 1 to 5.

Storage dam O & M Office will be in charge of operation and maintenance of the storage dam while the diversion dam O & M office will be handling the distribution of irrigation water to the Project Area through Mae Chang Main canal as well as the operation and maintenance of the diversion dam.

A zone office headed by a zoneman will be in charge of the operation and maintenance of respective irrigation system and carrying out water management in his covering area.

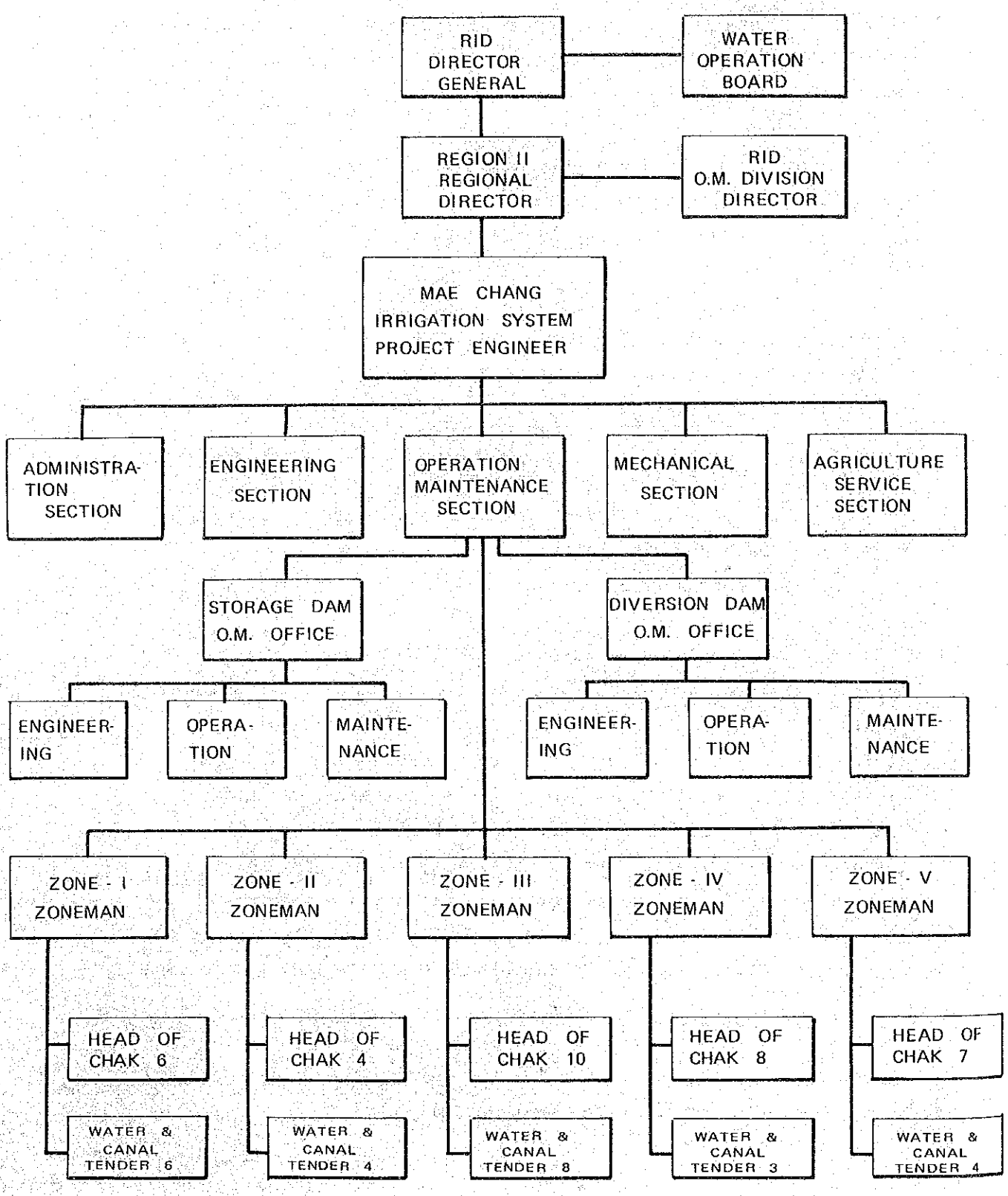
Several heads of chak and water and canal tenders will be assigned in the zone office under a zoneman. A head of chak will carry out water management in his assigned irrigation area and act as a chief of such area.

On the other hand, certain numbers of the water and canal tenders will be assigned for the maintenance of the irrigation facilities, such as main/lateral canals and related canal structures. They will be permanent employee of the system office.

Since available water resources for the Project Area are severely limited, proper operation of the storage and diversion dams should be carried out by the dam O & M offices under the supervision of Irrigation System Office. For proper operation of the dams, firstly estimation of water demand in the respective area should be made correctly. Estimated water demand by the zoneman will be gathered and informed to the Irrigation system Office. After gathering all of data on irrigation water demand and adjusting the distribution of water, irrigation programme will be instructed by the Project Engineer to the chief of dam O & M Offices and zonemen.

In prior to such operation of the irrigation system mentioned above, an irrigation programme for the said system will be scheduled at the beginning of the water year annually.

Fig.5-3 Organizational Set-up on Operation and Maintenance of Mae Chang Irrigation System



5.3.2. Operation and Maintenance Cost

The estimated annual Operation and Maintenance Cost for the Project is shown in Appendix 5.3-1 and summarized as follows:

	(Unit: ฿'000)
Operation Cost	
Salaries and Wages	4,632
Materials and Supplies	420
Maintenance Cost	
Improvement and Maintenance	748
Total of annual O & M Cost	5,800

A replacement cost once every six years is estimated at six million Baht for vehicles and other administrative facilities.

Those operation and maintenance cost is included into the Project evaluation as described in Chapter 6.

5.4. Consulting Services

The consulting services will consist of the engineering services for final design and for supervision of the overall implementation of the Project.

The consulting services will be rendered in the following two stages:

1) The first stage is for the final design of the Project as well as the preparation of tender documents. It will cover a 186 man-month period, 87 man-month for foreign consultants and 99 man-month for local consultants, starting from September 1984.

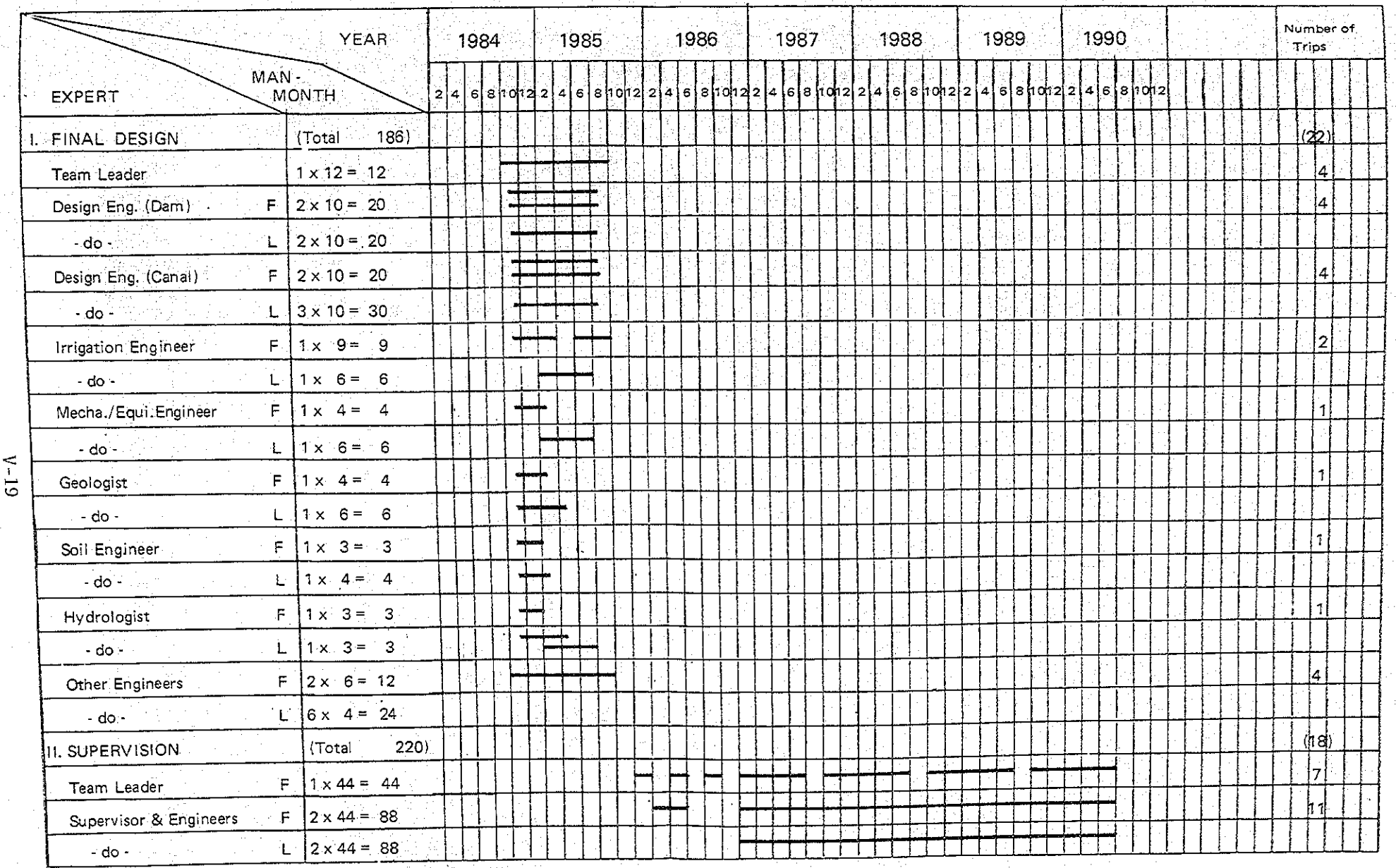
2) The second stage is for tendering and construction supervision in all aspects of the Project activities. The service period will cover 210 man-month, 132 man-month for foreign consultants and 88 man-month for local consultants, from November 1985 to 1990.

The proposed schedule of the consulting services is shown in Table 5-4. The cost of the consulting services is described in Table 4.6-2, Appendix 4.6-2 and summarized as follows:

(Unit: ฿'000)

Description	Total	Foreign Currency	Local Currency
i) Final Design			
Consultants Remuneration	25,320	17,400	7,920
Travel, Per Diem & Others	8,338	2,060	6,278
Survey & Investigation	4,500	2,500	2,000
Miscellaneous	3,842	2,040	1,802
Sub-total	42,000	24,000	18,000
ii) Supervision			
Consultants Remuneration	33,440	26,400	7,040
Travel, Per Diem & Others	9,946	2,740	7,206
Miscellaneous	3,614	1,860	1,754
Sub-total	47,000	31,000	16,000
Total	89,000	55,000	34,000

Fig. 5-4 Manning Schedule of Consulting Services



EXPERT		MAN-MONTH	Number of Trips
I. FINAL DESIGN		(Total 186)	(22)
Team Leader		1 x 12 = 12	4
Design Eng. (Dam)	F	2 x 10 = 20	4
- do -	L	2 x 10 = 20	
Design Eng. (Canal)	F	2 x 10 = 20	4
- do -	L	3 x 10 = 30	
Irrigation Engineer	F	1 x 9 = 9	2
- do -	L	1 x 6 = 6	
Mecha./Equi.Engineer	F	1 x 4 = 4	1
- do -	L	1 x 6 = 6	
Geologist	F	1 x 4 = 4	1
- do -	L	1 x 6 = 6	
Soil Engineer	F	1 x 3 = 3	1
- do -	L	1 x 4 = 4	
Hydrologist	F	1 x 3 = 3	1
- do -	L	1 x 3 = 3	
Other Engineers	F	2 x 6 = 12	4
- do -	L	6 x 4 = 24	
II. SUPERVISION		(Total 220)	(18)
Team Leader	F	1 x 44 = 44	7
Supervisor & Engineers	F	2 x 44 = 88	11
- do -	L	2 x 44 = 88	

NOTE: F: Foreign Consultant, L: Local Consultant.

CHAPTER VI : ECONOMIC EVALUATION AND FINANCIAL ANALYSIS

CHAPTER VI. ECONOMIC EVALUATION AND FINANCIAL ANALYSIS

6.1. Introduction

The economic evaluation presented here compares the economic returns of the proposed Project to the whole economy of Thailand by calculating the economic internal rate of return (EIRR). In order to determine the EIRR the present worth of both cost and benefit streams are discounted over the entire project life. The discount rate which makes the present worth of the cost and benefit streams equal is the EIRR.

Since the main components of the Project are a storage dam and a diversion dam which have a considerably long durable life the project life has been set at 50 years for the purpose of project evaluation.

Prices for agricultural inputs and outputs applied in the evaluation were estimated from data and information collected during the field works up to August, 1983. Crop prices for 1990 were based on the Half-Yearly Revision of Commodity Price Forecasts, IBRD, December 1982. Financial and economic price structures of crops are shown in Tables 6.1-1 to 6.1-7, Appendix 6.1-1.

Economic prices were calculated from financial prices by applying the following conversion factors from a World Bank publication which also includes an economic appraisal study on an irrigation project in Thailand.

Standard conversion factor	0.80
Conversion factor for construction	0.74
Conversion factor for transpotation	0.76
Conversion factor for government services	0.65

Table 6-1 Farm Gate Prices of Agricultural Outputs

(Unit: ₱/kg)

Items	1983		1990	
	Financial	Economic	Financial	Economic
Paddy				
Glutinous	2.81	3.50	4.11	4.94
Non-glutinous	3.00	3.77	4.45	5.35
Upland Rice	3.00	3.76	4.43	5.33
Sugarcane	0.69	0.78	0.68	0.77
Groundnuts	7.46	7.74	6.11	6.38
Maize	2.77	3.13	2.99	3.38
Mungbeans	6.00	6.78	7.62	8.61
Soybeans	6.39	6.55	8.13	8.32
Tobacco (Fresh Leaf)	2.45	3.47	1.51	2.52
Garlic	37.90	39.05	23.58	24.59
Others	26.53	27.34	16.51	17.21

Table 6-2 Farm Gate Prices of Agricultural Inputs

	Unit	1983		1990	
		Financial	Economic	Financial	Economic
Seed					
Paddy	฿/kg	5.00	4.74	6.95	6.59
Upland rice	฿/kg	3.60	3.41	5.00	4.74
Sugarcane	฿/stem	0.42	0.40	0.79	0.75
Groundnuts	฿/kg	16.50	15.64	16.50	15.64
Maize	฿/kg	5.50	5.21	6.22	5.90
Mungbeans	฿/kg	8.37	7.93	9.37	8.88
Soybeans	฿/kg	15.00	14.22	23.40	22.18
Tobacco	฿/ seedling	0.10	0.09	0.10	0.09
Garlic	฿/kg	30.00	28.44	30.00	28.44
Others	฿/kg	21.00	19.91	21.00	19.91
Manure	฿/kg	0.65	0.62	0.87	0.83
Paddy straw	฿/kg	1.50	1.42	1.58	1.50
Fertilizer					
16:20:0	฿/kg	4.80	3.32	6.43	6.10
20:20:12	฿/kg	5.00	4.74	6.70	6.35
14:24:12	฿/kg	9.00	8.53	12.06	11.43
13:13:21	฿/kg	6.00	5.69	8.04	7.62
13:0:46	฿/kg	6.20	5.88	8.30	7.87
4:16:24:4	฿/kg	6.25	5.93	8.38	7.94
A.S. (20)	฿/kg	4.90	4.65	6.57	6.23
Pesticide					
Azinmag	฿/kg	188.00	178.00	252.00	239.00
Furadan	฿/kg	23.00	18.40	30.82	24.66
Lannate or Methomyl	฿/kg	650.00	616.00	871.00	826.00
Kinsuma, Toku Thion, Carmitron or Kasumin	฿/kg	80.00	75.84	107.20	101.63
Labor	man-day	25.00	20.00	32.00	26.00

Farm gate prices for agricultural input and output based on 1983 constant prices are listed in Tables 6-1 and 6-2.

6.2. Economic Evaluation

The main objective of the proposed project is the development of water resources to irrigate 50,600 rai (8,095 ha) in Case-5 and 45,900 rai (7,349 ha) in Case-6. Under the Project, cropping intensity would increase from the present 111 per cent to 130 per cent in Case-5 and 135 percent in Case-6. Paddy production would increase from the present 9,109 tons to 25,434 tons in Case-5 and 7,853 tons to 22,856 tons in Case-6. Upland crop production would increase from the present 9,727 tons to 25,325 tons in Case-5 and 9,843 tons to 24,717 tons in Case-6. The "without" and "with" project production data for both cases are shown in Tables 6.2-1 to 6.2-6, Appendix 6.2-1. "With" project production increases would be substantial for all crops making a significant contribution towards meeting the Thai Government's objective of promoting "intensive" rather than "extensive" agriculture.

6.2.1. Economic Costs

1) Initial Project Costs

Tables 6-3 and 6-4 summarize the financial and economic initial Project costs. The economic initial Project costs were derived from the financial initial Project costs in the following manner:

i) the foreign currency portion of the costs remains the same except for price escalation which is deleted;

ii) the costs for land acquisition in the reservoir area and the Project Area, and all price escalation were deleted; and

Table 6-3 Summary of Initial Project Costs (Case 5)

(Unit: ฿ '000)

Description	Financial			Economic		
	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Total
1. Civil Works	280,600	243,180	523,780	280,600	179,949	460,549
2. Land Acquisition & Compensation (Sub-total)	-	59,760	59,760	-	9,026	9,026
2-1 Reservoir Area	-	39,700	39,700	-	-	-
2-2 Resettlement	-	12,000	12,000	-	9,026	9,026
2-3 Project Area	-	7,860	7,860	-	-	-
3. Construction Equipment	6,000	-	6,000	6,000	-	6,000
4. Project Facilities	-	10,000	10,000	-	7,400	7,400
5. Project Administration	-	16,100	16,100	-	11,913	11,913
6. Consulting Services	55,000	34,000	89,000	55,000	25,160	80,160
7. On-farm Development	-	-	-	10,120	22,456	32,585
Total (1 to 7)	341,600	363,040	704,640	351,720	255,913	607,633
8. Contingency	34,160	36,300	70,460	35,172	25,591	60,763
9. Price Escalation	121,910	120,810	242,720	-	-	-
Grand Total	497,670	520,150	1,017,820	386,892	281,504	668,296

Table 6-4 Summary of Initial Project Costs (Case 6)

(Unit: ฿ '000)

Description	Financial			Economic		
	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Total
1. Civil Works	269,280	226,920	496,200	269,280	167,918	437,198
2. Land Acquisition & Compensation (Sub-total)	-	21,000	21,000	-	3,996	3,996
2-1 Reservoir Area	-	8,400	8,400	-	-	-
2-2 Resettlement	-	5,400	5,400	-	3,996	3,996
2-3 Project Area	-	7,200	7,200	-	-	-
3. Construction Equipment	6,000	-	6,000	6,000	-	6,000
4. Project Facilities	-	10,000	10,000	-	7,400	7,400
5. Project Administration	-	16,100	16,100	-	11,913	11,913
6. Consulting Services	55,000	34,000	89,000	55,000	25,160	80,160
7. On-farm Development	-	-	-	9,180	20,380	29,560
Total (1 to 7)	330,280	308,020	638,300	339,460	236,767	576,227
8. Contingency	33,030	30,800	63,830	33,946	23,677	57,623
9. Price Escalation	117,860	107,710	702,130	-	-	-
Grand Total	481,170	446,530	927,700	373,406	260,440	633,850

iii) the conversion factor for construction was applied to the local currency portion of the costs.

The disbursement schedule of the economic initial Project costs including costs for on-farm development are shown in detail in Tables 6.2-19 and 6.2-20, Appendix 6.2-6.

2) Operation and Maintenance Costs

The economic costs for operation and maintenance of the storage dam, diversion dam, and main and lateral canals were calculated by applying the conversion factor for government services. Annual economic operation and maintenance costs which will be incurred from 1989 upon completion of the diversion dam and main canals are estimated to be 3,770,000 Baht.

3) Replacement Cost

Vehicles and equipment for operation and maintenance purposes are planned to be replaced every six-years after their initial purchase in 1986. The cost of replacement is estimated at a foreign currency equivalent of 6,000,000 Baht.

6.2.2. Economic Benefits

1) Major Direct Benefits

The major direct benefits of the Project will arise from the increase in agricultural production resulting from the introduction of irrigated agriculture. Other direct benefits are expected from fish production in the reservoir areas and increases in the production of beef cattle.

2) Agricultural Benefits

Project benefits arising from increases in agricultural production have been measured by comparing the "with" project and "without" project net values of production (NVP). The difference between the two net values of production is the annual incremental agricultural benefit. Annual incremental agricultural benefits are given in Table 6-5 and details of the calculations of net values of production are shown in the Tables 6.2-1 to 6.2-6, Appendix 6.2-1.

Table 6-5. Annual Incremental Agricultural Benefits

(Unit: ฿'000)

Case	"With" Project NPV	"Without" Project NPV	Annual Incremental Agricultural Benefits
5	192,101	51,641	140,460
6	180,271	46,207	134,064

3) Fishery Benefits

Benefits derivable from fish production in the reservoir area have been estimated from data collected from the Lampang Provincial Fishery Office. Introduction of fingerlings at the rate of 100 pieces per rai would give a yield of approximately 15 kg per rai resulting in an economic benefit of ฿351 per rai. The estimated fishery benefit in the reservoir areas are shown in Table 6-6.

