(unit: '000 Baht)

Item	Total Cost	1st Year 1995	2nd Year 1996	3rd year 1997	4th year 1998	5th year 1999
F/C	1,683,946	21,456	25,000	284,888	535,502	817,100
L/C	1,225,171	7,397	65,005	361,608	439,763	351,398
Total	2,909,117	28,853	90,005	646,496	975,265	1,168,498

2) Operation and Maintenance Costs

Operation and maintenance costs comprise administrative and general expenditure including salary and wage, costs of equipment repair and maintenance, and costs of fuel and office maintenance. Economic costs of the operation and maintenance cost are estimated as follows;

Annual operation and maintenance costs ..... 31,108,000 Baht

3) Replacement Cost

On the basis of the following lifespans of gates and pumps installed by the project, the replacement costs are estimated.

- Large-sized pump : 25 years
- Gate - small type : 25 years
- Gate - large type : 25 years
- motor for gate : 25 years

9. 2. 5 Economic Internal Rate of Return

The project justification is mainly appraised based on the calculation of economic internal rate of return (EIRR). Additionally, the net present value (NPV) and benefit/cost ratio (B/C) are also taken as economic indicators. The net present value and benefit/cost ratio were calculated using the discount rate of eight percent, ten percent and 12 percent.

The results of these calculations are as follows;

EIRR = 9%

Item	Discount Rate		
	8%	10%	12%
N.P.V (1,000 Baht)	155,156	- 361,506	- 655,781
B.C ratio	1.06	0.84	0.67

The opportunity cost rate (OCR) of capital of the Northeast region is estimated at around 10 percent taking into account that it is an autonomous regional economy with limited development potential. Consequently, the EIRR of nine percent shows that the project is economically feasible, as it may be expected to enrich the Northeast's economy after its completion.

Furthermore, in order to improve the traditional farming practices and vitalize depressed rural circumstances through poverty eradication, to increase agricultural productivity and income of rural people, and to contribute to the local economy, by the introduction of irrigated agriculture in the area, the project plan is recommended to be implemented in the early stage, although the estimated EIRR of nine percent seems to be a little bit on the low side.

9. 2. 6 Sensitivity Analysis

Sensitivity analysis was made in the event of variations in prices of farm products and crop yields and escalation of construction costs. The results are shown as follows;

Results of Sensitivity Analysis

Case	EIRR (%)
1. Original	9
2. Price/Yield of Farm Products	
10% of decline/decrease	8
20% of decline/decrease	7
3. Production Costs	
10% of increase	8
4. Construction Costs	
10% of increase	8
20% of increase	7
5. Delay of Production Target	
1 year	8
2 year	7
3 year	7
6. Combination with 2 and 4	
Each 10%	7
Each 20%	6

9. 3 Financial Analysis of Typical Farmers

In order to justify financial viability of the project at farm level, financial analysis (profit and loss, and cash flow) of typical farmers (average scale of farming) of upper and lower areas in the right bank and left bank area in the Project Area was made. These typical farmers are determined on the basis of the results of the farm survey. The cropping pattern with the project situation of the farmers was set up considering the introduction of an irrigation scheme based on the current farming pattern.

Features of typical farmers are summarized as follows:

Typical Farming Pattern

(unit: rai)

Location	Area	Cultivated Crop	Actual Situation		With Project	
			Wet S.	Dry S.	Wet S	Dry S.
Right Bank:						
Upper Area	28.88	Paddy Rice	28.21		27.92 (27.29)	
	(4.62 ha)	Cassava				
		Kenaf		0.66		
		Groundnut				2.85 (3.16)
		Soybean				0.96 (0.96)
		Watermelon				0.14 (0.14)
		Chilli				0.03 (0.03)
		Vegetables			- (0.63)	0.12 (0.12)
		Tree Crop			0.96 (0.96)	0.96 (0.96)
Lower Area	28.54	Paddy Rice	26.83		27.29 (27.08)	
	(4.57 ha)	Cassava		0.23		
		Kenaf		1.48		
		Groundnut				2.84 (3.28)
		Soybean				0.91 (0.91)
		Watermelon				0.62 (0.62)
		Chilli				0.04 (0.04)
		Vegetables			- (0.21)	0.14 (0.14)
		Tree crop			1.25 (1.25)	1.25 (1.25)
Left Bank:						
	30.01	Paddy Rice	24.73		28.9 1 (27.68)	
	(4.80 ha)	Cassava		1.44		
		Kenaf		4.04		
		Sweet Corn		0.02		
		Groundnut				3.15 (3.40)
		Soybean				1.00 (1.00)
		Watermelon				0.31 (0.31)
		Chilli				0.06 (0.06)
		Vegetables				0.14 (0.14)
		Fruit			1.10 (1.10)	1.10 (1.10)