Table 6-6. Fishery Benefits

	FWL (m)	Reservoir (rai)	Area (ha)	Total Yield (kg)	Benefit (฿'000)
Storage Dam A	280.1	3,250	520	48,750	1,141
Diversion Dam C	254	2,037	326	30,555	715
Diversion Dam D	249	1,319	211	19,785	463

Economic benefits from fishery production in the reservoir areas in Case-5 total ฿1,856,000 and in Case-6 total ฿1,604,000 per annum.

4) Livestock Benefits

Livestock benefits to be derived from the Project were estimated from data collected during the field surveys. The economic value of a live weight cow weighing 250 kg was estimated to be ฿4,000 at farm gate. Assuming that production costs (fee, medicine, etc.) are 60 per cent of the farm-gate value the benefit from one 250 kg cow would be ฿1,600. It is planned that 25 per cent of the total number of head would be sold annually, therefore, the annual benefits would be as shown in Table 6-7.

Table 6-7. Livestock Benefits

Case	Number of Head	Number to be sold Annually	Total Value (฿'000)	Production Cost (฿'000)	Net Benefit (฿'000)
5	6,545	1,182	4,718	2,837	1,891
6	5,832	1,053	4,212	2,527	1,685

5) Annual Incremental Benefits at Full Development

Table 6-8 shows the annual incremental benefits at full development taking into account the loss of the present benefits from the inundated areas and the expected benefits from the resettlement areas. It is assumed that it will take five years to attain the target yields proposed by the Project and therefore, full development is expected to be reached in 1996.

Table 6-8 Annual Incremental Benefits at Full Development

(Unit: '000 ฿)

Case	(1) 'Without' Project Benefits	(2) Present Benefits Inundated Area	(3) Future 'With' Project Benefits	(4) Expected Benefits Resettlement Area	(5) Fishery Benefits	(6) Livestock Benefits	Annual Incremental Benefits Full Development (3+4+5+6) - (1+2)
5	51,641	2,504	192,101	3,853	1,856	1,891	145,556
6	46,207	988	180,271	678	1,604	1,685	137,043

Table 6-9 Economic Comparison of the Two Cases

Case	Beneficial Area (rai)	Cropping Intensity (%)	Compensation Area (rai)	Resettlement No. of Households	Annual Economic Incremental Benefit Full Development ('000 ฿)	Economic Initial Investment Cost Including On-farm Development ('000 ฿)	E.I.R.R. (%)
5	50,600	130	1,304	125	145,556	668,296	13.6
6	45,900	135	664	22	137,043	633,850	13.4

6.2.3. Economic Internal Rate of Return (EIRR)

On the basis of the estimated economic costs and benefits mentioned previously the economic internal rate of return was calculated as follows:

Case	EIRR
5	13.6%
6	13.5%

Economic comparison of the two cases is shown in Table 6-9. The details of the calculations are shown in Table 6-10 for Case-5, Table 6-11 for Case-6 and Tables 6.2-12 and 6.2-13, Appendix 6.2-4.

The Net Present Worth (NPW) of both cases is shown in Table 6-10. When discounted at the opportunity cost o capital (11%) the NPW of both cases is positive meaning that they are both economically acceptable.

6.2.4. Sensitivity Test

Sensitivity testing or analysis is an effective way to check what happens to the earning capacity of a project if something does not go according to plan.

For this Project an analysis has been made on the following items for Case-5:

		Result (EIRR)
1)	Project cost overrun of 20%	11.9%
2)	Extension of the construction period	
	One year	12.7%
	Two years	11.8%
3)	Decrease in crop target unit yields by 10%	11.8%
4)	Delay in reaching the target year by five years	11.4%
5)	Applying conversion factors Table 3 Summary of Country Parameters for Thailand (1980) in the DRAFT report Shadow Prices for Economic Appraisal in Thailand (IBRD March 1982)	12.9%

Table 6-10 Calculation of Internal Rate of Return

(Unit: ฿ '000)

Discount Rate (%)	Present Worth Benefit	Present Worth Cost	B/C Ratio	NPW
10.00	662,321	452,659	1.46	209,662
11.00	563,672	431,591	1.31	132,081
12.00	483,176	412,105	1.17	71,071
13.00	416,859	394,004	1.06	22,855
14.00	361,744	377,132	0.96	-15,388
15.00	315,571	361,358	0.87	-45,787
16.00	276,605	346,573	0.80	-69,968
17.00	243,499	332,686	0.73	-89,187

Note: Internal Rate of Return; 13.6%.
NPW - Net Present Worth

Table 6-11 Calculation of Internal Rate of Return

(Unit: ฿ '000)

Discount Rate (%)	Present Worth Benefit	Present Worth Cost	B/C Ratio	NPW
10.00	623,041	430,390	1.45	192,651
11.00	550,284	410,203	1.29	120,081
12.00	454,611	391,552	1.16	63,059
13.00	392,279	374,242	1.05	18,037
14.00	340,487	358,119	0.95	-17,632
15.00	297,105	343,056	0.87	-45,951
16.00	260,503	328,947	0.79	-68,444
17.00	229,412	315,701	0.73	-86,289

Note: Internal Rate of Return; 13.5%.
NPW - Net Present Worth

The sensitivity test indicates that delay in reaching the target year by five years will have the greatest influence on the EIRR. Calculations for the sensitivity test are shown in Tables 6.2-15 to 6.2-19, Appendix 6.2-6.

6.2.5. Socio-Economic Impact

Along with the direct benefits of the Project various socio-economic impacts are expected to occur. The main socio-economic impacts are listed as follows:

Employment Opportunities
Income Distribution
Political Stability

1) Employment Opportunities

The demand for farm labour is estimated to increase from the present annual total of 1,229,100 man-days to 1,607,621 man-days in Case-5 and 1,516,029 man-days in Case-6. Assuming that the average farm laborer works 289 days per year this would mean 1,310 more full-time jobs or a 24 per cent increase in employment opportunities in Case-5 and 993 more full-time jobs or a 19 per cent increase in Case-6.

Also, fishing in the reservoir areas is expected to be able to provide employment for approximately 50 professional fishermen.

The increase in agricultural production should also have an effect on employment at agriculturally related businesses, especially, those dealing directly in agricultural inputs and outputs.

2) Income Distribution

According to the estimated farm budget analysis the farmer's disposal income in the case of the eight rai farm will increase from

the "without" Project amount of ฿9,281 to the "with" Project amount of ฿25,004 without taking into consideration off-farm income in the "with" Project case. This increase means that the amount available for household expenditure and savings will increase by nearly 270 per cent giving the farm household an opportunity to achieve a much higher standard of living than at present.

Such an increase in income will also mean that the farmers in the Project Area will have incomes on par with the national average.

3) Political Stability

Implementation of the Project will bring a lot of improvement into the Area and such improvements will naturally bolster the local people's confidence in the Thai Government.

Transportation and communication would be gradually improved to meet the demands of the Project. The road network will be expanded with th e construction or improvement of service roads along the routes of the irrigation and drainage canals. Expansion of activities by extension offices and cooperatives will bring more and better communication.

Increase in farm income will make it possible for the farmers to enjoy a better and healthier life.

6.2.6. Environmental Impact

1) General

The Areas to be inundated by construction of the storage dam and diversion dam are rather small in size compared with those created by other similar projects in Thailand up until now. Furthermore, there are no natural, cultural or aesthetic resources located in the proposed reservoir areas. Therefore, it is foreseen that implementation of the Project will cause few environmental effects.

2) Environmental Effects Derivable from Project Implementation

i) Effects on Fisheries

At present, fishing in the Mae Chang on a regular basis is not practical. However, after construction of the dams, fish production in the reservoir areas will be possible with the introduction of fingerlings by the Department of Fisheries on a regular basis.

ii) Effect on Water Resources

Introduction of irrigation in the Project Area will effect groundwater levels in a positive way. This will help to stabilize the groundwater supply which is the main source of water for domestic use in the village.

iii) Effect on Water Quality

Utilization of fertilizers and pesticides in the Project Area are very limited at present. Target unit yields set by the Project would require the introduction of proper amounts of both fertilizers and pesticides. Therefore, it is recommended that monitoring of the effects of such chemicals on the environment and especially the quality of drinking water be carried out.

iv) Effect on Scenic Beauty

The Mae Chang reservoir area may attract local people as well as tourists to the Project Area. A reservoir combined with forests in a mountainous area will provide a natural place for recreation and sightseeing.

6.3. Financial Analysis

6.3.1. Typical Farm Budget

Typical farm budgets have been estimated for "without" Project average farm size of eight rai and "with" Project representative farm sizes of five, eight and twelve rai. The cropping areas and agricultural production of each farm size are shown in Tables 6-13 and 6-14.

The estimated farm budgets have been calculated by applying the financial prices of agricultural inputs and outputs, and the target yields of crops. The financial crop production costs and farm incomes are detailed in the Tables 6.3-1 and 6.3-6, Appendix 6.3-1.

Table 6-12 summarizes the estimated farm budgets for all farm sizes. By comparing the "without" Project average farm of eight rai to the "with" Project medium scale farm of eight rai the results show that surplus income would nearly triple in the "with" Project case even without taking into consideration off-farm income.

Costs for hired labour have not been included in the estimated farm budgets since labour available per farm household is estimated at 2.9 persons which is more than sufficient for even a 12 rai size farm. This is based on the assumption that one person works 289 days per year giving a total of about 838 man days per year per farm household. The required number of man days per farm is shown below:

Farm-size (rai)	Total man-day required
5	183
8	274
12	405

Table 6-12 Estimated Farm Budgets

Item	'Without' Project	'With' Project (Case 5)		
1. Farm Size (rai)	8	5	8	12
2. Cropping Intensity (%)	100	130	130	130
3. Farm Household Income (฿)				
On-farm	9,508	24,359	34,576	40,067
Off-farm	1,902	-	-	-
Total	11,410	24,359	34,576	40,067
4. Expenditures (฿)				
Agri-inputs	2,089	7,300	9,532	10,376
Land Tax	40	25	40	60
(Disposal Income	9,281	17,034	25,004	29,631)
Household	6,497	11,924	17,503	20,742
Total	8,626	19,249	27,075	31,178
5. Surplus Income (฿)	2,784	5,110	7,501	8,889

Based on: RID Socio-Economic Survey 1980/81

Agricultural Statistics of Thailand 1981/82

Field Survey Results 1983

Table 6-13 'Without' and 'with' Project Cropping Area by Farm-Size

(Unit: rai)

Farm-size	Paddy	Soybeans		Groundnuts		Garlic	Tobacco	Others 2/	Total
	W	W	D 1/	W	D	D	D		
'Without'									
8 (Average)	6.0	-	-	0.5	-	-	-	1.5	8.0
'with' Project (Case 5)									
5	4.0	0.4		0.6	-	0.5	1.0	-	6.5
8	6.5	0.6	0.8	0.9	1.1	0.6	-	-	10.4
12	10.0	1.0	1.4	1.0	2.0	0.2	-	-	15.6

1/ W: Wet season 2/ Others: Sugarcane, Mungbean, Maize, etc.
D: Dry season

Source: Present, Report on Farmers' Socio-Economic Survey inside Mae Chang Reservoir Project Boundary RID 1980/81

Table 6-14 'Without' and 'with' Project Agricultural Production by Farm-Size

(Unit: kg)

Farm-size (rai)	Paddy	Soybeans	Groundnuts	Garlic	Tobacco	Others
'Without'						
8 (Average)	1,740	-	80	-	-	1,323
'with' Project (Case 5)						
5	2,512	108	150	350	2,600	-
8	4,082	302	555	420	-	-
12	6,280	690	850	140	-	-

6.3.2. Repayment of Construction Cost

Assuming that farmers are willing to re-invest at least two-thirds of their surplus income toward repayment of construction costs a total of ฿28,570,000 per annum would be realized at full development of the Project (Case-5).

This calculation is based on the assumption that 30 per cent of the representative farms are five rai in size, 50 per cent are eight rai and 20 per cent are 12 rai.

Assuming that the total amount of initial investment costs would be financed at an interest rate of 12 per cent per annum with a repayment period of 10 years, approximately 25 per cent of the total costs could be repaid by the farmers themselves.

6.4. Economic Evaluation on Hydropower Development

General

The purpose of the hydropower development plan is to generate electricity by construction of a hydropower plant immediately downstream from the proposed storage Dam A.

Designed installed capacity is 164 KW (two units of 82 KW) that will generate approximately 1.18 GWH of electricity per annum.

Implementation of the hydropower development plan is proposed to be carried in the future as Phase II of the Mae Chang Irrigation Project.

Cost

The construction cost is estimated to be ฿55,000,000 in total, of this ฿2,000,000 are local currency construction costs and the

remaining ฿53,000,000 are foreign currency costs. Therefore, the economic cost is approximately ฿54,500,000.

Replacement

Various moving party of the hydropower machinery are considered to be replaced after 25 years at a cost of ฿7,000,000 (foreign currency).

O & M Cost

For purpose of evaluation the cost for operation and maintenance has been roughly estimated at $175,000 per annum.

Benefits

Benefits are considered to be the proceeds derived from the fuel costs saved by utilization of hydropower.

Data obtained from the National Evergy Administration (NEA) shows that it requires 0.24, litres of diesel oil to produce on KWh of electricity and one litre of diesel oil in April 1981 cost 7.26 Baht.

Therefore, the cost for producing one KWH of electricity using diesel oil is calculated as follows;

Cost of diesel oil per litre (1981) = 7.26 Baht*
Cost of diesel oil per litre (1983) = 7.77 Baht
(1981 price x M.U.V. 1983 of 1.07)
Cost of producing one KWH of electricity = 1.87 Baht
(0.241 x 7.77 Baht)

Total cost saved (1,180,000 KWH x 1.87 Baht) = 2,206,000 Baht

Note: * Does not include transportation costs

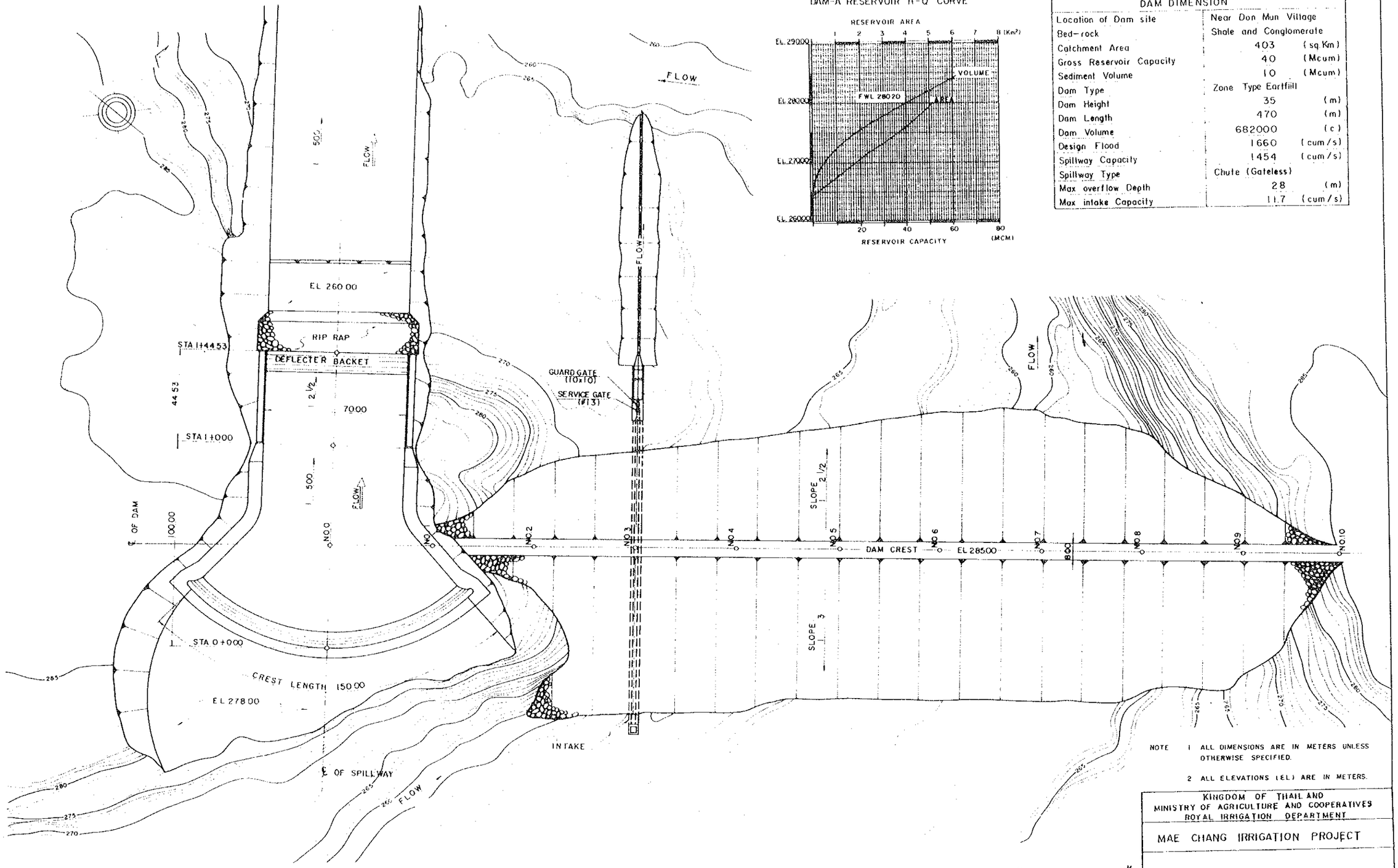
This means that the annual benefits from hydropower production will be approximately 2,206,000 Baht.

BC Ratio

As shown in Appendix 6.2-7, a result of the economic evaluation shows that a B/C ratio is at about 0.45. It is not feasible at the present to develop the hydropower generation.

LIST OF DRAWINGS

NO. OF DRAWINGS	TITLE
DWG 1	STORAGE DAM A 1/3
DWG 2	STORAGE DAM A 2/3
DWG 3	STARAGE DAM A 3/3
DWG 4	DIVERSION DAM C 1/2
DWG 5	DIVERSION DAM C 2/2
DWG 6	DIVERSION DAM D 1/2
DWG 7	DIVERSION DAM D 2/2
DWG 8	PROPOSED IRRIGATION SYSTEM (CASE-5)
DWG 9	TYPICAL CROSS SECTION OF MAIN/LATERAL CANAL (CASE-5)
DWG 10	IRRIGATION SYSTEM (CASE-6)
DWG 11	TYPICAL CROSS SECTION OF MAIN/LATERAL CANAL (CASE-6)
DWG 12	MAJOR STRUCTURES OF IRRIGATION CANAL 1/4
DWG 13	MAJOR STRUCTURES OF IRRIGATION CANAL 2/4
DWG 14	MAJOR STRUCTURES OF IRRIGATION CANAL 3/4
DWG 15	MAJOR STRUCTURES OF IRRIGATION CANAL 4/4
DWG 16	PROFILE OF MAIN CANAL (1) - MCMC and MPRC -
DWG 17	PROFILE OF MAIN CANAL (2) - MPLC, SCC adn MWC -
DWG 18	PLAN OF HYDROPOWER PLANT



DAM-A RESERVOIR H-Q CURVE

DAM DIMENSION		
Location of Dam site	Near Don Mun Village	
Bed-rock	Shale and Conglomerate	
Catchment Area	403	(sq.Km)
Gross Reservoir Capacity	40	(Mcum)
Sediment Volume	10	(Mcum)
Dam Type	Zone Type Eartfiill	
Dam Height	35	(m)
Dam Length	470	(m)
Dam Volume	682000	(c)
Design Flood	1660	(cum/s)
Spillway Capacity	1454	(cum/s)
Spillway Type	Chute (Gateless)	
Max overflow Depth	28	(m)
Max intake Capacity	11.7	(cum/s)

NOTE 1 ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

2 ALL ELEVATIONS (EL) ARE IN METERS.

SCALE 0 50 100M

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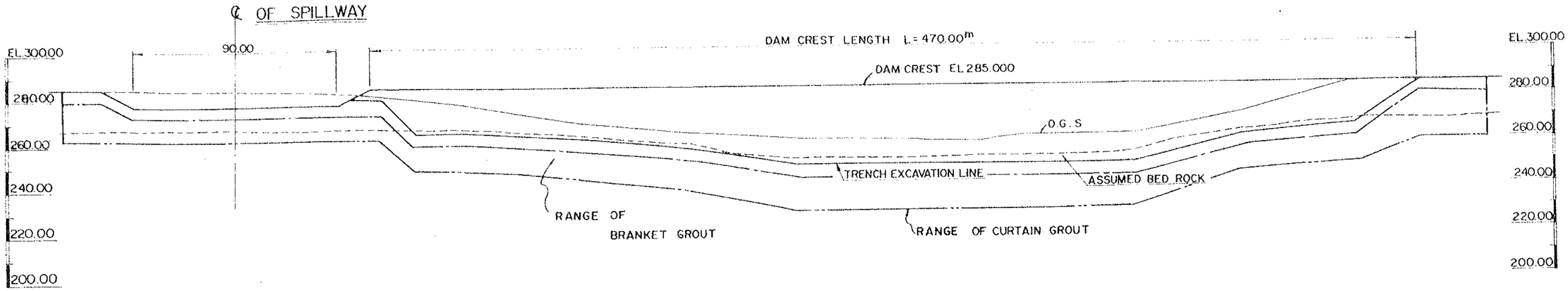
MAE CHANG IRRIGATION PROJECT