Note: Figures within parenthesis in the "with project" show the type-II (from 5th year after the project implementation)

Calculation of the farm household economy of typical farmers was made on the basis of the following conditions.

1) Gross farm income is estimated based on farmgate prices of farm products and crop yield obtained by the farm survey, DOAE and OAE.
2) Production costs are expressed by financial prices.
3) Family labor is excluded from production costs.
4) For production costs, the loan conditions of BAAC are applied. Borrowing period sets up six months for annual crops and three years for tree crops. Annual interest is 12.5 percent.
5) Production value with the project is estimated by the target yield.
6) Repayment of interest concerns only the loan interest for production costs.
7) O/M charge for on-farm canal is estimated at 400 Baht/ha.

Results of Financial Analysis of Typical Farmers

(unit: Baht)

Typical Farmer		Gross Income	Production Cost	Living Expense	Repayment Interest	O/M Charge	Surplus
Right Bank							
Upper area	w/o	23,035	6,424	18,855	0	0	-2,244
	w	70,249	23,524	18,555	49	1,805	26,015
Lower area	w/o	23,595	4,988	17,259	0	0	1,348
	w	68,971	23,000	17,259	92	1,717	26,903
Left Bank:							
	w/o	32,072	6,527	24,000	0	0	1,545
	w	79,761	27,933	24,000	113	1,574	26,141

Note: w/o = Without Project
w = With Project (the target year of type-II)

Taking all this into consideration, substantial improvement of farm household economy in the project area can be expected as a result of project implementation.

CHAPTER X. ENVIRONMENTAL IMPACT ANALYSIS

CHAPTER X. ENVIRONMENTAL IMPACT ANALYSIS

10.1 Introduction

The proposed Lam Dom Yai Basin Irrigation Project has the main project features larger than the project scale given in the NEB' (National Environmental Board) guideline (as given below), and hence, the detailed Environmental Impact Statement or Environmental Impact Study (EIS) will be required by law.

The following give the main features of Lam Dom Yai Basin Irrigation Project.

Project Features	Size	Min. NEB Guideline that require EIS
Effective Storage	104.6 MCM	100 MCM
Reservoir Area	43.3 sq.km	15 sq.km
Irrigation Area	34,000 ha	12,800 ha
	(212,500 rai)	(80,000 rai)

Under the framework of the Feasibility Study, only a preliminary investigation including field survey and data collection/analysis was carried out within the limited time available. The investigation was, therefore, carried out at the level of initial environmental examination (IEE), focusing on the aspects of aquatic and terrestrial ecosystems and social environment, not being covered in the paragraph of 2.11 "Environment Conditions", with the main purpose for preliminarily pointing out the probable environmental effects and constraints as might be caused by the project implementation on the ecological resources and social setting in the Project Area.

As mentioned above, a detailed EIS study will be required for this project in addition to the Feasibility Study. In the EIS study, detailed environmental impact analyses and evaluation, as well as the recommendations for additional studies, and mitigation and resettlement plans for the evacuees (if any), are made based on more detailed information and sufficient amount of field data. Four main environmental categories are included in the EIS report, namely, Physical Resources, Ecological Resources,

Human Use Value and Quality of Life Value, the scope of which is beyond the framework of the present study.

10. 2 Environmental Setting

10. 2. 1 Aquatic Ecosystem

The impoundment of the Lam Dom Yai reservoir will alter existing conditions of fisheries and aquatic biology to some extent. The impoundment by itself would cause aquatic the population in the lower-basin of the river to change as a consequence of changes in the river flow regime. The fish production from the reservoir will be expected to increase considerably, but some species may be affected by the blockage of river flow by the dam. Socio-economically, the fishing occupation will become more important for subsistence fishermen than at present, and a great number of households may be converted from rice farmers to full-time fishermen, depending on the extent to which fish production will increase.

The results of the study on hydro-biological and the fishery survey in Sirinthorn Reservoir, Ubon Ratchathani Province (in 1988), in which a reservoir was created by the closure of the dam on the Lam Dom Noi at Amphoe Phibun Mangsahan near to the project on the Lam Dom Yai, are summarized below.

Secchidisc transparency in open water	:	120 - 150 cm
Water temperature	:	24 - 33.5 degree c
pH	:	5.5 - 7.3
DO	:	5.2 - 9.6 mg/l
CO_2	:	2 - 6 mg/l
Alkalinity	:	12 - 32 mg/l as $CaCO_3$
Hardness	:	10 - 28 mg/l as $CaCo_3$

And then, the water quality is suitable for freshwater aquatic organisms, except that the turbidity of the water inlet is rather high.

Plankton were composed of 32 varieties, and 11 species of Phyto- and Zooplanktons had a total abundance of 1.02 million cell/cu.m. A total of 11 species of benthic organism were observed with a density of 462 ind./sq.m (43

ind./sq.ft). Fish standing crop estimated by spot poisoning was calculated at 42.38 kg/ha (6.78 kg/rai). The ratio of forage to carnivorous species (F/C) was 0.58. The equilibrium ratio should be between 3.00 - 6.00. The variation of fish standing crop between the time at the beginning of the dam filling in 1970 and recently in 1987 are as follows:

The crop ratio of carp of 26.42 percent in 1970 decreased to 14.80 percent in 1987. That of mullet of 56.66 percent to 25.40 percent and on the contrary, that of miscellaneous species of 16.12 percent to 58.5 percent. The catch per unit of effort estimated by electro-fishing was 0.835 kg/hr. A total of 22 families including 52 species were found for the sampling period.

As a result of the survey, it is recommended that for a balanced fish population, herbivorous species should be added in this reservoir. Giant freshwater prawn stocks and the establishment of a fisheries unit should be considered as a part of an overall fisheries management program in the future.

The survey data from the fisheries statistics in 1989 show that the annual fish production from natural ponds in the Project Area (in Amphoe Det Udom) was 79.4 kg/ha (12.7 kg/rai), while in Ubon Ratchathani Province, (excluding Sirinthorn reservoir) it was 203.8 kg/ha (32.6 kg/rai). The fish production from private fish ponds in the Project Area and Ubon Ratchathani Province were, 1,673.8 kg/ha (267.8 kg/rai) and 2,096.8 kg/ha (335.5 kg/rai), from the paddy fields were 125.0 kg/ha (20.0 kg/rai) and 435.0 kg/ha (69.6 kg/rai), respectively. It shows that fishery activity is very low.

10. 2. 2 Terrestrial Ecosystems

1) Forest Ecology

Forests are one of the most important ecological resources for any irrigation development project. Flooding of the reservoir area will undoubtedly destroy the forest areas in the impoundment zone. Regarding the Lam Dom Yai Basin Irrigation Project, the reservoir area of about 43.3 sq.km (27.1 thousand rai) would destroy the forestry areas of 24 sq.km (15.0 thousand rai). In these affected areas, it is necessary to investigate existing forest ecology and

economics in order to assess the total impacts resulting from the project development.

2) Methodology

The study on forest ecology was carried out inside the proposed reservoir area. This area was divided by the Lam Dom Yai into left bank forest and right bank forest. Circular sample plots were established in each forest type distributed along both the banks at random. Each circular sample plot had a radius of 17.85 m, covering an area of 0.1 ha or 1,000 sq.m. Within each of these plots, the diameter of every tree with diameter more than 10 cm at breast height (dbh) was measured (classified as commercially valuable trees), and the records were made on the number of merchantable logs (each with a length of 10 m) together with the local names of the trees. These data were used for calculation of stem volumes for economic evaluation, as well as for calculation of stand density. At the center of each plot, the circular radius of 12.64 m and 5.65 m were set up in order to record the number of saplings (trees having dbh below 10 cm) and seedlings (trees less than 1.30 m in height). The data on sapling and seedling were used in estimating the abundance of forest natural generation.