STORAGE DAM A 1/3

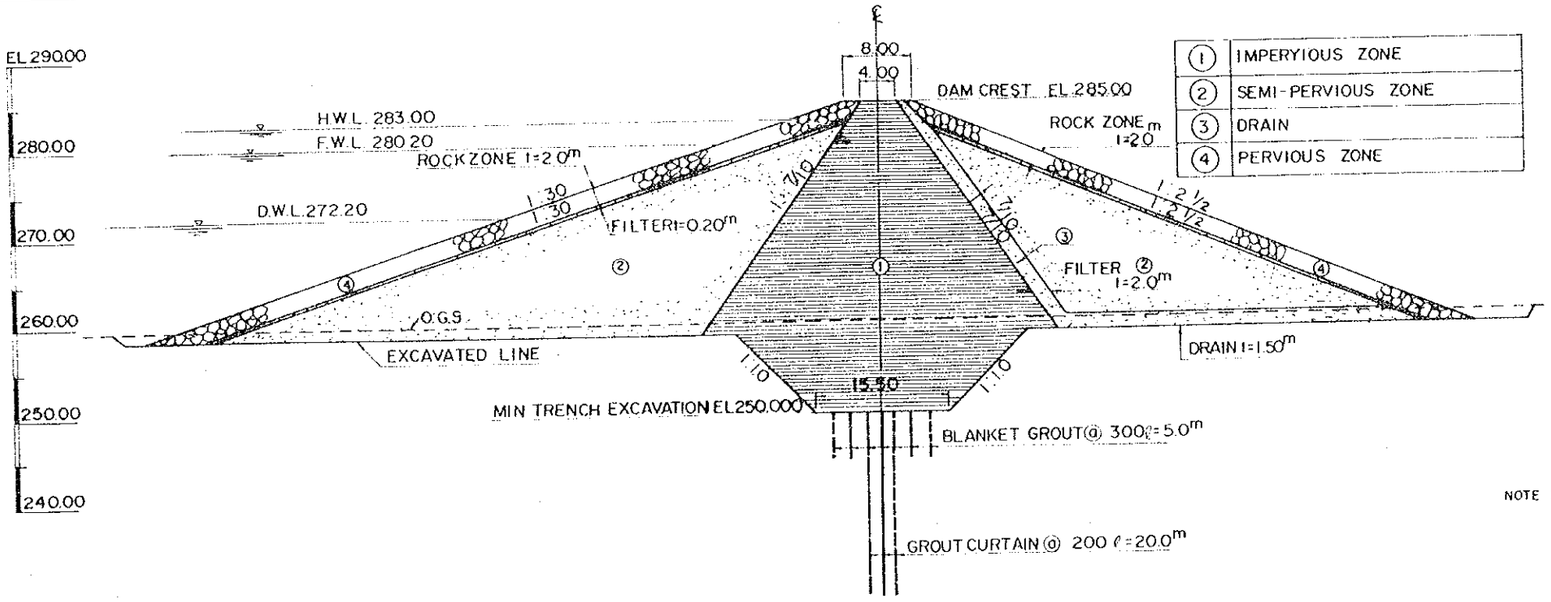
DATE		DWG	DWG 1

JAPAN INTERNATIONAL COOPERATION AGENCY



LONGITUDINAL SECTION

STATION	DISTANCE	GROUND ELEVATION	TRENCH ELEVATION
NO. 0	0.000	285.27	—
NO. 1	50.00	283.00	271.00
NO. 2	44.00	278.00	265.00
NO. 3	50.00	269.20	262.00
NO. 4	50.00	264.50	258.00
NO. 5	50.00	261.30	250.00
NO. 6	50.00	261.60	250.00
NO. 7	50.00	262.50	250.00
NO. 8	50.00	262.70	250.00
NO. 9	50.00	271.50	262.00
NO. 10	50.00	285.00	266.00
+29.00	+29.00	285.00	285.00
NO. 11	21.00	285.50	—



DAM TYPICAL SECTION

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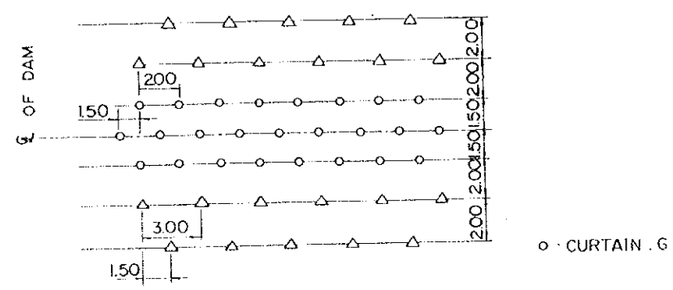
①	IMPERVIOUS ZONE
②	SEMI-PERVIOUS ZONE
③	DRAIN
④	PERVIOUS ZONE



GROUT PATTERN

SCALE
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o · CURTAIN . G

△ BLANKET . G

NOTE : 1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

2. ALL ELEVATIONS (EL) ARE IN METERS

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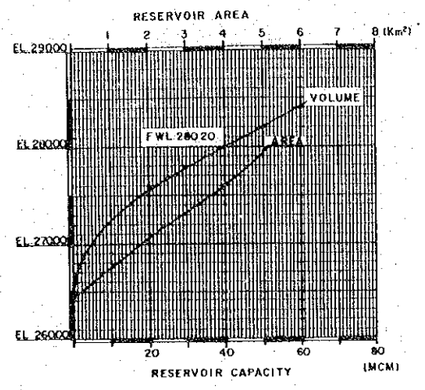
STORAGE DAM A 2/3

DATE | DWG | DWG 2

JAPAN INTERNATIONAL COOPERATION AGENCY

DAM-A RESERVOIR H-Q CURVE



DAM DIMENSION		
Location of Dam site	Near Don Mun Village	
Bed-rock	Shale and Conglomerate	
Catchment Area	403	(sq.Km)
Gross Reservoir Capacity	40	(Mcum)
Sediment Volume	10	(Mcum)
Dam Type	Zone Type Eortfiill	
Dam Height	35	(m)
Dam Length	470	(m)
Dam Volume	682000	(c)
Design Flood	1660	(cum/s)
Spillway Capacity	1454	(cum/s)
Spillway Type	Chute (Gateless)	
Max. overflow Depth	2.8	(m)
Max. Intake Capacity	11.7	(cum/s)

NOTE : 1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

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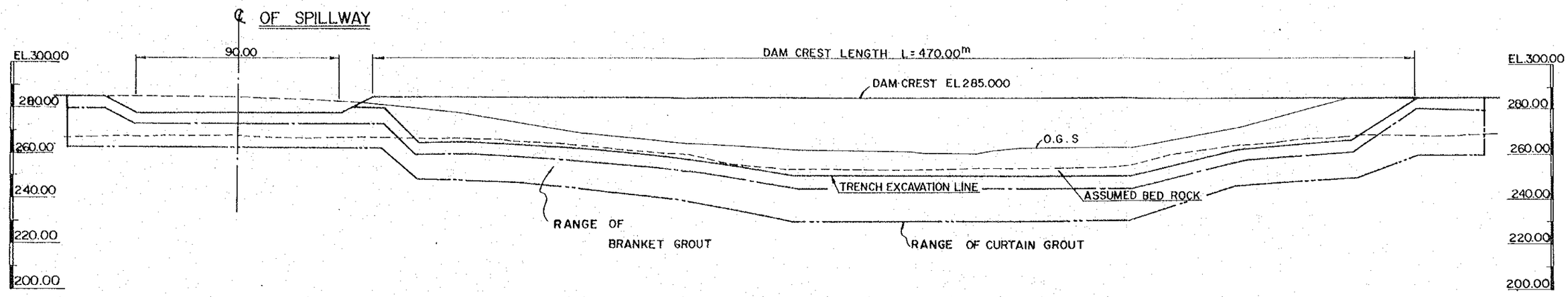
MAE CHANG IRRIGATION PROJECT

STORAGE DAM A 1/3

DATE		PWG	DWG 1

JAPAN INTERNATIONAL COOPERATION AGENCY



LONGITUDINAL SECTION

STATION	DISTANCE	GROUND ELEVATION	TRENCH ELEVATION
NO. 0	0.00	285.27	—
NO. 1	50.00	283.00	271.00
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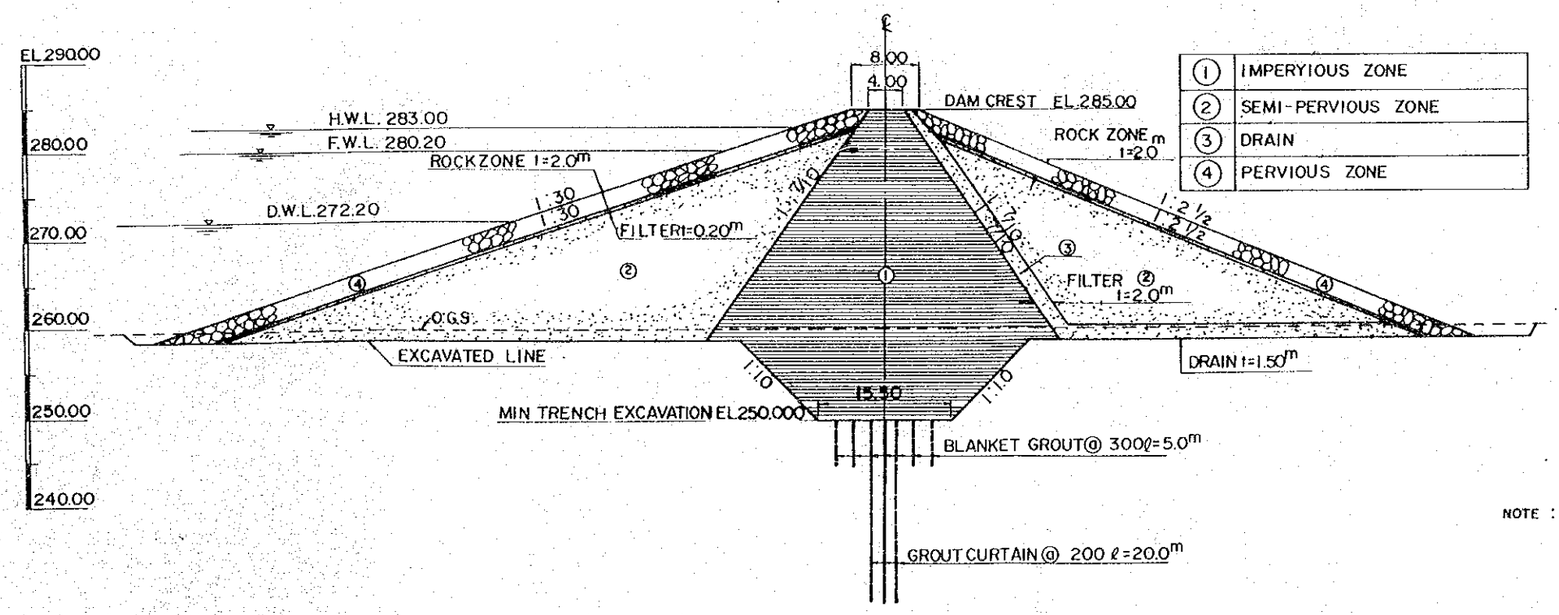
NO. 6	50.00	261.60	250.00
NO. 7	50.00	262.50	250.00
NO. 8	50.00	262.70	250.00
NO. 9	50.00	271.50	262.00
NO. 10	50.00	285.00	266.00
+29.00	+29.00	285.00	285.00
NO. 11	21.00	285.50	—



①	IMPERVIOUS ZONE
②	SEMI-PERVIOUS ZONE
③	DRAIN
④	PERVIOUS ZONE

DAM TYPICAL SECTION

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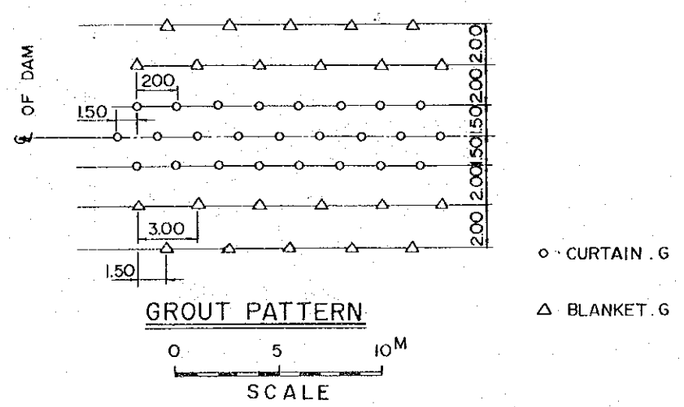

GROUT PATTERN

SCALE
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NOTE : 1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

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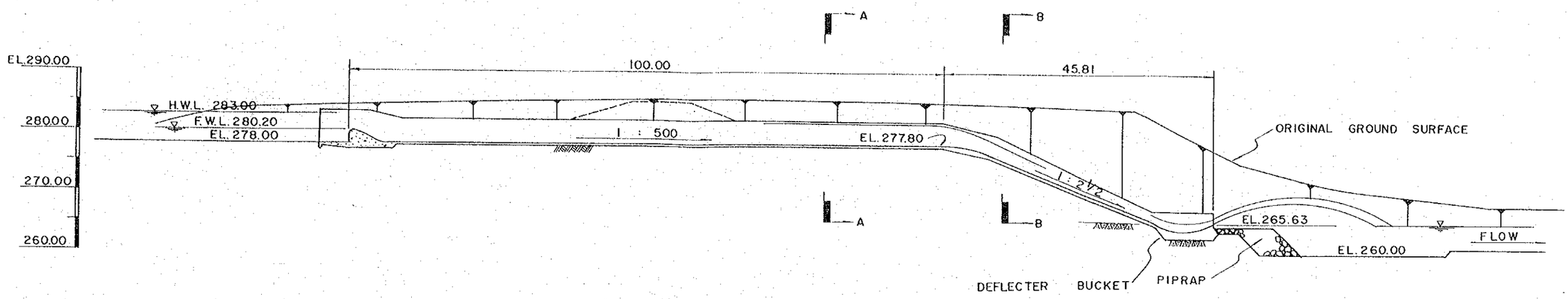

PROFILE OF SPILLWAY

0 10 20 30 M

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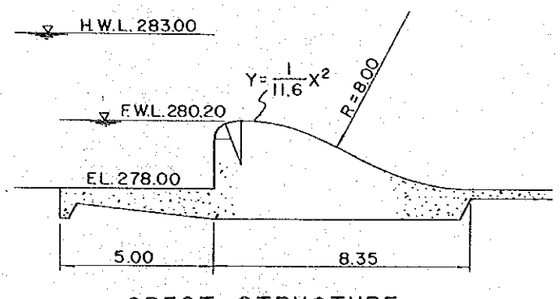

CREST STRUCTURE

0 1 2 3 4 5M

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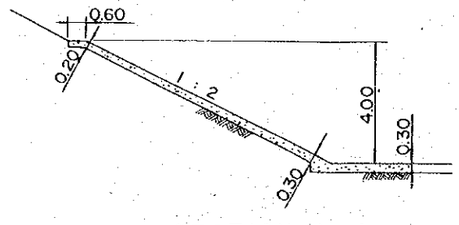

SECTION A–A

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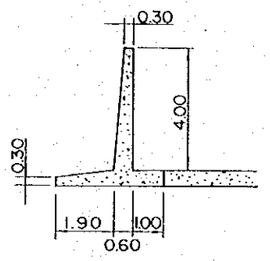

SECTION B–B

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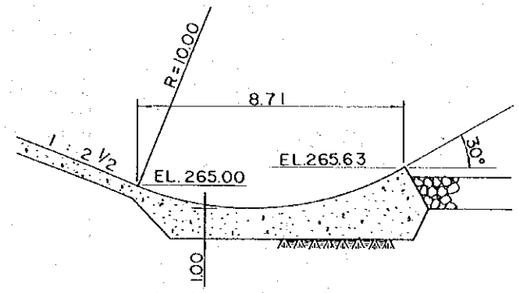

DEFLECTER BUCKET STRUCTURE

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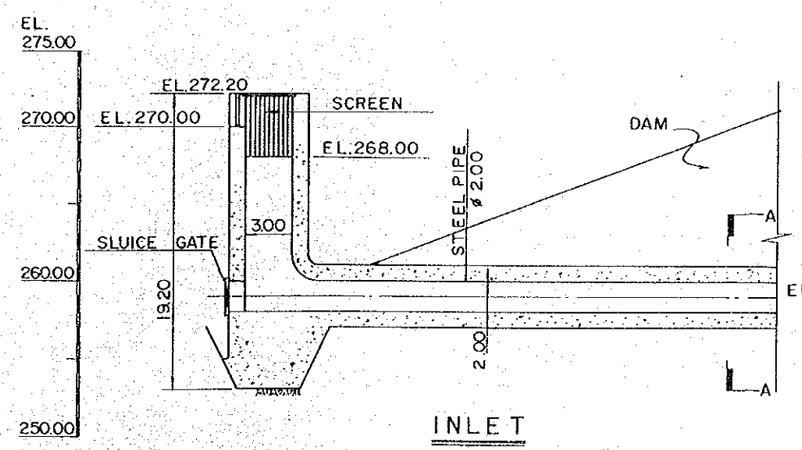
SCALE



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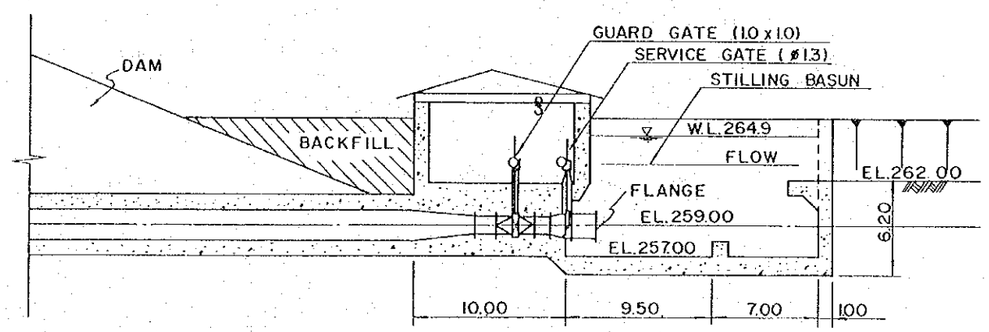

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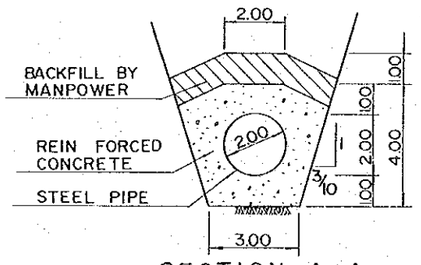