3) Result of the Study (Distribution and ecological characteristics of forest communities inside the reservoir area)

Forests in the Project Area can be divided into two major types: i) mixed deciduous forest and ii) dry dipterocap forest. Distribution and ecological characteristics of each forest type can be discussed in detail as follows:

a) Mixed Deciduous Forest

Mixed deciduous forest covers a major area of bout 16 sq.km or 66.7 percent of the total forest within the reservoir area. The unique characteristics of this phenotype is the hard wood with dark color. Other common species were found during the inventories such as Tabaek (Largerstroemia Cuspidata), Dang or Iron Wood (Xylia xylocarpa), Pradun(Ptercarpus macrocarpus), Nakok or Hog Plum (Spondias pinnata), Saan (Dillenia obovata), Taklow or Celon Oak (Schleichera oleasa).

Mixed deciduous forest in the reservoir area is mainly formed by small-sized trees with diameter at breast height (dbh) ranging from 10 to 30 cm. A few trees with dbh exceeding 60 cm and with the heights of more than 15 m were found and the important species are Tabaek and Dang.

b) Dry Dipterocarp Forest

Dry dipterocarp forest found in the reservoir area covers about 8 sq.km or only 33.3 percent of the total reservoir area. This forest type is mainly composed of small to medium-sized trees with diameter at breast height (dbh) ranging from 10 to 30 cm. The common tree species are Teng or Burma Sal. (Shorea obtusa) and Dang.

As a result of the field surveys conducted during Phase II field survey, the followings was discovered:

Concerning the plant density of each plot inside the reservoir area, the forest is mainly formed by small-sized trees with diameters (dbh) ranging from 10 to 30 cm, the occupying ratio of which is 72 percent on the right bank and 62 percent on the left bank. No saplings and a low density of seedlings, that is, 156 and 433/ha on the right bank and left bank respectively were found.

The total tree volume of various timber qualities were 27.607 cu.m/ha and 41.718 cu.m/ha for the right and left bank respectively. The forest area on the right bank was about 1,448.7 ha (9.1 thousand rai), and potential timber prices will be 26 million Baht (1,448.7 ha × 17,800 Baht/ha). The forest area on the left bank was about 951.3 ha (5.9 thousand rai), with potential timber prices of 36 million Baht (951.3 ha × 38,000 Baht/ha).

10.2.3 Social Setting

1) Introduction

The Lam Dom Yai Basin Irrigation Project Area covers four Amphoes in Changwat Ubon Ratchathani, namely, Amphoe Det Udom, Amphoe Phibun Mungsahan, Amphoe Na Chalui and Amphoe Nam Yun. According to the plan, the water will be fed by pumping to the irrigation areas lying on both the sides

of the river downstream from the reservoir, that is, there are 8,800 ha (55.0 thousand rai) of irrigation area on the left side and 25,200 ha (157.5 thousand rai) on the right side.

At the planned compensation water level of El.140.0 m, in the Lam Dom Yai reservoir, eight villages in five Tambons would be affected in case of flooding, without protection dikes. There will be 122 households with the total population of 659 to be affected even in the case of a flooding with protection dikes of two meter in height. These villagers have to be evacuated to a selected resettlement site. The basic socio-economic data as well as public health information of the communities both in the irrigation areas and in the inundated areas are necessary for the evaluation of the impacts on Quality of Life Value and in the drafting of an effective resettlement plan.

2) Methodology of Data Collection

The basic socio-economic data for the communities in the Project Area were obtained mainly from data collection, field observation and field survey. The field survey was conducted during the Phase II field survey period using questionnaire forms which had been prepared in advance for the purpose of finding out the present socio-economic background of the villagers in the proposed inundated area and in the areas to be irrigated by the project. In addition, the questionnaires also aim at finding out, indirectly, the villagers' attitude towards the general idea of developing water resources by the construction of weirs and dams. The total number of 103 sets of questionnaires were used, of which 32 sets were for the inundated villages, and 71 sets for the irrigated areas.

The questionnaire consists of the following items:

- General village conditions
- Occupation of villagers
- Sources of water supply
- General sanitation and health
- Infrastructure, such as roads, electricity and water supply
- Problems and needs for local development
- Attitude towards water resources development in general, on awareness and attitude on the governmental land reforming

scheme, on Pak Mun Dam Project selected as a typical case of a large-scale water resources scheme.

For the inundated area, all the villagers were surveyed, and several samples for each village were interviewed. The persons interviewed include village leaders, priests, teachers and some villagers selected at random. But for the irrigated areas, only one interview with the village leader of each village could possibly be made in this survey to obtain the general picture of the villages.

3) Result of the Study

a) General Village Characteristics

The people living in the Project Area recently migrated from nearby areas and were provided with 10 to 30 year periods to settle and convert forests into cultivated lands. Although most of them do not hold complete official documents of land ownership, but they do pay land duty regularly to the local district offices. Most villagers hold temporary land permits.

All the villagers in the Project Area have similar characteristics. Nearly all the houses are of semi-permanent type, indicating the well-being of the villagers, with average income levels being on the medium scale.

The main occupation is farming (rice-growing), followed by crop plantation using rain water, for which a family owns a large strip of cultivated land. The villagers also grow vegetables and rear livestock for their own consumption.

Electric power lines have been laid to all the villages by the Provincial Electricity Authority, with a network of relatively good rural roads joining the villages, although most roads become impossible to pass in the wet season. The tradition of using water buffaloes for plowing the paddy fields is still practiced. Drinking water comes from stored rainwater in jars and shallow wells without boiling, but the water for general use is obtained from deep groundwater pumping wells, which has an unpleasant taste. The villagers expressed a general need for additional water for cultivation to supplement rainwater. The

water in Lam Dom Yai has not been used because of the great distance between the cultivation fields and the source of water.

The general conditions of public health of the villagers appear to be good. Some water-borne diseases and malaria have occasionally been reported. Nearly all the households in the Project Area use pit latrines.

There is one Wat (temple) in each village and one priest, on average, in each Wat. The cooperation and the joint tree felling of the villagers are relatively good. Usually each village consists of several clusters of houses, and there is a leader for each cluster. Each village will have its own rules which promote shared concerns among the villagers and helps everyone to take care of their properties. Problems of theft are none.

b) Attitude Towards Construction of Water Resources Projects

With regards to opinions on water resource development schemes in general, the majority of the villagers (over 80 percent) in the area to be inundated prefer weirs to dams. About 50 percent of the people fear that the construction of a large dam would deprive them of their lands and that the compensation cost would not be adequate. However, if the dam construction is unavoidable, they want fair compensation cost, a nearby resettlement site and they would probably not change their occupation.

Similar attitudes were expressed by people in the proposed irrigated areas of the project. Most villagers in the areas surveyed support the idea of agricultural land reform schemes, but they do not like the waiving of the right to sell their land.

10. 3 Environmental Interaction by Project

10. 3. 1 Construction Phase

1) Water quality in Lam Dom Yai downstream of the reservoir will certainly deteriorate due to turbidity and suspended solids. However, this impact will only be on short term basis.

2) Water released from the reservoir is expected to be clear, resulting from the impoundment effect. It is anticipated that some erosion will take place along the downstream basin of the Lam Dom Yai, in order to balance the natural sediment regime of the river.

3) It is expected that dissolved oxygen (DO) level in the immediate downstream area will be reduced, but it will eventually be re-aerated along the river course. In the early stages of impoundment, water is expected to be polluted due to organic biomass in the reservoir area. However, the water quality will improve after a certain period of time.

Thus, proper planning and scheduling should be carried out to reduce soil erosion during construction. Water quality monitoring program may have to be introduced after the reservoir construction.

4) With respect to public health conditions, the spreading of malaria among construction workers, problem of respiratory diseases and water-borne diseases will give cause for anxiety in the worker' camps under improper sanitation conditions. The problems of accident, violence and work injuries are also common in this phase.