SECTION A–A

0 1 2 3 4 5M

SCALE

INTAKE FACILITY

0 1 2 3 4 5M

SCALE

NOTE : 1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

2. ALL ELEVATIONS (EL) ARE IN METERS.

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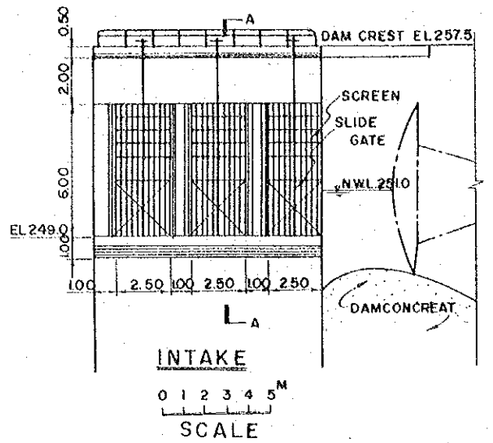
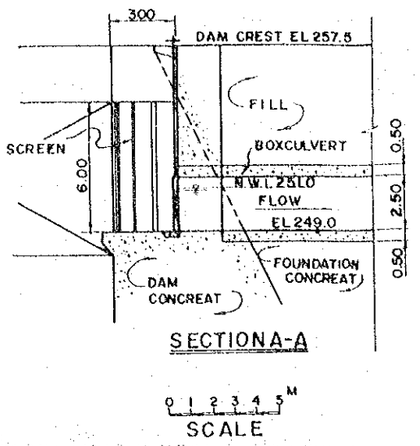
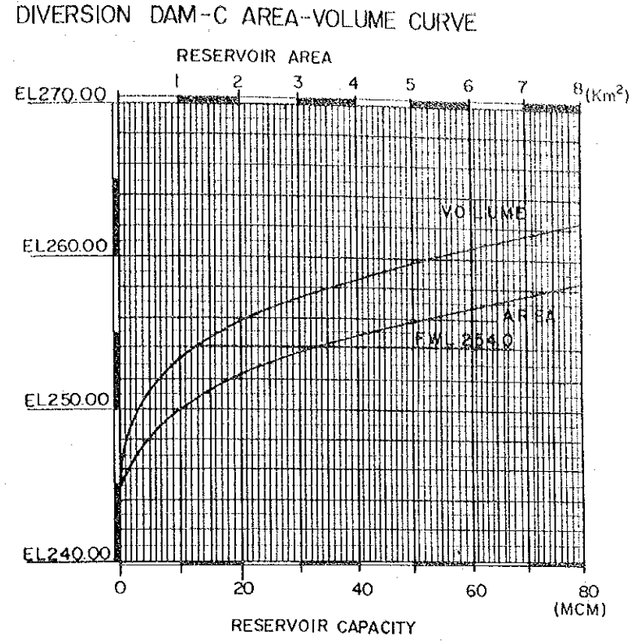
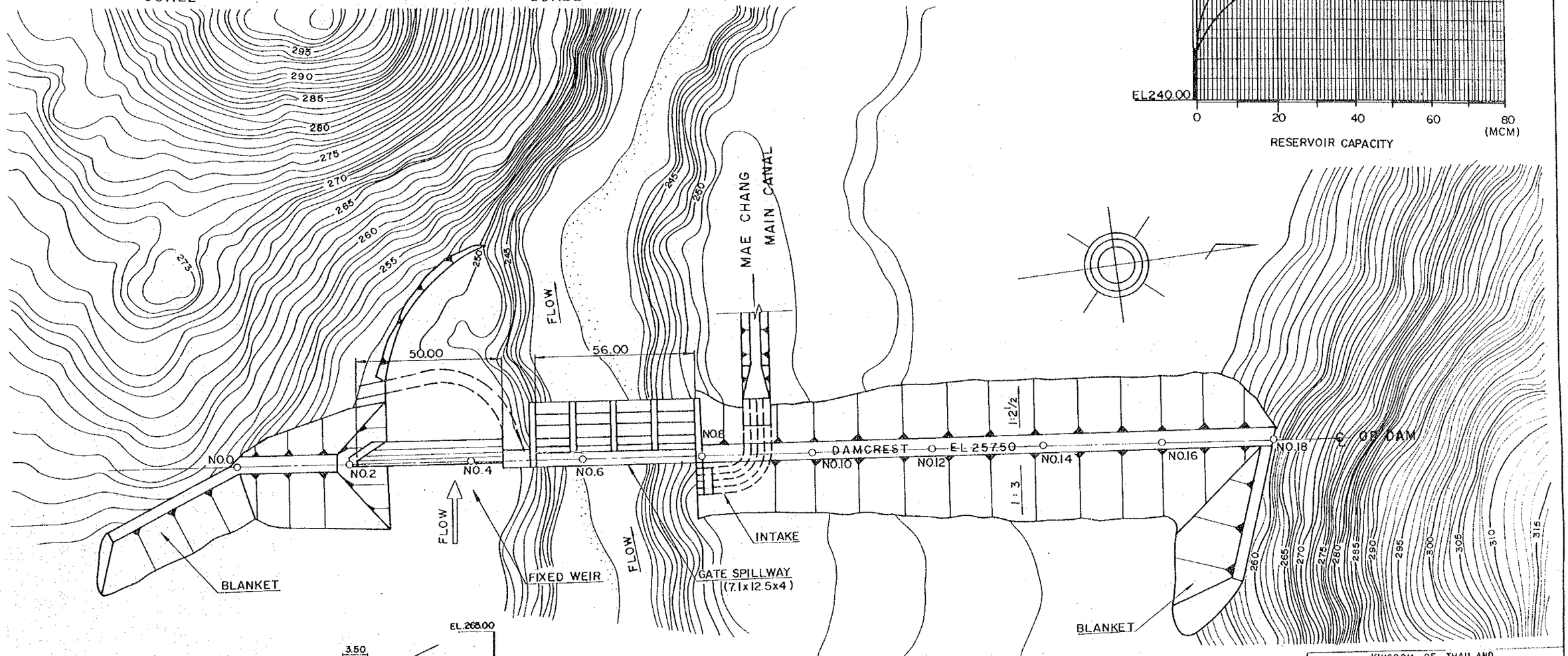
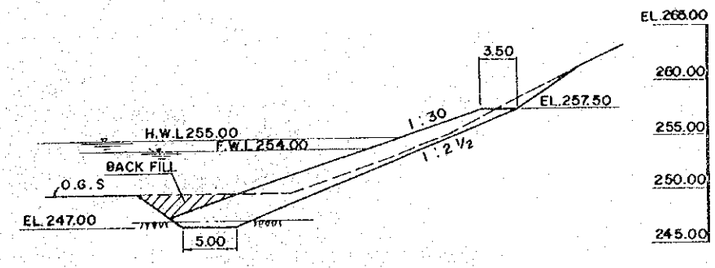




DAM DIMENSION		
Location of Dam site	Near Ban Sop Po Village	
Bed-rock	Limestone	
Catchment Area	254	(sq.Km)
Gross Reservoir Capacity	12	(Mcum)
Usable Reservoir Capacity	7	(Mcum)
Dam Type	Combination Type	
Dam Height	22.5	(m)
Dam Length	360	(m)
Dam Volume (cum)	CONC.11.700 FILL. 67.700	
Design Flood	1803	(cum/s)
Spillway Capacity	1803	(cum/s)
Spillway Type	Gated Type (12.5x7.1x4)	
Max. overflow Depth	6.6	(m)
Max. intake Capacity	10.5	(cum/s)







TYPICAL CROSS SECTION OF BLANKET

NOTE : 1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

2. ALL ELEVATIONS (EL) ARE IN METERS

0 50 100 M

SCALE

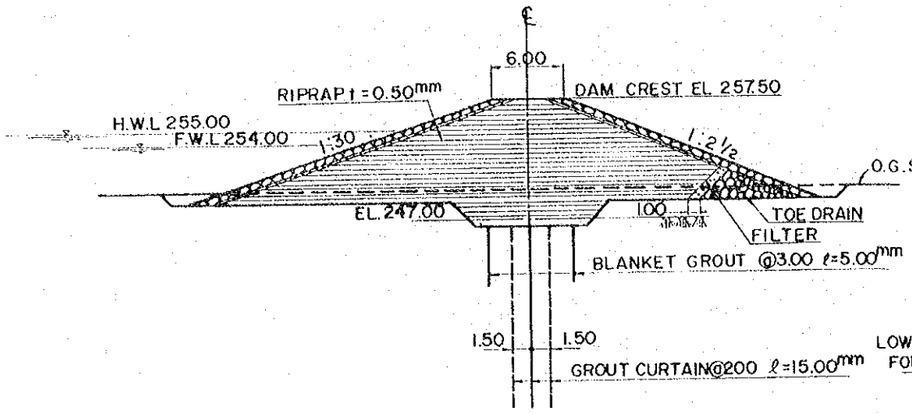
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

MAE CHANG IRRIGATION PROJECT

DIVERSION DAM C 1/2

DATE | DWG DWG 4

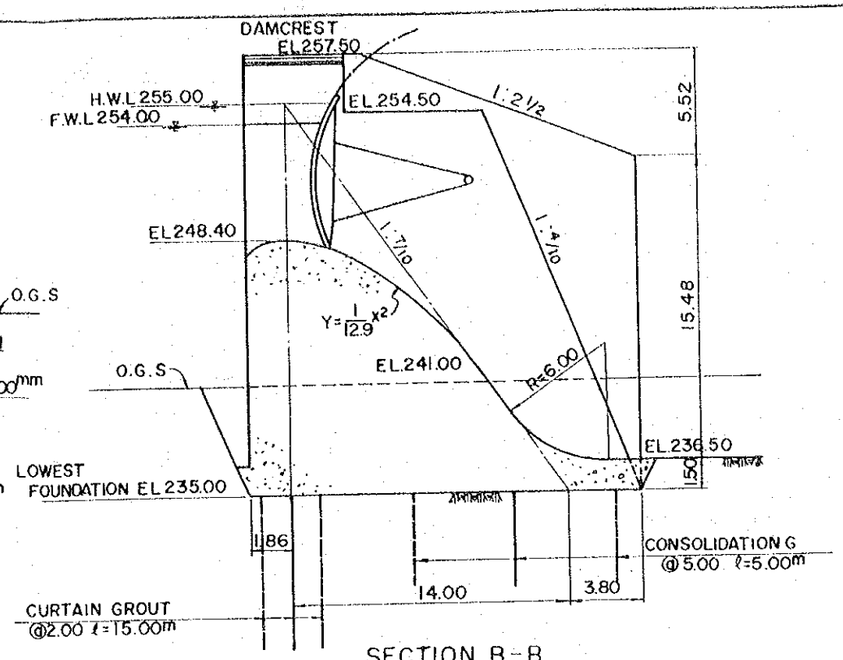
JAPAN INTERNATIONAL COOPERATION AGENCY



SECTION A-A

0 5 10 15 20M

SCALE



SECTION B-B

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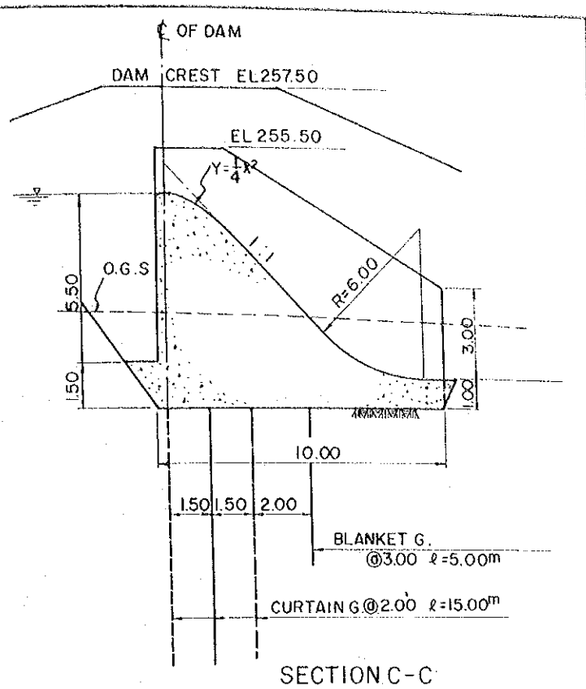
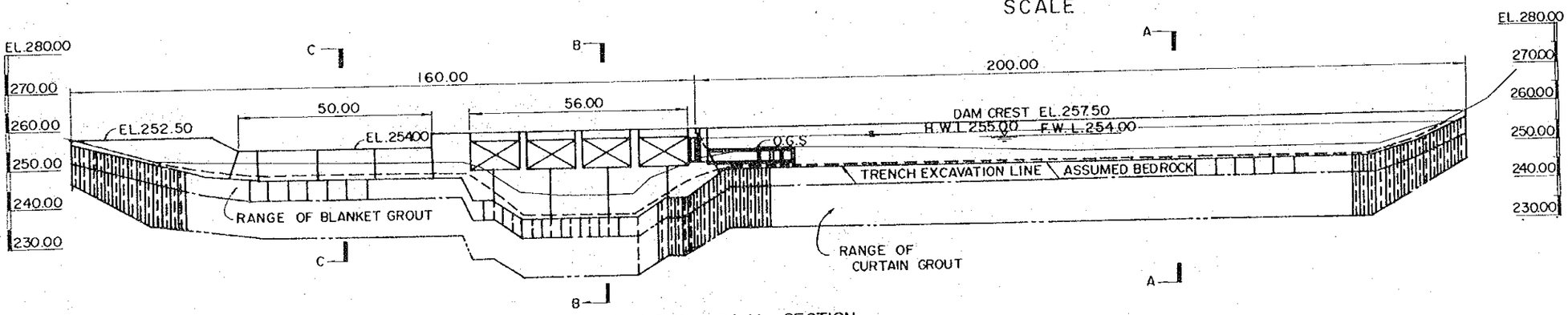
SCALE



SECTION C-C

0 5M

SCALE



LONGITUDINAL SECTION

STATION NO	DISTANCE	ACCUMULATIVE DISTANCE	GROUND ELEVATION	TRENCH ELEVATION	DAM CREST
			FIXED SPILLWAT		
NO. 0	0.00	0.00	257.70	256.50	257.50
NO. 1	20.00	20.00	252.20	251.20	257.50
+15.00	15.00	35.00	251.00	247.50	257.50
NO. 2	5.00	40.00	250.90	247.00	257.50
+2.50	2.50	42.50	250.90	246.60	
+7.50	5.00	49.50	250.70	246.00	
NO. 3	12.50	60.00	250.50	246.00	
NO. 4	20.00	80.00	250.25	246.00	
			SPILLWAY WITH GATE		
NO. 5	20.00	100.00	250.00	246.00	
+2.50	2.50	102.50	249.30	240.00	
+7.50	5.00	107.50	246.60	240.00	
+15.00	7.50	115.00	242.00	235.00	
NO. 6	5.00	120.00	241.50	235.00	
NO. 7	20.00	140.00	240.90	235.00	
+5.00	5.00	145.00	241.90	235.00	
+12.50	7.50	152.50	246.60	240.00	
+17.50	5.00	157.50	248.50	240.00	
NO. 8	2.50	160.00	249.40	241.70	
+7.50	7.50	167.50	251.00	247.00	257.50
NO. 9	12.50	180.00	252.00	247.00	257.50
NO. 10	20.00	200.00	252.00	247.00	257.50
NO. 11	20.00	220.00	251.50	247.00	257.50
NO. 12	20.00	240.00	250.60	247.00	257.50
NO. 13	20.00	260.00	250.00	247.00	257.50
NO. 14	20.00	280.00	250.00	247.00	257.50
NO. 15	20.00	300.00	250.00	247.00	257.50
NO. 16	20.00	320.00	250.00	247.00	257.50
+15.00	15.00	335.00	250.00	247.00	257.50
NO. 17	5.00	340.00	250.80	248.50	257.50
+5.00	5.00	345.00	252.30	249.80	257.50
NO. 18	15.00	360.00	258.00	256.40	257.50

NOTE :

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2. ALL ELEVATIONS (EL) ARE IN METERS.

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

MAE CHANG IRRIGATION PROJECT

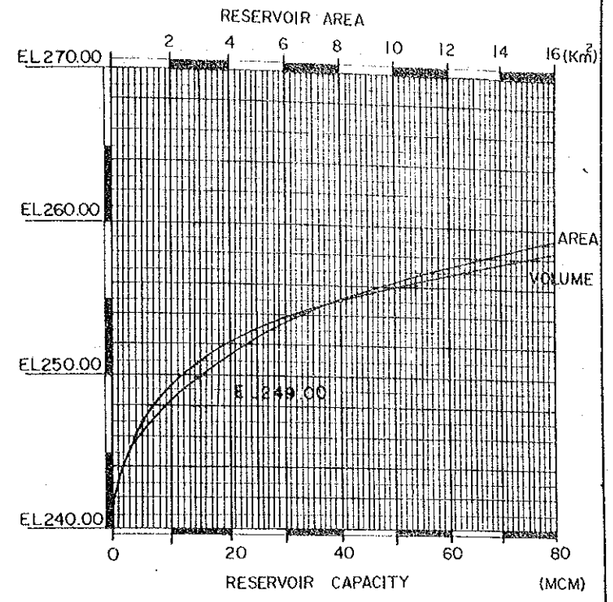
DIVERSION DAM C 2/2

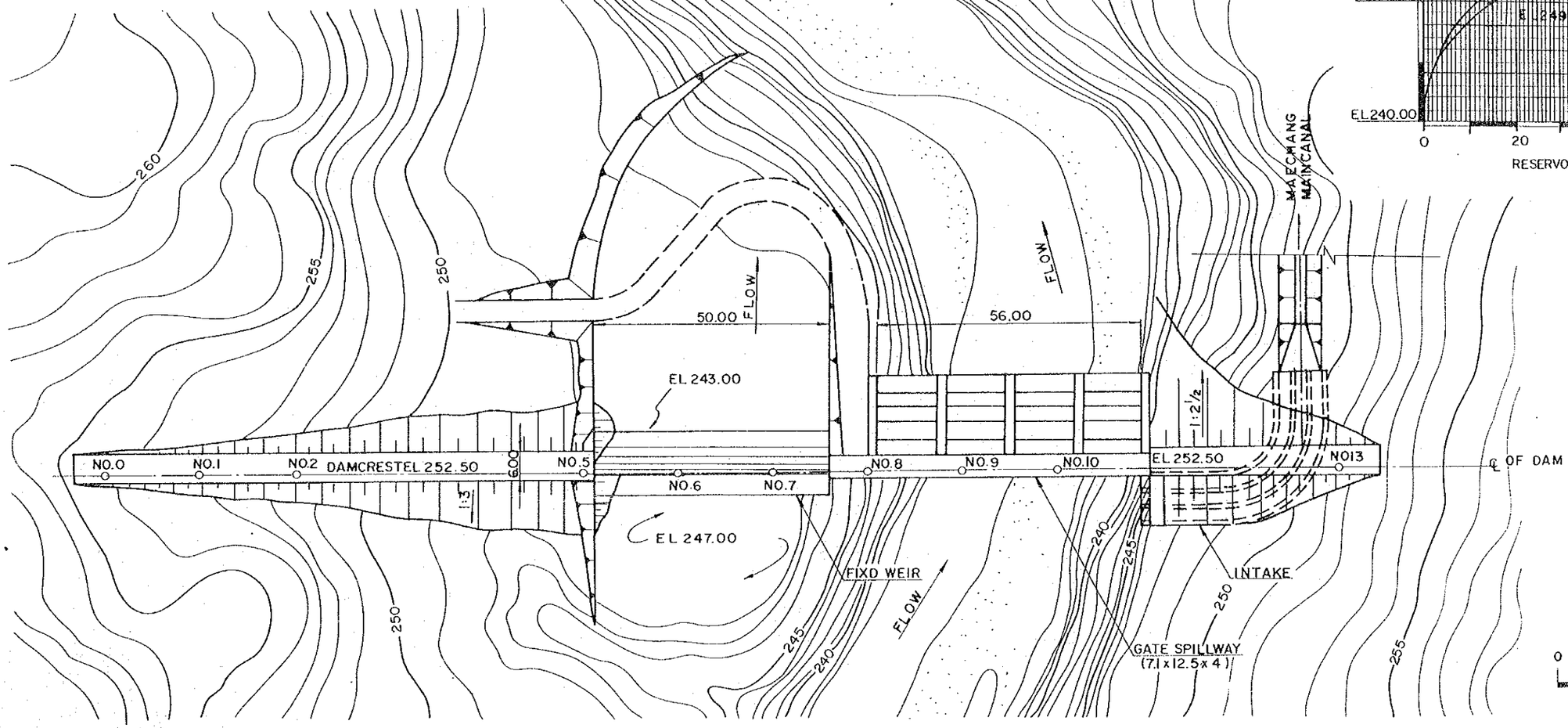
DATE | DWG | DWG 5

JAPAN INTERNATIONAL COOPERATION AGENCY

DAM DIMENSION	
Location of Dam site	Near Ban SoP Po Village
Bed-rock	Limeston
Catchment Area	293 (sq.Km)
Gross Reservoir Capacity	9 (Mcum)
Usable Reservoir Capacity	2 (Mcum)
Dam Type	Combination Type
Dam Heignt	21.5 (m)
Dam Length	257 (m)
Dam Volume (cum)	CONC. 11800 FILL. 13200
Design Flood	1809 (cum/s)
Spillway Capacity	1809 (cum/s)
Spillway Type	Gated Type (12.5x7.1x4)
Max. overtlow DePth	6.6 (.m)
Max. intake CaPacity	10.5 (cum/s)

DAM-D RESERVOIR H-Q CURVE
DIVERSION DAM D AREA-VOLUME CURVES





NOTE : 1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.