10. 3. 2 Operation and Maintenance Phase

1) After impoundment, potential changes anticipated are the changes in the downstream river regime and water quality due to storage and control of water release. These changes would include:

- Reduction in peak flows and downstream flood level
- Run-off increase in the dry season by released water

- Changes in erosion and sediment pattern
- Fluctuation of the released water influencing oxygen and nutrient concentration

2) It is very likely that the creation of the impoundment will provide suitable habitats for major mosquito-borne diseases such as malaria and hemorrhagic fever. The problem of schistosomiasis may be a potential health hazard for the communities in the project area. Therefore, a good public health program may be necessary.

3) Since the reservoir is underlain by salt formation, the rise of ground water level in the reservoir area due to water impoundment may bring salt elements from deeper layers of soil to the surface, causing water logging problems which could have a detrimental effect on agricultural practices and plant life. Since the rock salt lies relatively deep, it is possible that the salinity effects may not be serious. Nevertheless, detailed investigations on this problem are needed to confirm the impact.

4) The reservoir will provide a large surface water body serving the villages around the reservoir and, in particular, the irrigable lands on both sides of Lam Dom Yai downstream of the reservoir. Fish production in the reservoir will provide additional income and a source of protein to the people in the area. Socio-economic benefits of reservoir fish production are expected to have effects at local and regional levels. The effects of dam blockage on fish migration needs detailed studies.

5) As the reservoir is flooded, permanent loss of agricultural land and forest land within the reservoir area will occur. The destruction of forest areas where animals live, impoundment of water and noise generated when the project is implemented, will affect local fauna. Some species may benefit from the impoundment, especially water birds, such as various egrets and herons. Since such wildlife as big game animals in the proposed reservoir area are relatively scarce, as a result of human pressure in the form of agricultural development, the existing wildlife in this area are of common species and probably not abundant, based on the information obtained during a field survey. Therefore, the impact of the project on wildlife in the reservoir area is expected to be small. Nevertheless, activities of wildlife management agencies

concerned, are proposed both for the flooding of the reservoir and for the reservoir life.

6) It is expected that the roads constructed to the reservoir will encourage forest encroachment and illegal timber cutting, especially along the road sides. The protection of the forest, particularly the forest land outside the reservoir area has to be seriously considered, requiring close cooperation for forest control with the Royal Forestry Department, Royal Irrigation Department and the local people in the watershed area.

7) Resistance from the villagers against being evacuated to a new resettlement site is anticipated. Nearly all the affected households do not want to be evacuated. They are uncertain about the resettlement site, the resettlement plan, the compensation cost, future income and property value. The dissatisfaction with unclear answer and worries could drive many of the villagers and village leaders to join the dam construction opposition groups from outside, similarly as is happening in the other projects of the same kind.

8) Social effects caused by the dam construction project include discomfort among villagers that have to be evacuated from the area. Their discomforts and anxieties seem to stem from the uncertainty of their future living conditions, the fear of being separated from relatives, friends and old neighborhoods, and the fear that their new social environment will be different. From the villagers' point of view, the evacuation means disaster, since they are forced to leave their own properties for an uncertain future, and the compensation cost may not be adequate. These problems may require a strong public campaign in the early stages of project development. Resettlement sites should not be far away and special attention should be paid to compensation payment which should be fair and paid properly and immediately once the agreement is made.

9) From the preliminary field reconnaissance survey, it appears that there are no major prehistorical sites or objects of archaeological values to be found in the reservoir area. A salvage program may not be necessary. However, for detailed EIS study, a thorough archaeological investigation should be conducted to confirm the above conclusion.