2. ALL ELEVATIONS (EL) ARE IN METERS.

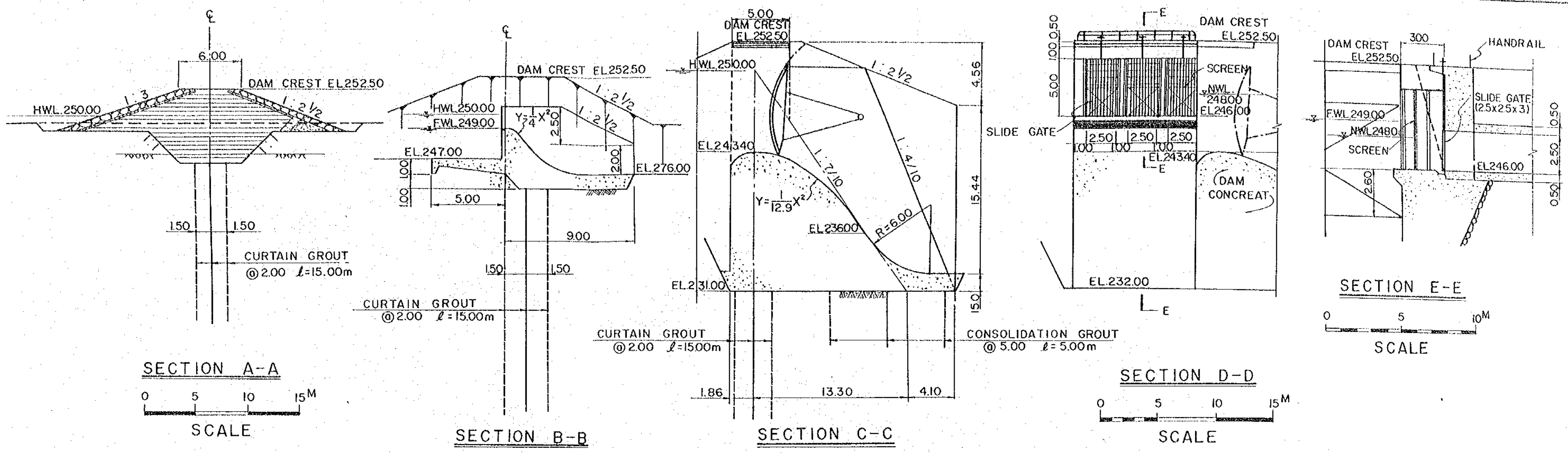
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

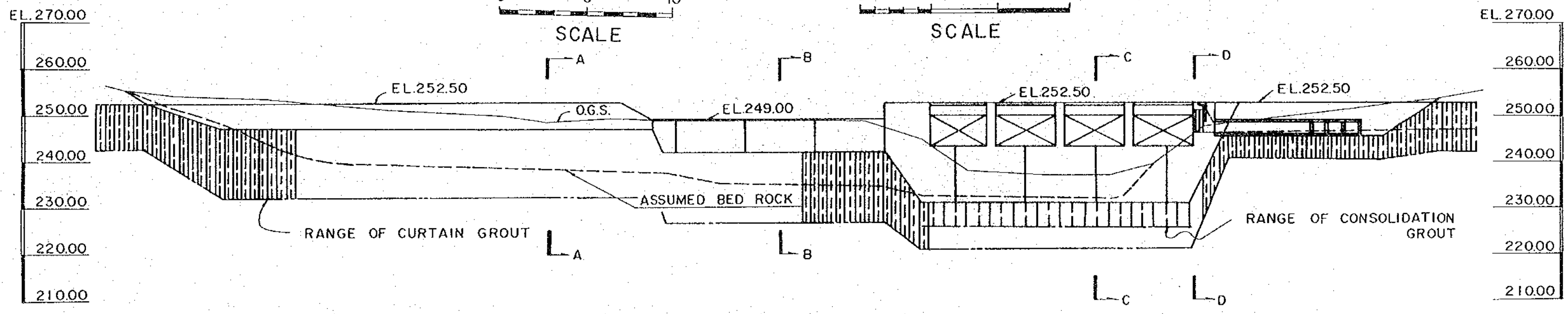
MAE CHANG IRRIGATION PROJECT

DIVERSION DAM D 1/2

DATE | DWG DWG 6

JAPAN INTERNATIONAL COOPERATION AGENCY





LONGITUDINAL SECTION

DAM CREST		252.50	252.50	252.50	252.50	252.50	252.50	252.50	252.50	250.40			FIXED WEIR				GATE SPILLWAY		IN TAKE		252.50	252.50	252.50	252.50	252.50
TRENCH ELEVATION	255.50	252.50	250.40	247.00	247.00	247.00	247.00	247.00	247.00	247.00	247.00	242.00	242.00	242.00	242.00	231.00	231.00	231.00	231.00	236.00	245.50	245.50	245.50	246.70	253.50
GROUND ELEVATION	255.50	254.80	254.00	253.60	253.30	251.40	250.00	248.50	249.00	249.00	249.00	249.00	249.00	249.00	249.00	245.00	237.50	237.50	245.50	247.50	248.00	249.30	252.30	252.50	253.50
ACCUMULATIVE DISTANCE	0.00	4.50	11.00	21.00	31.00	51.00	71.00	91.00	107.00	111.00	113.50	116.00	131.00	151.00	143.50	151.00	171.00	191.00	208.50	211.00	216.00	231.00	249.50	251.00	261.50
DISTANCE	0.00	4.50	6.50	10.00	10.00	20.00	20.00	20.00	16.00	4.00	2.50	2.50	15.00	20.00	12.50	7.50	20.00	20.00	17.50	2.50	5.00	15.00	18.50	1.50	10.50
STATION NO.	-11.00	-6.50	NO. 0	+10.00	NO. 1	NO. 2	NO. 3	NO. 4	+16.00	NO. 5	+2.50	+5.00	NO. 6	NO. 7	+12.50	NO. 8	NO. 9	NO. 10	+17.50	NO. 11	+5.00	NO. 12	+18.50	NO. 13	+10.50

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2. ALL ELEVATIONS (EL) ARE IN METERS.

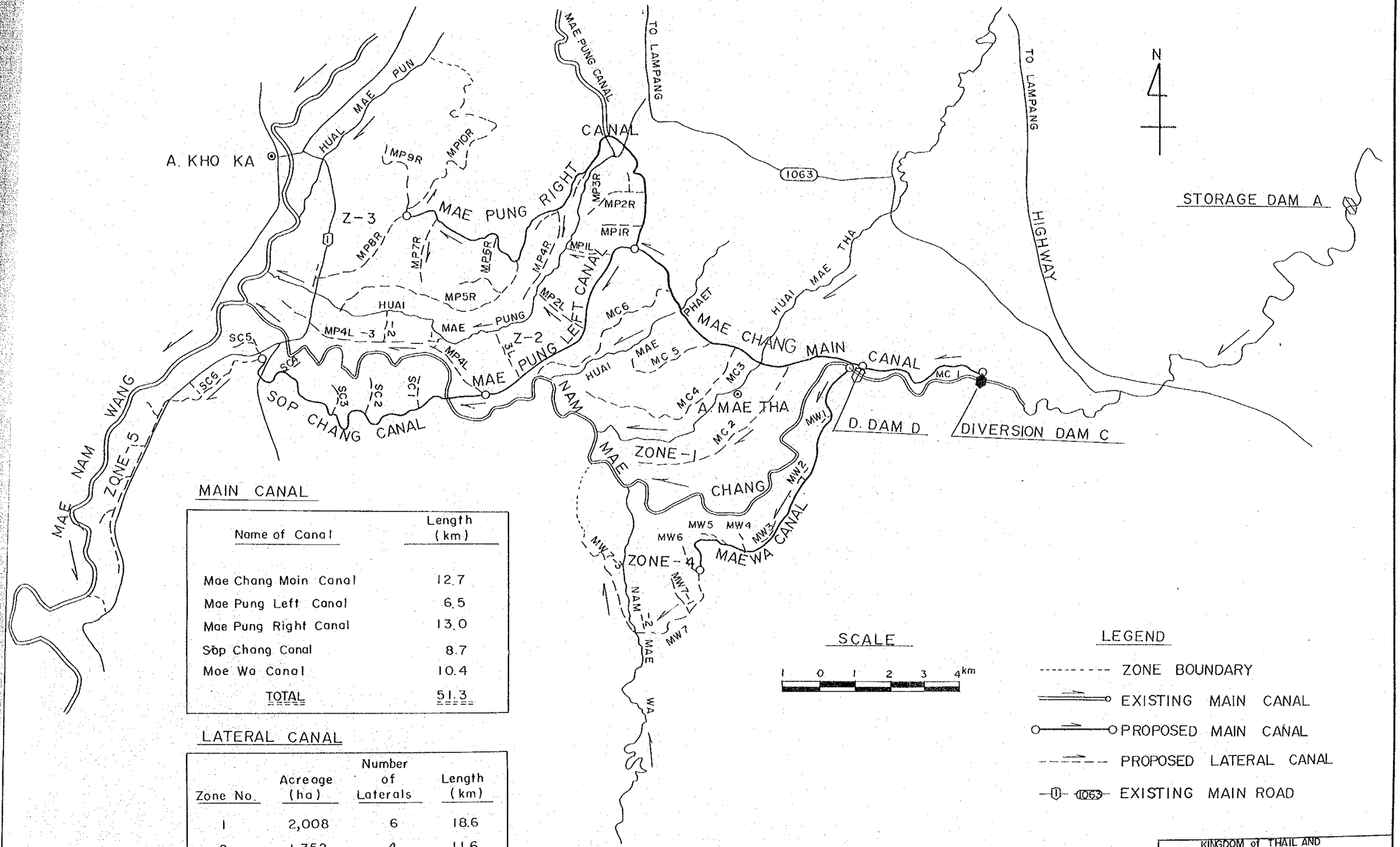
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

MAE CHANG IRRIGATION PROJECT

DIVERSION DAM D 2/2

DATE		DWG	DWG 7

JAPAN INTERNATIONAL COOPERATION AGENCY



MAIN CANAL

Name of Canal	Length (km)
Mae Chang Main Canal	12.7
Mae Pung Left Canal	6.5
Mae Pung Right Canal	13.0
Sŏp Chang Canal	8.7
Moe Wa Canal	10.4
TOTAL	51.3

LATERAL CANAL

Zone No.	Acreage (ha)	Number of Laterals	Length (km)
1	2,008	6	18.6
2	1,352	4	11.6
3	2,646	10	34.9
4	935	7	13.0
5	1,154	6	15.2
TOTAL	8,095	33	93.3

KINGDOM of THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROTAL IRRIGATION DEPARTMENT

MAE CHANG IRRIGATION PROJECT

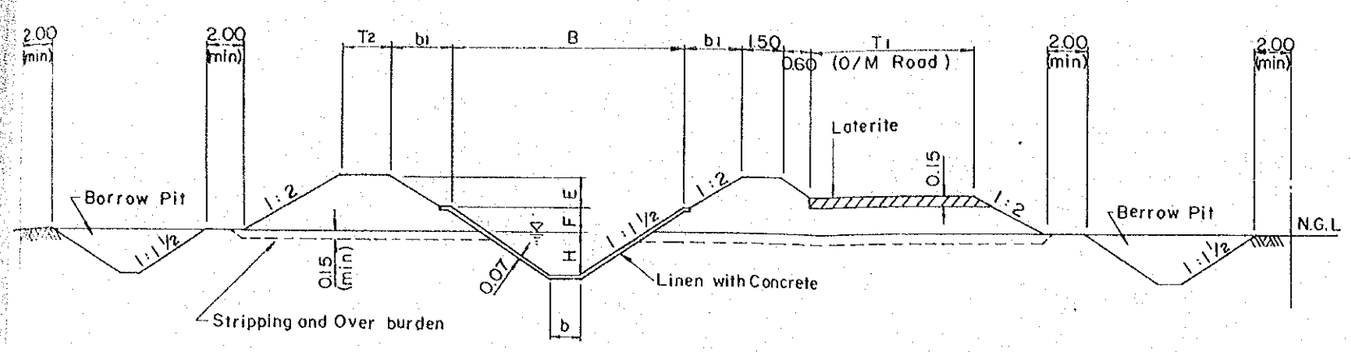
PROPOSED IRRICATION SYSTEM
(CASE-5)

DATE | DWG | DWG 8

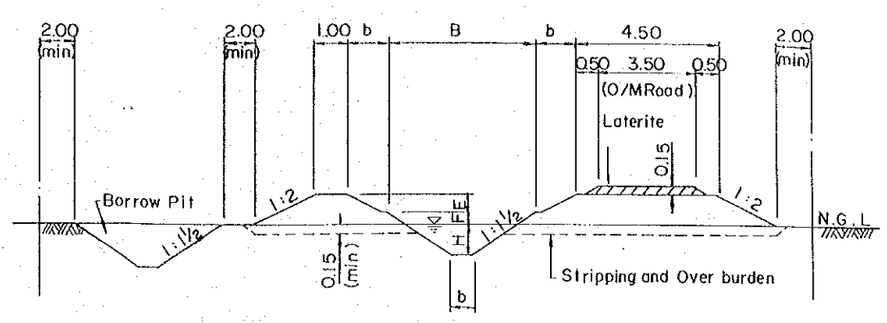
JAPAN INTERNATIONAL COOPERATION AGENCY

TYPICAL CROSS SECTION

MAIN CANAL



LATERAL CANAL



DIMENSION TABLE

MAIN CANAL

Name of Canal	Length (km)	Discharge (cu.m/sec)	Velocity (m/sec)	Slope (I)	b (m)	H (m)	F (m)	E (m)	B (m)	b_1 (m)	T_1 (m)	T_2 (m)
Mae Chang Main Canal	1.60	10.52	0.93	1:7,000	2.70	1.99	0.35	0.50	9.75	1.15	5.00	3.50
	2.80	10.45	0.93	1:7,000	2.70	1.98	0.35	0.50	9.75	1.15	5.00	3.50
	2.10	9.23	0.90	1:7,000	2.70	1.87	0.35	0.50	9.45	1.15	5.00	3.50
	1.00	8.17	0.87	1:7,000	2.70	1.76	0.30	0.45	9.00	1.05	5.00	3.50
	1.30	8.09	0.87	1:7,000	2.70	1.75	0.30	0.45	8.85	1.05	5.00	3.50
	0.70	7.41	0.85	1:7,000	2.70	1.67	0.30	0.45	8.70	1.05	5.00	3.50
	1.80	7.05	0.84	1:7,000	2.70	1.63	0.30	0.45	8.55	1.05	5.00	3.50
	1.40	6.70	0.83	1:7,000	2.70	1.59	0.30	0.45	8.40	1.05	5.00	3.50
	(12.70)											
Mae Pung Left Canal	0.80	3.26	1.11	1:2,000	1.80	0.93	0.20	0.40	5.25	0.95	3.50	2.00
	2.50	2.96	1.07	1:2,000	1.80	0.88	0.20	0.40	5.10	0.95	3.50	2.00
	2.00	2.66	1.05	1:2,000	1.80	0.84	0.20	0.40	9.45	0.95	3.50	2.00
	1.20	2.23	1.00	1:2,000	1.80	0.76	0.20	0.40	4.80	0.95	3.50	2.00
	(6.50)											
Mae Pung Right Canal	0.90	3.44	0.75	1:6,000	1.80	1.26	0.20	0.40	6.30	0.95	3.50	2.00
	1.00	3.24	0.74	1:6,000	1.80	1.22	0.20	0.40	6.15	0.95	3.50	2.00
	2.60	2.99	0.72	1:6,000	1.80	1.17	0.20	0.40	6.00	0.95	3.50	2.00
	1.80	2.91	0.72	1:6,000	1.80	1.16	0.20	0.40	6.00	0.95	3.50	2.00
	2.30	2.43	0.68	1:6,000	1.80	1.05	0.20	0.40	5.55	0.95	3.50	2.00
	1.30	1.78	0.67	1:5,000	1.80	0.86	0.20	0.40	5.10	0.95	3.50	2.00
	2.30	1.65	0.66	1:5,000	1.80	0.83	0.20	0.40	4.95	0.95	3.50	2.00
	0.80	1.25	0.62	1:5,000	1.20	0.83	0.20	0.40	4.35	0.95	3.50	2.00
	(13.00)											
Mae Wa Canal	2.40	1.22	0.61	1:5,000	1.80	0.71	0.20	0.40	4.65	0.95	3.50	2.00
	2.30	1.07	0.58	1:5,000	1.80	0.66	0.20	0.40	4.50	0.95	3.50	2.00
	1.30	0.99	0.64	1:4,000	1.20	0.70	0.15	0.30	3.75	0.75	3.50	2.00
	1.00	0.83	0.63	1:4,000	1.20	0.68	0.15	0.30	3.75	0.75	3.50	2.00
	0.50	0.86	0.61	1:4,000	1.20	0.65	0.15	0.30	3.60	0.75	3.50	2.00
	2.90	0.68	0.58	1:4,000	1.20	0.58	0.15	0.30	3.45	0.75	3.50	2.00
	(10.40)											
Sop Chang Canal	2.30	1.50	0.69	1:4,000	1.80	0.74	0.20	0.40	4.65	0.95	3.50	2.00
	1.40	1.33	0.67	1:4,000	1.80	0.70	0.20	0.40	4.50	0.95	3.50	2.00
	1.80	1.14	0.64	1:4,000	1.80	0.64	0.20	0.40	4.35	0.95	3.50	2.00
	1.80	1.01	0.62	1:4,000	1.80	0.60	0.20	0.40	4.20	0.95	3.50	2.00
	1.40	0.92	0.62	1:4,000	1.20	0.67	0.15	0.30	3.75	0.75	3.50	2.00
	(8.70)											
	(51.30)											

LATERAL CANAL

Name of Canal	Length (km)	Discharge (cum/s)	Velocity (m/s)	Slope (I)	b (m)	H (m)	F (m)	E (m)	B (m)	b_1 (m)
MC1	0.50	0.08	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MC2	1.80	1.06	0.66	1:1,500	1.20	0.75	0.20	0.40	4.05	0.90
	2.10	0.80	0.62	1:1,500	0.80	0.70	0.15	0.30	3.35	0.70
	1.40	0.40	0.52	1:1,500	0.50	0.60	0.15	0.30	1.85	0.70
MC3	0.10	0.09	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MC4	1.40	0.68	0.59	1:1,500	0.80	0.65	0.15	0.30	3.20	0.70
	2.20	0.45	0.53	1:1,500	0.50	0.60	0.15	0.30	2.75	0.70
	1.70	0.23	0.52	1:1,000	0.50	0.40	0.15	0.30	2.15	0.70
MC5	2.30	0.36	0.51	1:1,500	0.50	0.55	0.15	0.30	2.60	0.70
MC6	2.50	0.36	0.51	1:1,500	0.50	0.55	0.15	0.30	2.60	0.70
	2.60	0.12	0.45	1:1,500	0.50	0.40	0.15	0.30	2.15	0.70
	(18.6)									
MP1L	1.10	0.30	0.48	1:1,500	0.50	0.50	0.15	0.30	2.45	0.70
MP2L	1.20	0.29	0.48	1:1,500	0.50	0.50	0.15	0.30	2.45	0.70
MP3L	1.20	0.44	0.53	1:1,500	0.50	0.60	0.15	0.30	2.75	0.70
MP4L	2.40	0.73	0.61	1:1,500	0.80	0.70	0.15	0.30	3.35	0.70
	1.10	0.52	0.56	1:1,500	0.80	0.60	0.15	0.30	3.05	0.70
MP4L-1	0.60	0.21	0.45	1:1,500	0.50	0.45	0.15	0.30	2.30	0.70
MP4L-2	0.80	0.33	0.51	1:1,500	0.50	0.55	0.15	0.30	2.60	0.70
MP4L-3	3.20	0.20	0.45	1:1,500	0.50	0.45	0.15	0.30	2.30	0.70
	(11.6)									
MP1R	1.20	0.20	0.52	1:1,000	0.50	0.40	0.15	0.30	2.15	0.70
MP2R	0.50	0.25	0.56	1:1,000	0.50	0.45	0.15	0.30	2.30	0.70
	2.20	0.13	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MP3R	0.50	0.80	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MP4R-1	3.10	0.34	0.59	1:1,000	0.50	0.50	0.15	0.30	2.45	0.70
MP4R-2	1.00	0.14	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MP5R	1.70	0.65	0.59	1:1,500	0.80	0.65	0.15	0.30	3.20	0.70
	1.80	0.42	0.53	1:1,500	0.50	0.60	0.15	0.30	2.75	0.70
	4.20	0.22	0.52	1:1,000	0.50	0.40	0.15	0.30	2.15	0.70
MP6R	0.90	0.14	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
MP7R	1.40	0.39	0.62	1:1,000	0.50	0.55	0.15	0.30	2.60	0.70
MP8R	2.40	0.49	0.65	1:1,000	0.50	0.60	0.15	0.30	2.75	0.70
	2.00	0.25	0.56	1:1,000	0.50	0.45	0.15	0.30	2.30	0.70
MP9R	0.80	0.62	0.45	1:3,000	0.80	0.75	0.15	0.30	3.50	0.70
	3.10	0.36	0.46	1:2,000	0.50	0.60	0.15	0.30	2.75	0.70
MP10R	8.10	0.38	0.46	1:2,000	0.50	0.60	0.15	0.30	2.75	0.70
	(34.9)									
MW1	0.50	0.15	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
MW2	0.70	0.08	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MW3	0.50	0.06	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MW4	0.50	0.08	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MW5	1.10	0.18	0.52	1:1,000	0.50	0.40	0.15	0.30	2.15	0.70
MW6	1.30	0.17	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
MW7	1.20	0.51	0.51	1:2,000	0.80	0.65	0.15	0.30	3.20	0.70
	1.20	0.34	0.51	1:1,500	0.50	0.55	0.15	0.30	2.60	0.70
MW7-1	1.20	0.17	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
MW7-2	0.80	0.14	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
MW7-3	4.00	0.20	0.52	1:1,000	0.50	0.40	0.15	0.30	2.15	0.70
	(13.0)									
SC1	0.70	0.17	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
SC2	1.10	0.19	0.45	1:1,500	0.50	0.40	0.15	0.30	2.15	0.70
SC3	0.70	0.13	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
SC4	0.40	0.09	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
SC5	1.10	0.21	0.45	1:1,500	0.50	0.45	0.15	0.30	2.30	0.70
SC6	4.20	0.71	0.47	1:3,000	0.80	0.80	0.15	0.30	3.65	0.70
	2.60	0.36	0.51	1:1,500	0.50	0.55	0.15	0.30	2.60	0.70
	4.40	0.10	0.45	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
	(15.2)									
	(93.3)									