LIST OF DRAWINGS

DRW NO.	DRAWINGS
NO. 1	GENERAL PLAN OF DAM
NO. 2	TYPICAL CROSS SECTION OF DAM
NO. 3	PROFILE OF DAM
NO. 4	PROFILE AND PLANE OF SPILLWAY
NO. 5	PROFILE OF OUTLET
NO. 6	LEFT BANK PUMP FACILITIES
NO. 7	RIGHT BANK PUMP FACILITIES
NO. 8	LOCATION MAP OF CANAL SYSTEMS
NO. 9	TYPICAL CROSS SECTION AND PROFILE OF IRRIGATION CANAL
NO. 10	RELATED STRUCTURE OF IRRIGATION CANAL (1/4)
NO. 11	RELATED STRUCTURE OF IRRIGATION CANAL (2/4)
NO. 12	RELATED STRUCTURE OF IRRIGATION CANAL (3/4)
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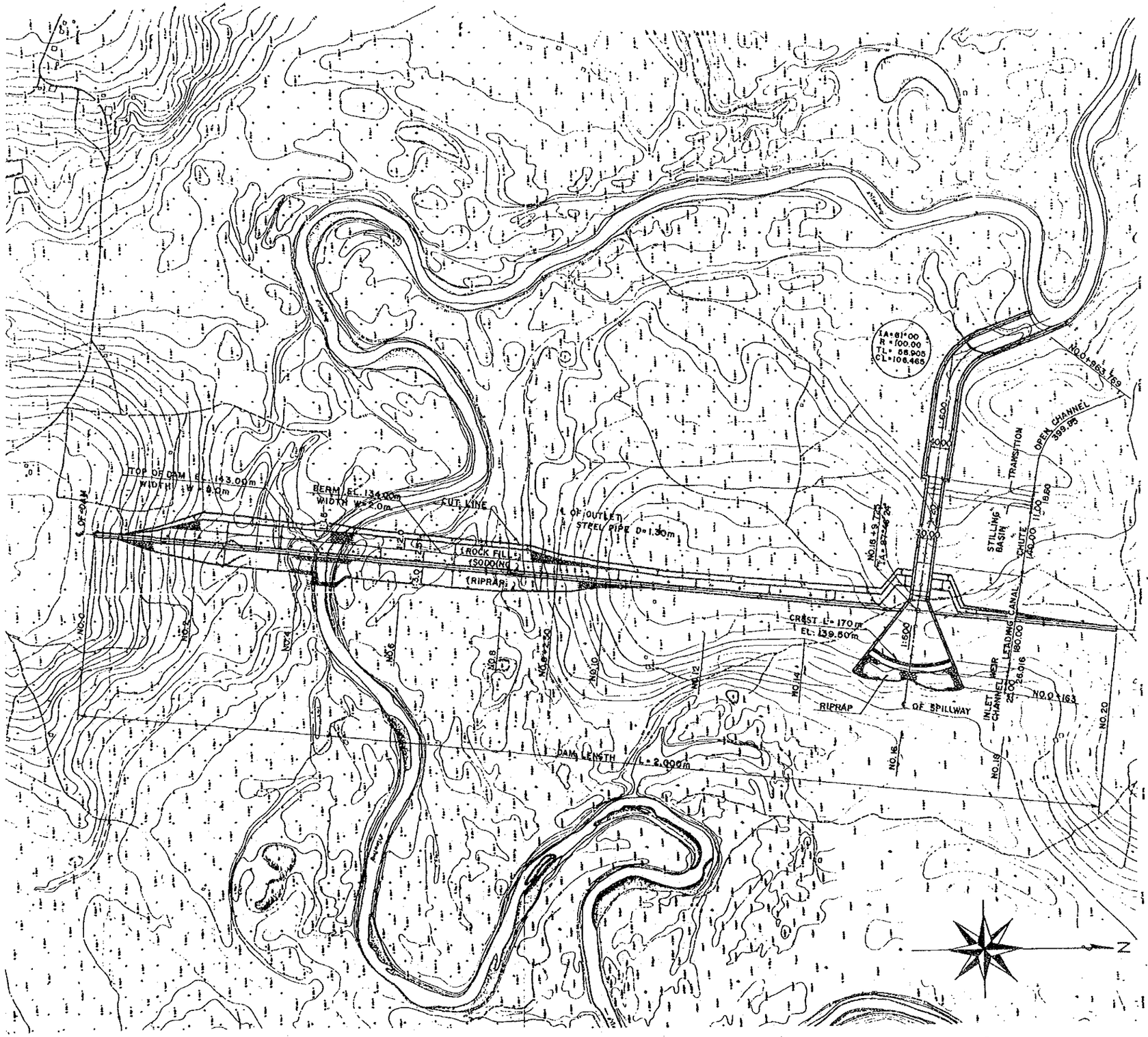
NO. 14	TYPICAL DESIGN OF ON-FARM FACILITIES
NO. 15	DIAGRAM OF PROPOSED IRRIGATION SYSTEMS