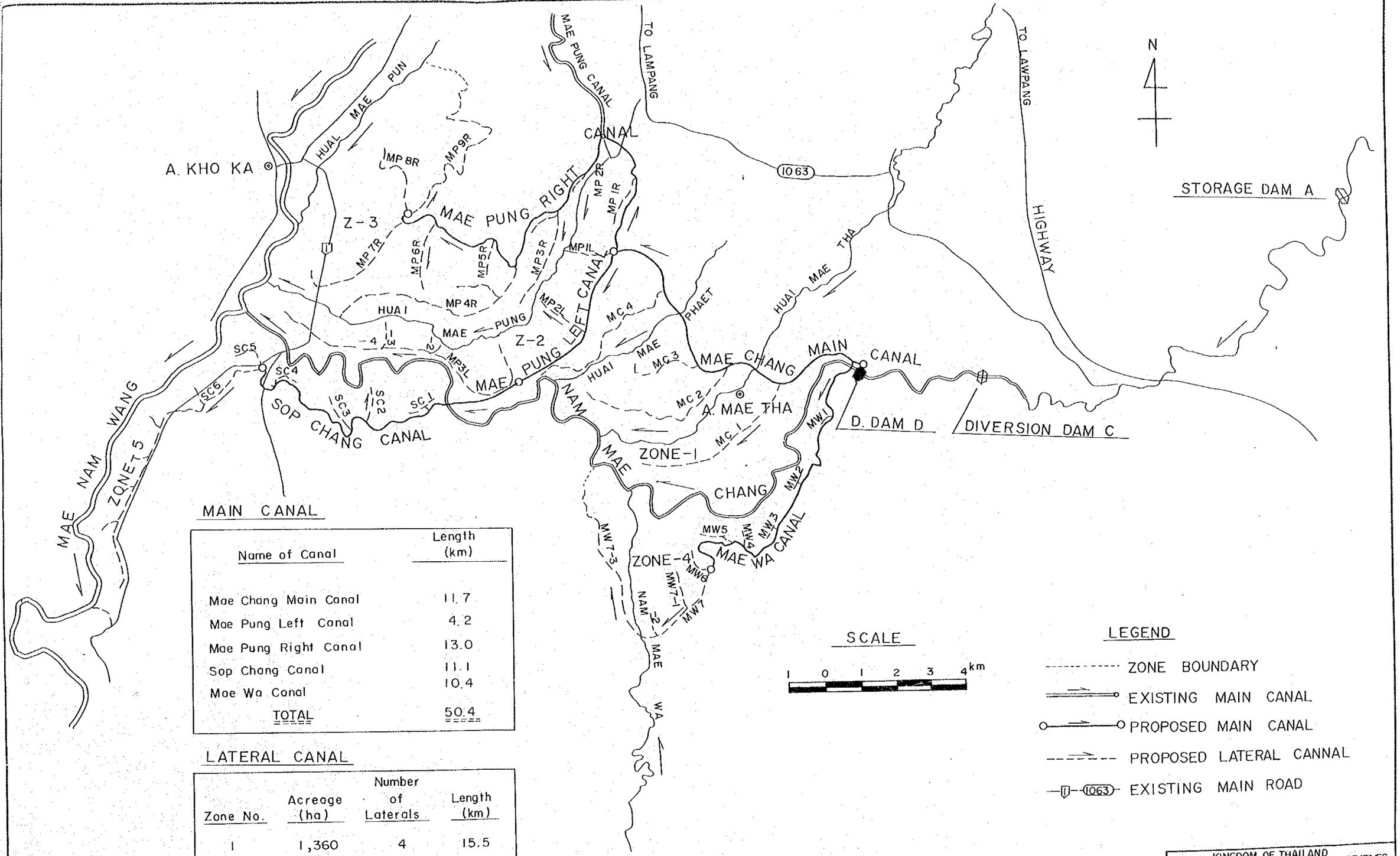
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

MAE CHANG IRRIGATION PROJECT

TYPICAL CROSS SECTION OF MAIN/LATERAL CANAL (CASE-5)

DATE | DWG DWG 9

JAPAN. INTERNATIONAL COOPERATION AGENCY



Name of Canal	Length (km)
Mae Chang Main Canal	11.7
Mae Pung Left Canal	4.2
Mae Pung Right Canal	13.0
Sop Chang Canal	11.1
Mae Wa Canal	10.4
TOTAL	50.4

LATERAL CANAL

Zone No.	Acreage (ha)	Number of Laterals	Length (km)
1	1,360	4	15.5
2	1,302	3	13.5
3	2,300	9	30.6
4	761	7	13.0
5	1,126	6	14.7
TOTAL	7,349	29	87.3

SCALE

1 0 1 2 3 4 km

LEGEND

- ZONE BOUNDARY
- EXISTING MAIN CANAL
- PROPOSED MAIN CANAL
- PROPOSED LATERAL CANNAL
- 1063 EXISTING MAIN ROAD

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPATMENT

MAE CHANG IRRIGATION PROJECT

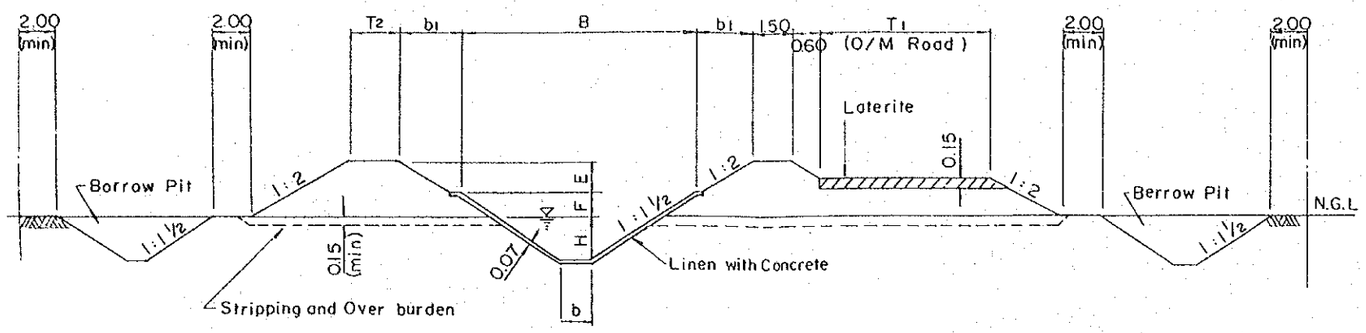
IRRICATION SYSTEM
(CASE-6)

DATE | DWG | DWG 10

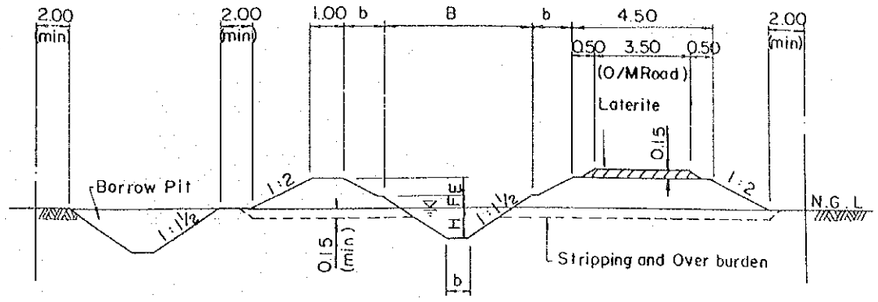
JAPAN INTERNATIONAL COOPERATION AGENCY

TYPICAL CROSS SECTION

MAIN CANAL



LATERAL CANAL



DIMENSION TABLE

MAIN CANAL

Name of Canal	Length (km)	Discharge (m³/sec)	Velocity (m/sec)	Slope (1)	b (m)	H (m)	F (m)	E (m)	B m	b_1 (m)	T_1 (m)	T_2 (m)
Mae Chang Main Canal	0.95	9.55	0.91	1:7,000	2.70	1.90	0.35	0.50	9.45	1.15	5.00	3.50
	2.95	8.56	0.89	1:7,000	2.70	1.80	0.35	0.50	9.15	1.15	5.00	3.50
	2.40	7.37	0.85	1:7,000	2.70	1.67	0.30	0.45	8.60	1.05	5.00	3.50
	1.15	6.92	0.84	1:7,000	2.70	1.62	0.30	0.45	8.45	1.05	5.00	3.50
	3.30	6.56	0.86	1:7,000	2.70	1.58	0.30	0.45	8.35	1.05	5.00	3.50
	1.75	6.15	0.81	1:7,000	2.70	1.53	0.30	0.45	8.20	1.05	5.00	3.50
	(11.70)											
Mae Pung Left Canal	0.05	3.16	0.78	1:5,000	1.80	1.40	0.20	0.40	6.60	0.95	3.50	2.00
	2.75	2.87	0.76	1:5,000	1.80	1.30	0.20	0.40	6.30	0.95	3.50	2.00
	1.40	2.61	0.75	1:5,000	1.80	1.30	0.20	0.40	6.30	0.95	3.50	2.00
	(4.20)											
Mae Pung Right Canal	2.10	2.99	0.77	1:5,000	1.80	1.12	0.20	0.40	5.75	0.95	3.50	2.00
	1.60	2.69	0.75	1:5,000	1.80	1.06	0.20	0.40	5.60	0.95	3.50	2.00
	2.00	2.61	0.75	1:5,000	1.80	1.05	0.20	0.40	5.55	0.95	3.50	2.00
	2.30	2.18	0.71	1:5,000	1.80	0.96	0.20	0.40	5.30	0.95	3.50	2.00
	1.20	1.72	0.72	1:4,000	1.80	0.80	0.20	0.40	4.80	0.95	3.50	2.00
	1.20	1.60	0.71	1:4,000	1.80	0.77	0.20	0.40	4.70	0.95	3.50	2.00
	1.95	1.22	0.66	1:4,000	1.80	0.67	0.20	0.40	4.40	0.95	3.50	2.00
	0.65	0.73	0.62	1:4,000	1.80	0.51	0.15	0.30	3.80	0.75	3.50	2.00
	(13.00)											
Mae Wa Canal	2.40	0.99	0.59	1:5,000	1.20	0.74	0.15	0.30	3.90	0.75	3.50	2.00
	2.30	0.87	0.56	1:5,000	1.20	0.69	0.15	0.30	3.75	0.75	3.50	2.00
	1.30	0.81	0.56	1:5,000	1.20	0.67	0.15	0.30	3.75	0.75	3.50	2.00
	1.00	0.76	0.59	1:4,000	1.20	0.61	0.15	0.30	3.60	0.75	3.50	2.00
	0.50	0.70	0.58	1:4,000	1.20	0.59	0.15	0.30	3.45	0.75	3.50	2.00
	2.90	0.55	0.54	1:4,000	1.20	0.52	0.15	0.30	3.30	0.75	3.50	2.00
	(10.40)											
Sop Chang Canal	3.70	1.46	0.69	1:4,000	1.80	0.73	0.20	0.40	4.60	0.95	3.50	2.00
	1.50	1.29	0.67	1:4,000	1.80	0.69	0.20	0.40	4.50	0.95	3.50	2.00
	1.20	1.10	0.64	1:4,000	1.80	0.64	0.20	0.40	4.30	0.95	3.50	2.00
	2.80	0.96	0.70	1:3,000	1.20	0.64	0.15	0.30	3.60	0.75	3.50	2.00
	1.90	0.68	0.64	1:3,000	1.20	0.54	0.15	0.30	3.30	0.75	3.50	2.00
	(11.10)											
	(50.40)											

LATERAL CANAL

Name of Canal	Length (km)	Discharge (cu.m/sec)	Velocity (m/sec)	Slope (1)	b (m)	H (m)	F (m)	E (m)	B (m)	b_1 (m)
MC1	1.00	1.20	0.61	1:2,000	1.20	0.82	0.20	0.40	4.35	0.90
	2.10	0.80	0.55	1:2,000	0.80	0.75	0.15	0.30	3.50	0.70
	1.40	0.40	0.46	1:2,000	0.50	0.61	0.15	0.30	2.90	0.70
MC2	4.20	0.45	0.48	1:2,000	0.50	0.65	0.15	0.30	2.90	0.70
MC3	2.10	0.36	0.45	1:2,000	0.50	0.58	0.15	0.30	2.75	0.70
MC4	4.70	0.41	0.46	1:2,000	0.50	0.61	0.15	0.30	2.90	0.70
	(15.50)									
MP1L	1.45	0.29	0.48	1:1,500	0.50	0.50	0.15	0.30	2.45	0.70
MP2L	1.20	0.27	0.47	1:1,500	0.50	0.48	0.15	0.30	2.45	0.70
MP3L	0.40	1.14	0.60	1:2,000	1.20	0.80	0.20	0.40	4.20	0.90
	3.70	0.74	0.54	1:2,000	0.80	0.73	0.15	0.30	3.50	0.70
	1.10	0.53	0.50	1:2,000	0.80	0.62	0.15	0.30	3.20	0.70
MP3L-1	1.20	0.40	0.46	1:2,000	0.50	0.61	0.15	0.30	2.90	0.70
MP3L-2	0.55	0.21	0.43	1:1,500	0.50	0.41	0.15	0.30	2.30	0.70
MP3L-3	0.80	0.33	0.49	1:1,500	0.50	0.52	0.15	0.30	2.60	0.70
MP3L-4	3.10	0.20	0.43	1:1,500	0.50	0.41	0.15	0.30	2.30	0.70
	(13.50)									
MP1R	1.40	0.31	0.49	1:1,500	0.50	0.51	0.15	0.30	2.60	0.70
MP2R	-	0.08	(Deversion only)							
MP3R-1	3.10	0.34	0.50	1:1,500	0.50	0.53	0.15	0.30	2.60	0.70
MP3R-2	1.00	0.12	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MP4R	1.40	0.46	0.53	1:1,500	0.50	0.54	0.15	0.30	2.60	0.70
	1.60	0.31	0.49	1:1,500	0.50	0.51	0.15	0.30	2.60	0.70
	3.20	0.14	0.46	1:1,000	0.50	0.32	0.15	0.30	2.00	0.70
MP5R	0.90	0.12	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MP6R	2.40	0.38	0.51	1:1,500	0.50	0.56	0.15	0.30	2.75	0.70
MP7R	4.40	0.49	0.55	1:1,500	0.50	0.63	0.15	0.30	2.90	0.70
MP8R	3.10	0.37	0.51	1:1,500	0.50	0.55	0.15	0.30	2.60	0.70
MP9R	8.10	0.36	0.50	1:1,500	0.50	0.54	0.15	0.30	2.60	0.70
	(30.60)									
MW1	0.50	0.15	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
MW2	0.70	0.08	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MW3	0.50	0.06	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MW4	0.50	0.08	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
MW5	1.10	0.18	0.52	1:1,000	0.50	0.40	0.15	0.30	2.15	0.70
MW6	1.30	0.17	0.44	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
MW7	1.20	0.51	0.51	1:2,000	0.80	0.65	0.15	0.30	3.20	0.70
	1.20	0.34	0.51	1:1,500	0.50	0.55	0.15	0.30	2.60	0.70
MW7-1	1.20	0.17	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
MW7-2	0.80	0.14	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
MW7-3	4.00	0.20	0.52	1:1,000	0.50	0.40	0.15	0.30	2.15	0.70
	(13.00)									
SC1	0.70	0.17	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
SC2	1.10	0.19	0.45	1:1,500	0.50	0.40	0.15	0.30	2.15	0.70
SC3	0.70	0.15	0.49	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
SC4	0.40	0.09	0.45	1:1,000	0.50	0.30	0.15	0.30	1.85	0.70
SC5	1.10	0.21	0.45	1:1,500	0.50	0.45	0.15	0.30	2.30	0.70
SC6	4.20	0.71	0.47	1:3,000	0.80	0.80	0.15	0.30	3.65	0.70
	2.60	0.36	0.51	1:1,500	0.50	0.55	0.15	0.30	2.60	0.70
	3.90	0.10	0.45	1:1,000	0.50	0.35	0.15	0.30	2.00	0.70
	(14.70)									
	(87.30)									

KINGDOM OF THAIL AND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

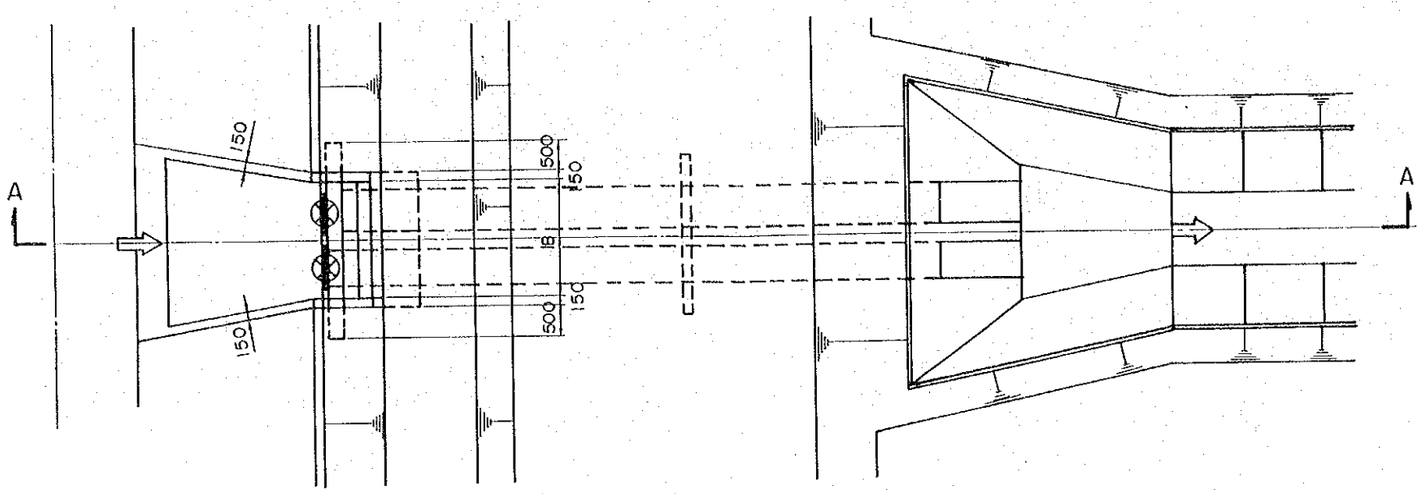
MAE CHANG IRRIGATION PROJECT

TYPICAL CROSS SECTION OF MAIN/LATERAL CANAL (CASE-6)

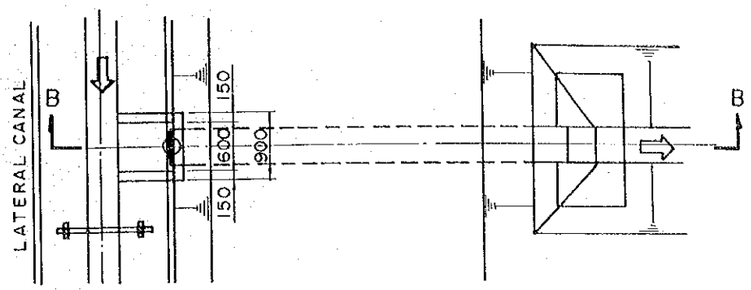
DATE | | DWG | DWG 11

JAPAN INTERNATIONAL COOPERATION AGENCY

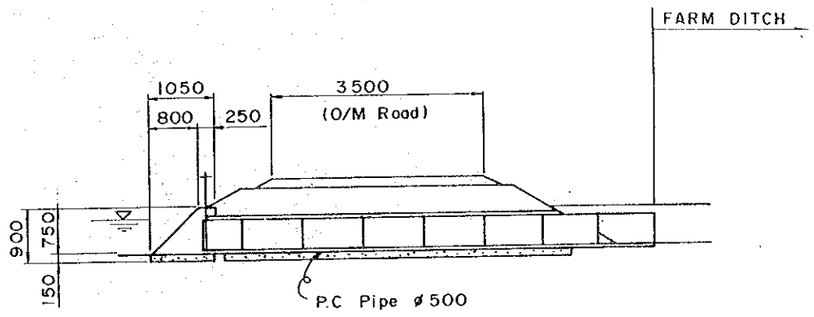
PLAN OF DIVERSION WORKS



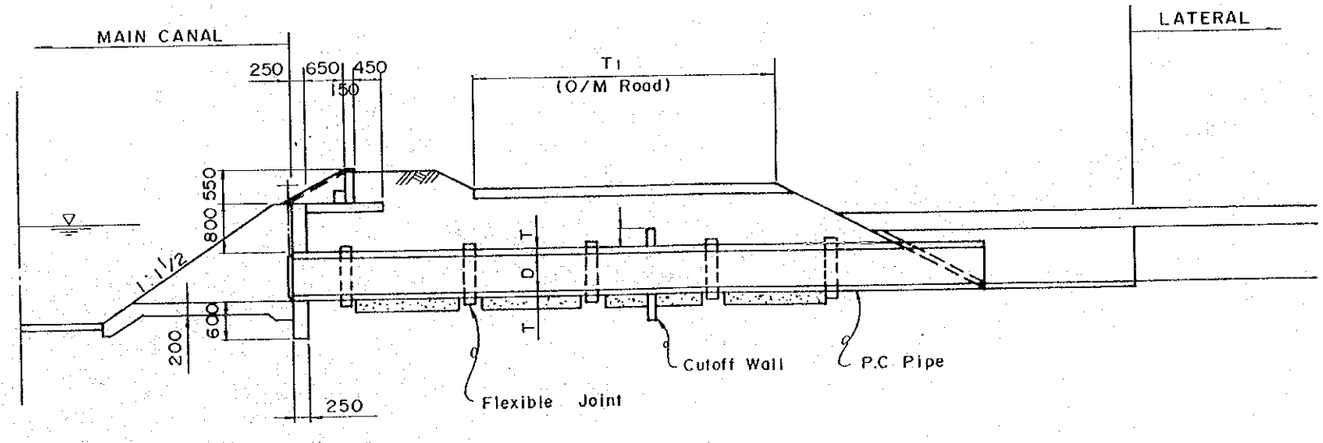
PLAN OF TURN OUT WORKS



SECTION B-B



SECTION A-A



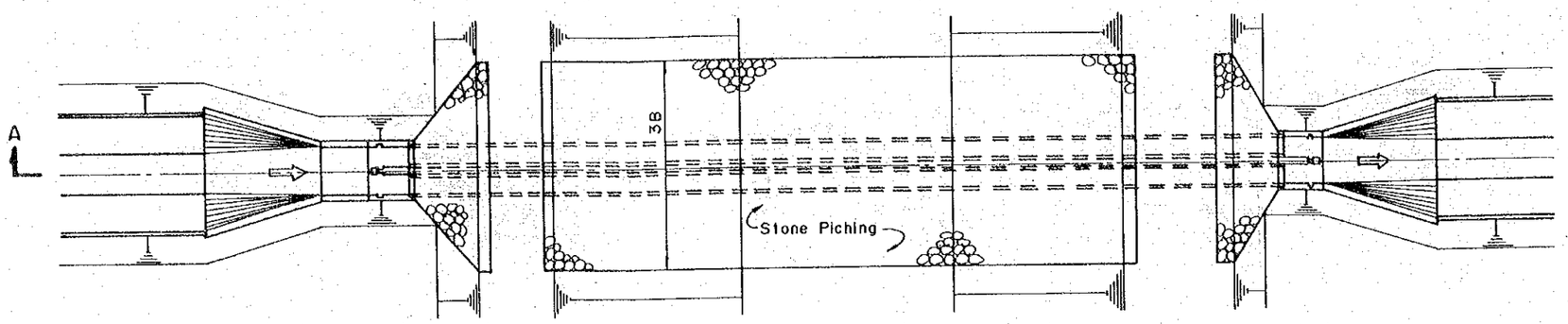
Notes

1) Dimension shows in mm.

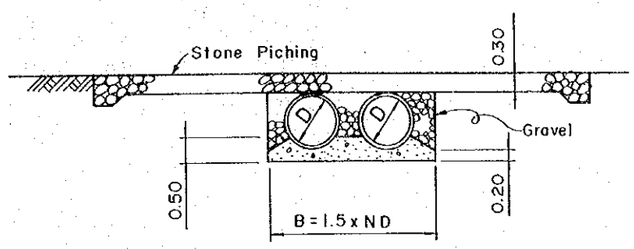
2) Each dimention should be decided by canal sizes and discharges diverted.

KINGDOM OF THAILAND MINISTRY OF AGRICULTURE AND COOPERATIVES ROYAL IRRIGATION DEPARTMENT	
MAE CHANG IRRIGATION PROJECT	
MAJOR STRUCTURES OF IRRIGATION CANAL 1/4	
DATE	DWG DWG 12
JAPAN INTERNATIONAL COOPERATION AGENCY	

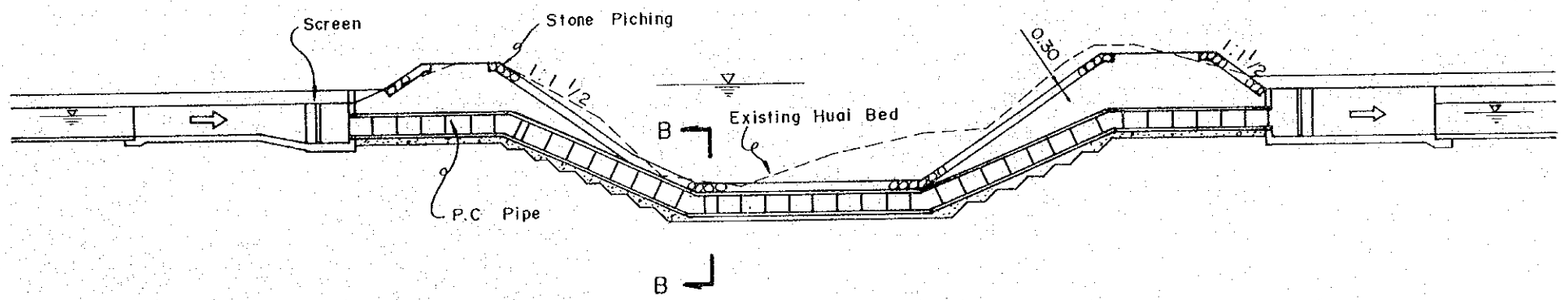
GENERAL PLAN OF SYPHON



SECTION B-B



SECTION A-A

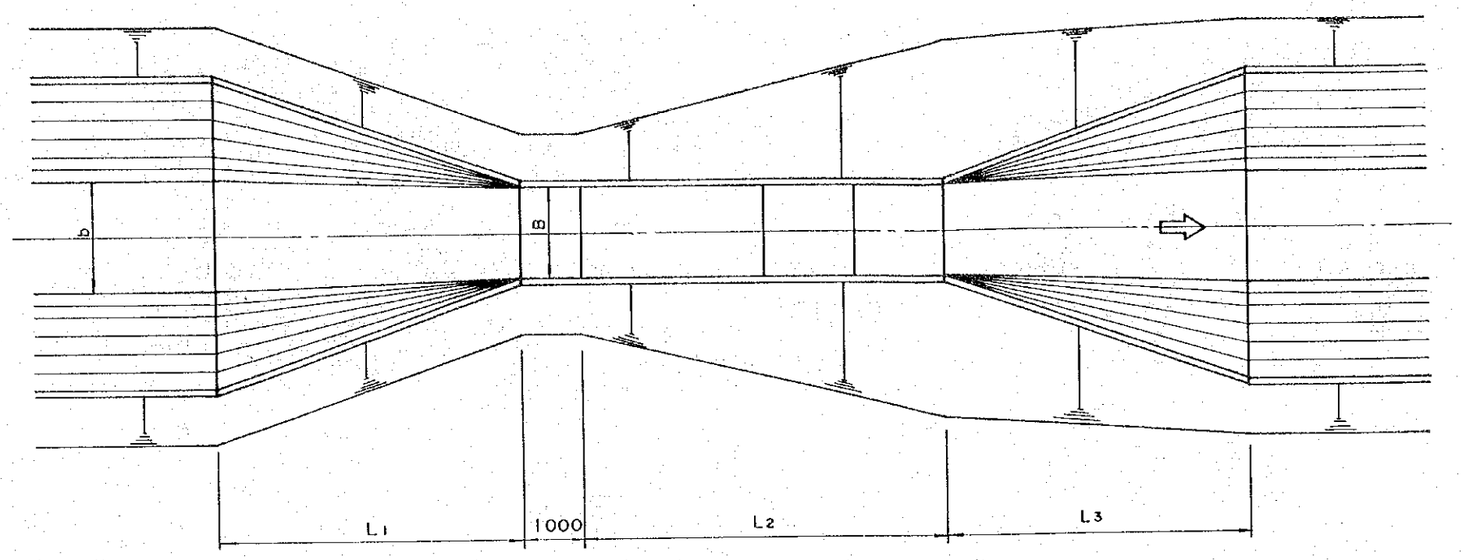


Notes

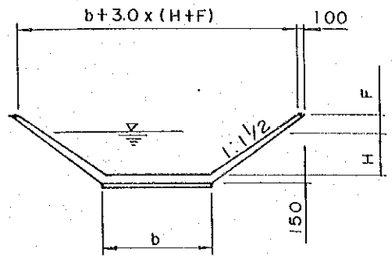
1. Pipe diameter should be decided by the hydraulic computation.
2. The velocity in the syphon should be designed as 1.5 times as it in the open channel.
3. All dimensions are in meters unless otherwise specefied.

KINGDOM OF THAIL AND MINISTRY OF AGRICULTURE AND COOPERATIVES ROYAL IRRIGATION DEPARTMENT	
MAE CHANG IRRIGATION PROJECT	
MAJOR STRUCTURES OF IRRIGATION CANAL 2/4	
DATE	DWG DWG 13
JAPAN INTERNATIONAL COOPERATION AGENCY	

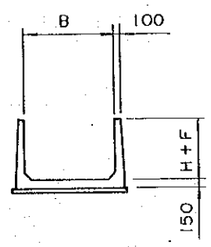
GENERAL PLAN OF DROP WORKS
(IN MAE PUNP LEFT CANAL)



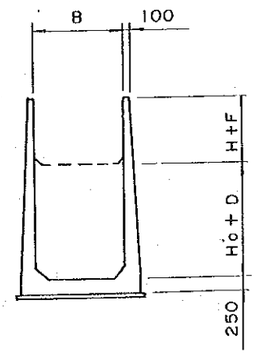
SECTION A-A



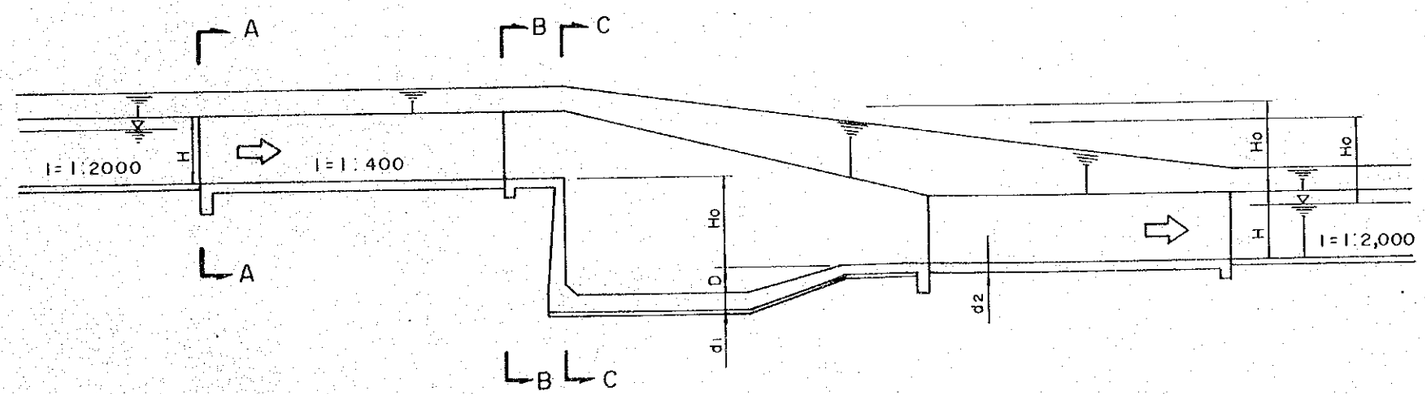
SECTION B-B



SECTION C-C



PROFILE

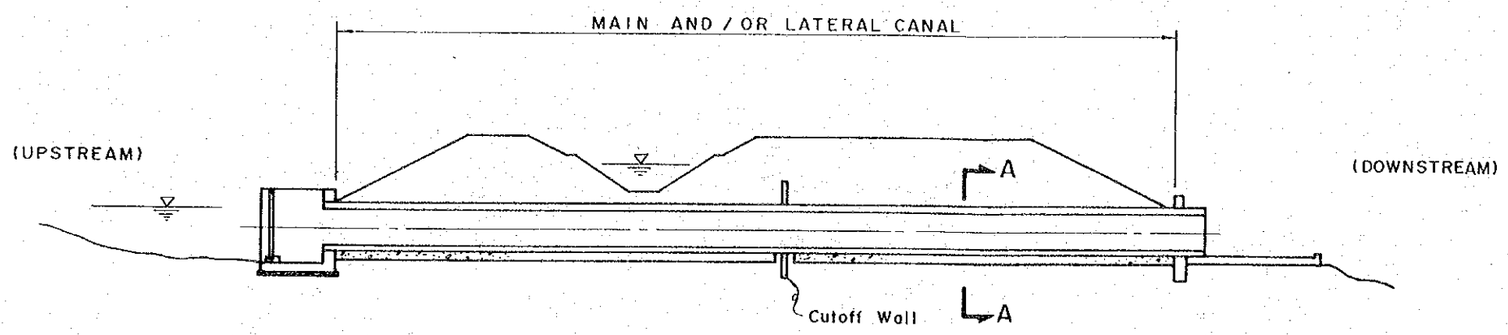


Notes

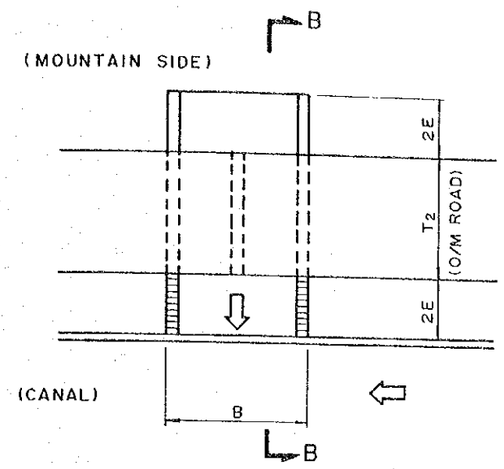
Each dimension should be decided by the hydraulic computations.

KINGDOM OF THAILAND MINISTRY OF AGRICULTURE AND COOPERATIVES ROYAL IRRIGATION DEPARTMENT
MAE CHANG IRRIGATION PROJECT
MAJOR STRUCTURES OF IRRIGATION CANAL 3/4
DATE | DWG DWG 14
JAPAN INTERNATIONAL COOPERATION AGENCY

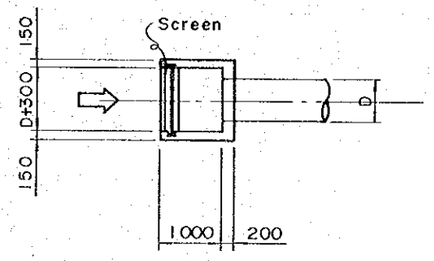
GENERAL SECTION OF CULVERT
(UNDER FLOW TYPE)



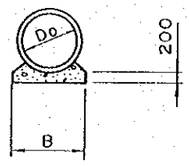
GENERAL PLAN OF CULVERT
(INFLOW TYPE)



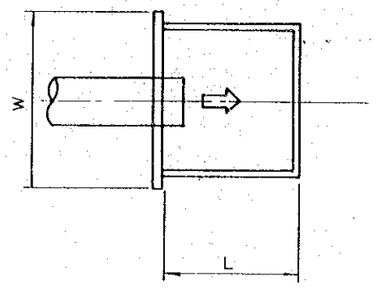
PLAN OF INLET



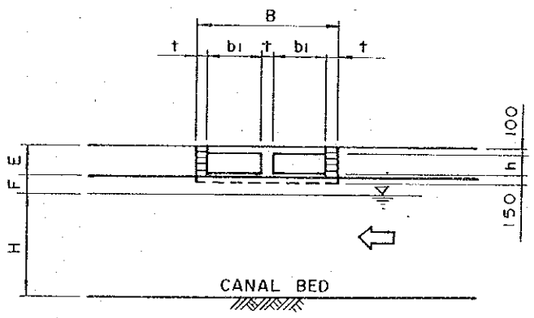
SECTION A-A



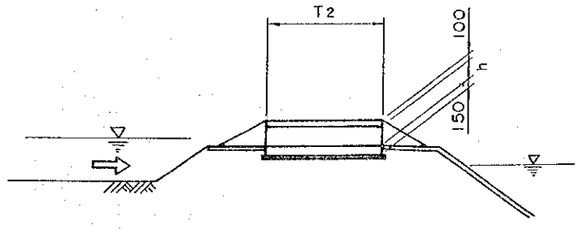
PLAN OF OUTLET



FRONT VIEW



SECTION OF B-B

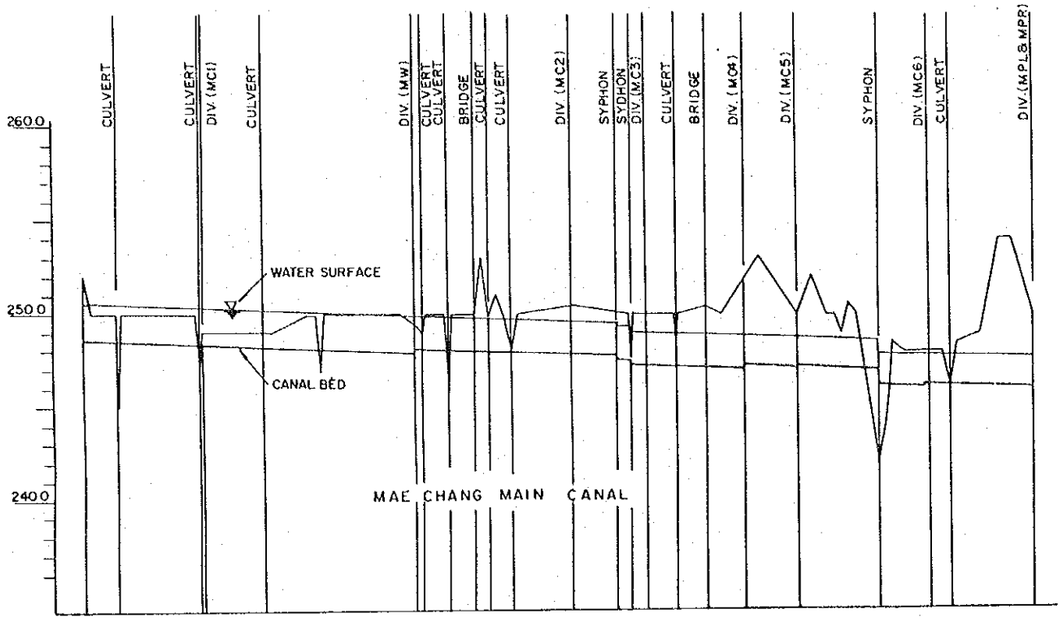


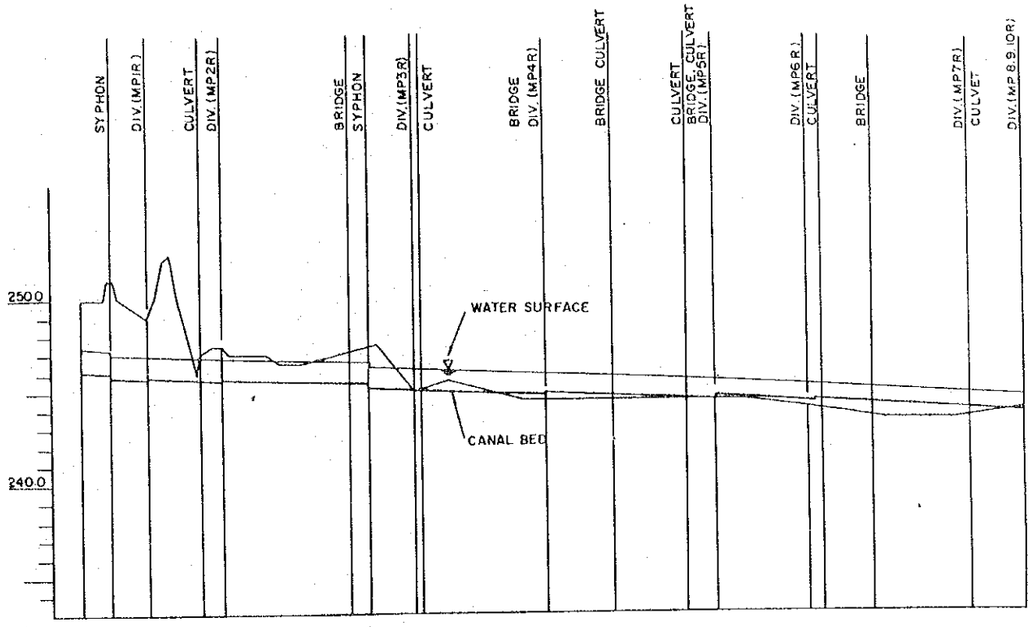
Notes

1) Dimension should be decided under consideration of canal sizes and run off volume of the Huai.

2) Under flow-type and inflow-type should be classified by the criteria in the main text.

KINGDOM OF THAILAND MINISTRY OF AGRICULTURE AND COOPERATIVES ROYAL IRRIGATION DEPARTMENT	
MAE CHANG IRRIGATION PROJECT	
MAJOR STRUCTURES OF IRRIGATION CANAL 4/4	
DATE	DWG DWG 15
JAPAN INTERNATIONAL COOPERATION AGENCY	





STATION	DISTANCE (M)	ACCUMULATIVE DISTANCE (M)	GROUND ELEVATION (M)	CANAL BED ELEVATION (M)	WATER SURFACE (M)	DISCHARGE (CUM/S)	HYDRAULIC GRADIENT
						Q=10.52	1:7,000
NO.0	0	0	252.0	248.59	250.58		
+100	100	100	250.0				
+450	350	450	250.0	248.52	250.51		
+500	50	500					
NO.1	500	1,000	250.0	248.45	250.44		
+550	50	1,050	247.0	248.36	250.35		
+600	50	1,100	249.0		(250.34)		
NO.2	400	2,000	249.0	248.30	250.28		
+400	400	2,400	249.0	248.25	250.23	Q = 10.45	
NO.3	600	3,000	250.0	248.16	250.14		
+150	150	3,150	247.0				
NO.4	850	4,000	250.0	248.02	250.00		
+400	400	4,400	249.5	247.96	249.94		
+500	100	4,500	248.0	(248.07)			
+850	350	4,850	245.0	247.98	249.85		
NO.5	150	5,000	250.0				
+200	200	5,200	250.0	247.93	249.80		
+400	200	5,400	250.0				
+700	300	5,700	248.0	247.84	249.71		
NO.6	300	6,000	250.0				
+500	500	6,500	250.5	247.77	249.64	Q = 9.23	
				(247.88)			
NO.7	500	7,000	250.2	247.79	249.55		
+100	100	7,100	250.0	(247.83)	(249.70)		
+300	200	7,300	250.0	247.52	249.28		
+500	200	7,500	250.0	247.55	(249.31)		
				(247.26)			
+900	400	7,900	248.0	247.19	248.94	Q=8.17	
NO.8	100	8,000	251.5				
+300	300	8,300	250.5	247.12	248.87	Q=8.09	
+500	200	8,500	250.0				
+800	300	8,800	251.8	247.07	248.82		
NO.9	200	9,000	253.0	(247.15)	248.80	Q=7.41	
+500	500	9,500	250.0	247.13	248.72		
				(247.09)			
NO.10	500	10,000	250.0	247.02	248.65	Q= 7.05	
+300	300	10,300	250.0	246.99	248.62		
+600	300	10,600	242.0	246.97	248.60		
+800	200	10,800	248.5	(246.22)	(247.85)		
NO.11	200	11,000	248.0	246.22	247.83		
+300	300	11,300	248.0	246.16	247.76		
+500	200	11,500	246.0	(246.17)	247.77		
+600	100	11,600	248.5	246.14	247.73		
+700	100	11,700	248.5	(246.18)	247.75		
NO.12	300	12,000	249.0	246.10	247.69	Q = 6.70	
+400	400	12,400	254.0	246.04	247.63		
+700 (E.P.)	300	12,700	250.0	246.00	247.59		

STATION	DISTANCE (M)	ACCUMULATIVE DISTANCE (M)	GROUND ELEVATION (M)	CANAL BED ELEVATION (M)	WATER SURFACE (M)	DISCHARGE (CUM/SEC)	HYDRAULIC GRADIENT
						Q=3.44	1: 6,000
NO.0	0	0	250.0	246.13	(247.59)		
+400	400	400	251.0	246.06	247.39		
				245.86	(247.12)		
+900	500	900	249.0	245.78	247.04	Q=3.24	
NO.1	100	1,000	250.0	(245.82)	247.01		
+100	100	1,100	252.0	245.79			
+900	800	1,900	247.5	243.65	246.87		
NO.2	100	2,000	247.0	(245.70)	246.85		
				245.68			
+700	700	2,700	246.5	245.57	246.74		
NO.3	300	3,000	246.5	245.52	246.69	Q = 2.99	
+900	900	3,900	247.4	245.37	(246.54)		
NO.4	100	4,000	247.5	(245.71)	246.32		
				245.15			
+500	500	4,500	245.0	245.07	246.24		
				(245.08)			
NO.5	500	5,000	245.5	245.00	246.16	Q = 2.91	
NO.6	1,000	6,000	244.5	244.77	245.91		
+300	300	6,300	244.5	244.78	245.94		
				(244.89)			
NO.7	700	7,000	244.5	244.77	245.82		
+200	200	7,200	244.5	244.74	245.79	Q = 2.43	
NO.8	800	8,000	244.5	224.61	245.66		
+600	600	8,600	244.5	244.51	245.56		
NO.9	400	9,000	244.5	(244.70)	245.48	Q = 1.78	
+900	900	9,900	244.1	244.44	245.30		
NO.10	100	10,000	244.0	(244.71)	245.28		
				244.45			
+800	800	10,800	243.5	244.29	245.12	Q = 1.65	
NO.11	200	11,000	243.5	244.25	245.08		
NO.12	1,000	12,000	243.5	244.01	244.84		
+200	200	12,200	243.6	(243.97)	244.80	Q=1.25	
NO.13 (E.P.)	800	13,000	244.0	243.85	244.68		

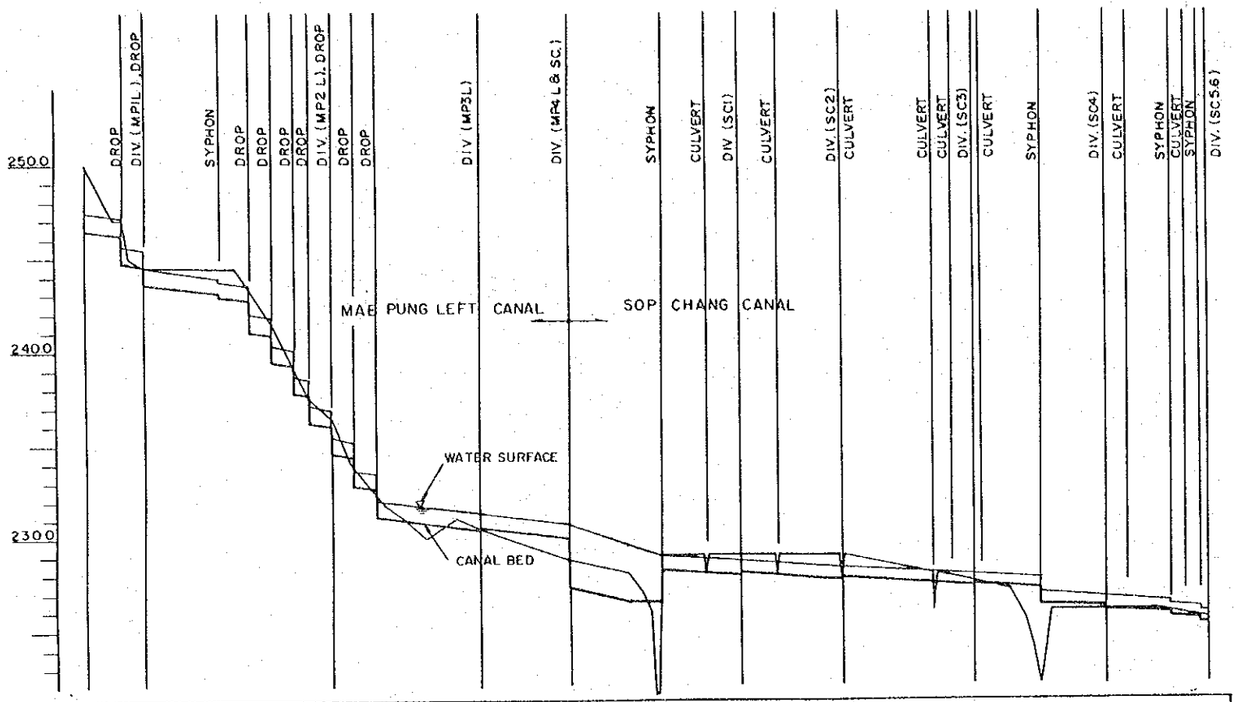
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

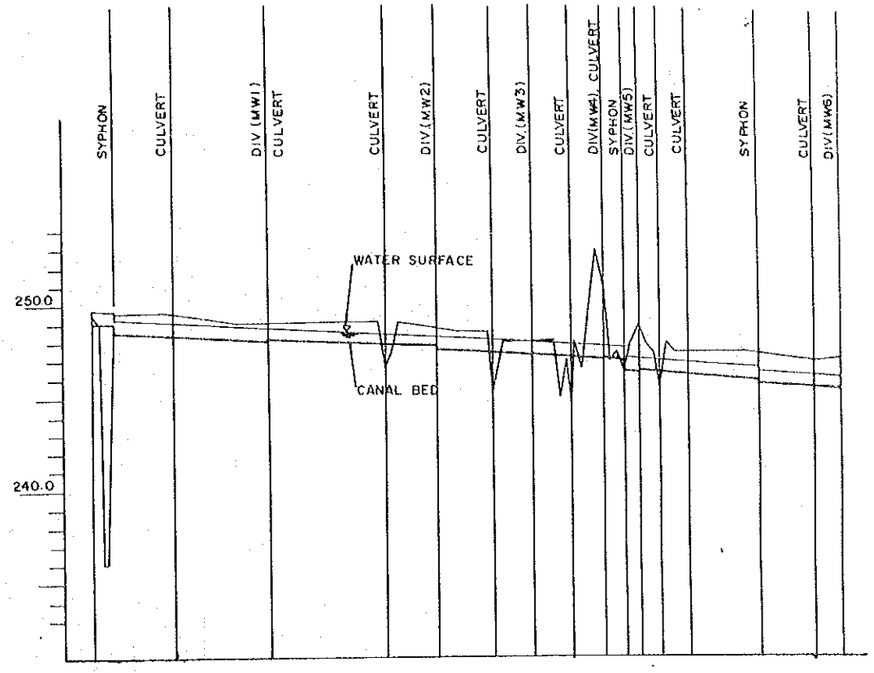
MAE CHANG IRRIGATION PROJECT

PROFILE OF MAIN CANAL (1)
- MCMC and MPRC -

DATE | DWG | DWG 16

JAPAN INTERNATIONAL COOPERATION AGENCY





STATION	DISTANCE (M)	ACCUMULATE DISTANCE (M)	GROUND ELEVATION (M)	CANAL BED ELEVATION (M)	WATER SURFACE (M)	DISCHARGE (CUM/SEC)
						I = 1 : 2,000 / I = 1 : 4,000
NO. 0	0	0	250.0	246.46	247.59 (247.39)	Q = 3.26
+ 500	500	500	247.0	246.21	247.14 (245.66)	
+ 800	300	800	244.5	244.56	245.49 (244.49)	
NO.1	200	1,000	244.5	243.81	244.39	
+800	800	1,800	244.5	243.11	243.99 (243.79)	Q = 2.96
NO.2	200	2,000	244.5	242.91	243.69	
+200	200	2,200	243.2	242.71	243.59	
+ 500	300	2,500	241.5	241.00	241.94 (240.29)	
+800	300	2,800	239.0	238.26	240.14 (238.04)	
NO.3	200	3,000	237.5	236.01	237.94 (236.04)	
+300	300	3,300	236.5	234.50	235.74 (233.64)	
+600	300	3,600	233.7	232.80	233.59 (232.99)	
+900	300	3,900	232.3	232.85	233.39 (231.15)	
NO.4	100	4,000	231.8	231.10	231.94	
NO. 5	1,000	5,000	231.0	230.60	231.44	Q = 2.66
+300	300	5,300	230.5	230.45 (230.53)	231.29	
NO. 6	700	6,000	229.5	230.18	230.94	Q = 2.23
+500 (NO.0)	500	6,500 (0)	228.8	229.93 (227.30)	230.69 230.54	Q = 1.50
+ 500	500	500	228.8	226.60	229.98	
NO. 1	500	1,000	228.0	225.50	229.42	Q = 1.33
+250	250	1,250	229.0	228.25	228.99	
+850 NO.2	600 150	1,850 2,000	228.0 229.0	228.10 228.06	228.84 228.80	Q = 1.14
+ 300	300	2,300	229.0	227.99 228.03	228.73	
+800 NO.3	500 200	2,800 3,000	228.0 229.0	227.90 227.85	228.60 228.55	Q = 1.01
+700 NO.4	700 300	3,700 4,000	228.0 228.8	227.68 (227.74) 227.66	228.30 228.30	Q = 0.92
NO.5	1,000	5,000	228.0	227.41	228.05	
+ 500	500	5,500	227.5	227.29 (227.33)	227.93	
NO.6	500	6,000	227.0	227.20	227.80	
+400	400	6,400	222.0	227.10 (226.30)	227.70 (226.90)	
NO.7	600	7,000	226.0	226.15	226.75	
+ 300	300	7,300	226.7	226.07 (226.00)	226.67	
NO.8	700	8,000	226.0	225.83	226.50	
+ 200	200	8,200	225.8	(225.58)	(226.25)	
+600	400	8,600		225.48	226.15	
+700 (E.P.)	100	8,700 (15,200)	225.5	(225.28) 225.23	(225.95) 225.90	

STATION	DISTANCE (M)	ACCUMULATE DISTANCE (M)	GROUND ELEVATION (M)	CANAL BED ELEVATION (M)	WATER SURFACE (M)	DISCHARGE (CUM/ST)
						I = 1 : 5,000 / I = 1 : 4,000
NO. 0	0	0	249.5	249.03	249.94 (249.74)	Q = 1.22
+100	100	100	249.8	248.97	249.72	
+200	100	200	249.2	248.91	249.44	
+300	100	300	249.5	(248.47)	(249.18)	
NO. 1	700	1,000	249.5	248.33	249.04	Q = 1.07
NO. 2	1,000	2,000	249.0	248.13	248.84	Q = 0.99
+400	400	2,400	249.0	248.05 (248.10)	248.76	Q = 0.93
NO. 3	600	3,000	249.0	247.18	248.64	Q = 0.86
+900	900	3,900	249.0	247.80	248.45	Q = 0.68
NO.4	100	4,000	246.5	247.78	248.44	
+200	200	4,200	249.0	247.74	248.40	
+700	500	4,700	248.8	247.64 (247.60)	248.30	
NO. 5	300	5,000	248.5	247.52	248.22	
+400	400	5,400	248.5	247.43	248.13	
+450	50	5,450	245.0	247.41	248.11	
NO. 6	550	6,000	248.0	247.28 (247.30)	247.98	
+500	500	6,500	247.0	247.17	247.85	
+550	50	6,550	244.5	247.16	247.84	
NO. 7	450	7,000	251.0	247.05 (247.08)	247.73 (247.65)	
+300	300	7,300	246.4	246.97 (246.42)	247.65 (247.10)	
+500	200	7,500	249.0	246.45	247.02	
+800	300	7,800	245.5	246.37	246.93	
NO. 8	200	8,000	247.5	246.26		
NO. 9	1,000	9,000	247.5	246.08	246.73	
+200	200	9,200	247.5	(245.90)	(246.48)	
NO.10	800	10,000	247.1	245.70	246.28	
+400 (E.P.)	400	10,400	247.2	245.60	246.18	

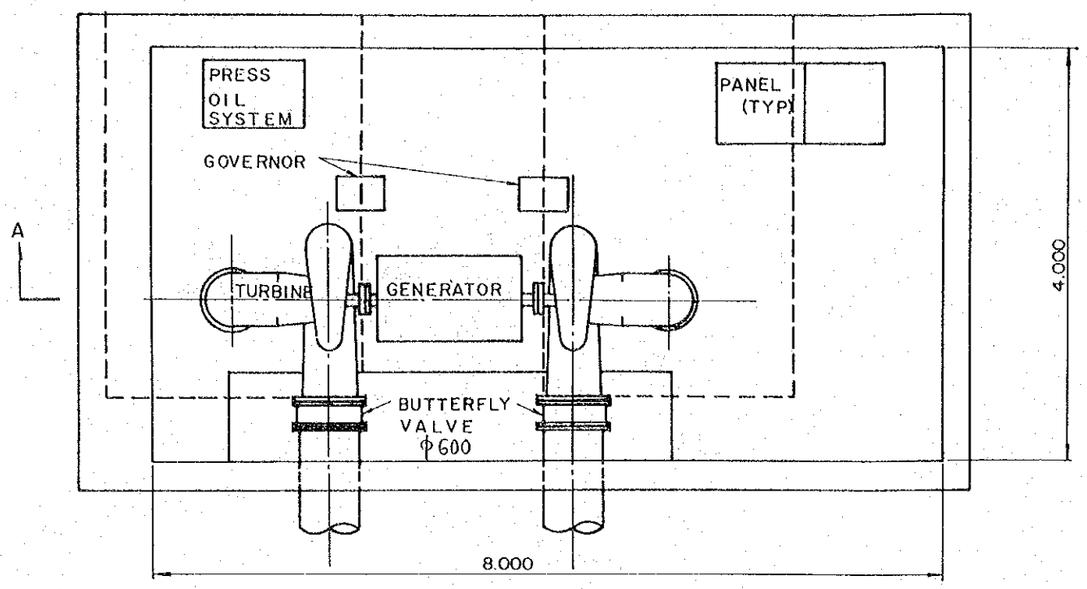
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

MAE CHANG IRRIGATION PROJECT

PROFILE OF MAIN CANAL (2)
- MPLC, SCC and MWC -

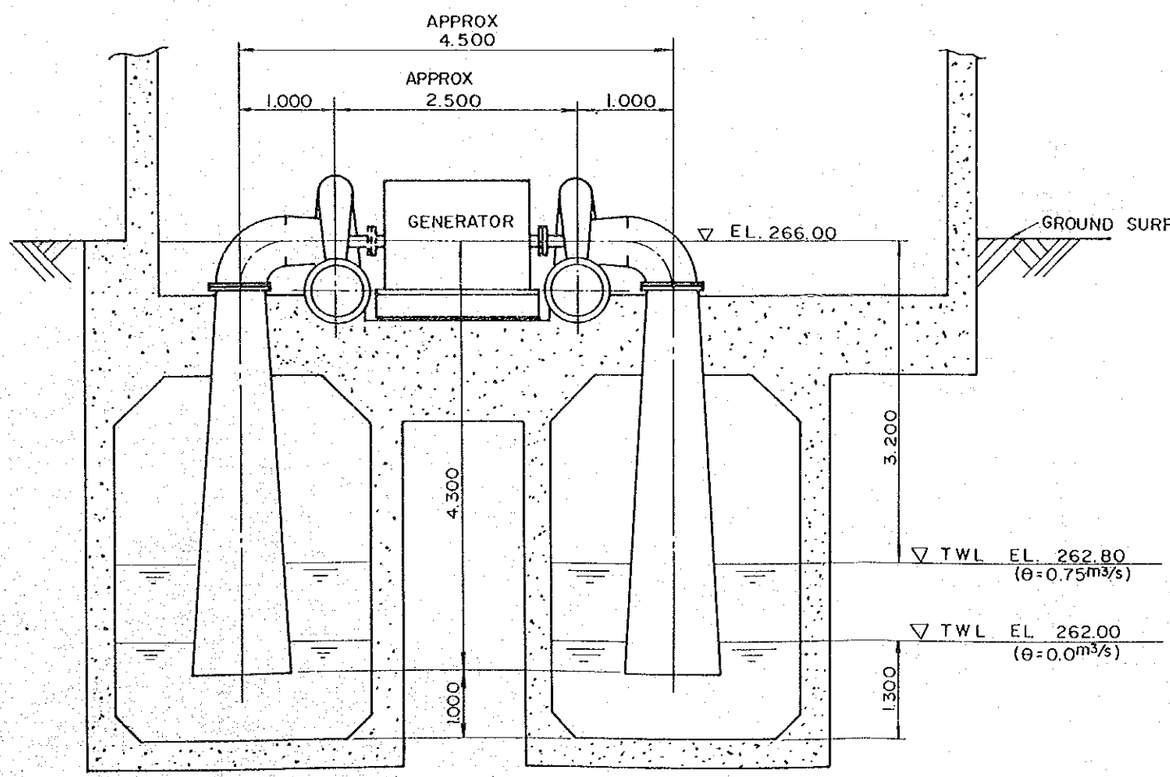
DATE | DWG | DWG 17

JAPAN INTERNATIONAL COOPERATION AGENCY



GENERAL PLAN

NON SCALE

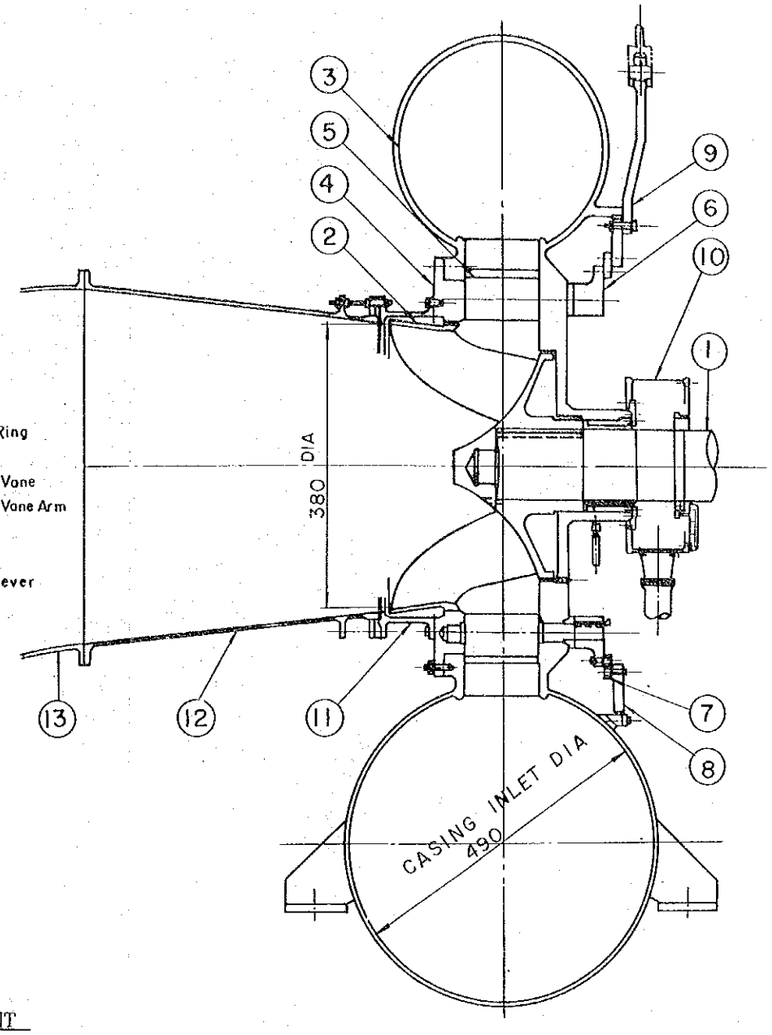


A-A SECTION

NON SCALE

A

Parts NO	Description
①	Turbine Shaft
②	Runner
③	Spiral Case with Stay Ring
④	Bottom Ring
⑤	Wicket Gate or Guide Vane
⑥	Wicket Gate or Guide Vane Arm
⑦	Link
⑧	Gate Operating Ring
⑨	Gate Operating Ring Lever
⑩	Sealing Box
⑪	Discharge Ring
⑫	Draft Tuke Cone
⑬	Draft Tube



SECTION OF TURBINE ASSEMBLY

NON SCALE

DESIGN REQUIREMENT

HYDRAULIC TURBWE

(1) No. of Unit	:	2 sets
(2) Type	:	Horizontal Shaft Francis
(3) Rated Output	:	82 kW each
(4) Rated Speed at 50 Hz	:	1000 rpm
(5) Rated Net Head	:	13.0 m
(6) Rated Flow	:	0.75 m^3/s each
(7) Net Head Range	:	9.0 m Min. - 17.0 m Max.
(8) Flow Range	:	0.5 m^3/s - 1.65 m^3/s

SYNCHRONOUS GENERATOR

(1) No. of Untis	:	1 set
(2) Type	:	Horizontal shaft synchronous, hydraulic turbines driven at both shaft ends.
(3) Output	:	278 kVA
(4) Rated Voltage	:	416 V
(5) Power Factor	:	80 %
(6) Frequency	:	50 Hz
(7) No. of Poles	:	6 P
(8) No. of Phases	:	3 Phase
(9) Rated Speed	:	1000 rpm
(10) Rating	:	Continuous
(11) Class of Insulation	:	Class B

(NOTE)

1. ALL DIMENSION ARE SHOWN IN MILLIMETER AND ELEVATION IN METER UNLESS OTHERWISE INDICATED

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

MAE CHANG IRRIGATION PROJECT

PLAN OF HYDROPOWER PLANT

DATE		DWG	DWG 18

JAPAN INTERNATIONAL COOPERATION AGENCY