GENERAL PLAN

MAJOR FEATURES OF LAM DOM YAI RESERVOIR

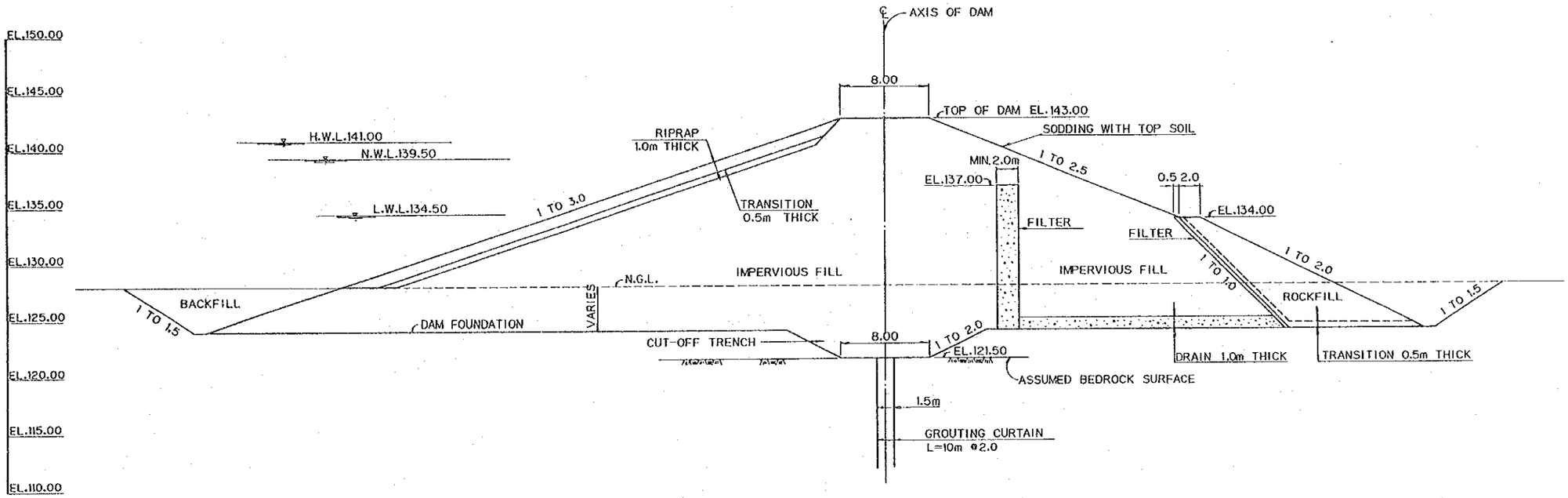
ITEM	DESCRIPTION
(1) RESERVOIR	
a) RIVER BASIN	LAM DOM YAI
b) RIVER NAME	LAM DOM YAI
c) WATERSHED AREA (km²)	1,245
d) TOTAL STORAGE (MCM)	117
e) EFFECTIVE STORAGE	105
f) H.W.L. (MSL)	141.0
g) N.W.L. (MSL)	139.5
h) L.W.L. (MSL)	134.4
(2) FOUNDATION	SAND STONE SILT STONE
(3) DAM-BODY	
a) DAM TYPE	HOMOGENEOUS FILL DAM
b) DAM CREST EL (MSL)	143.0
c) DAM HEIGHT (m)	21.5
d) CREST LENGTH (m)	2,000
e) EMBANKMENT (m³)	900,000
f) FOUNDATION TREATMENT	CURTAIN GROUT
(4) SPILLWAY	
a) DESIGN FLOOD (cms)	1,087
b) SPILLWAY CAPACITY (cms)	641
c) SPILLWAY TYPE	CHUTE
d) CREST LENGTH (m)	170
(5) OUTLET	
a) CAPACITY (cms)	5.50
b) CONDUIT Φ (m)	1.30

FEASIBILITY STUDY
LAM DOM YAI BASIN IRRIGATION PROJECT

GENERAL PLAN OF DAM

DRAWING NO. 1 | NOVEMBER, 1992

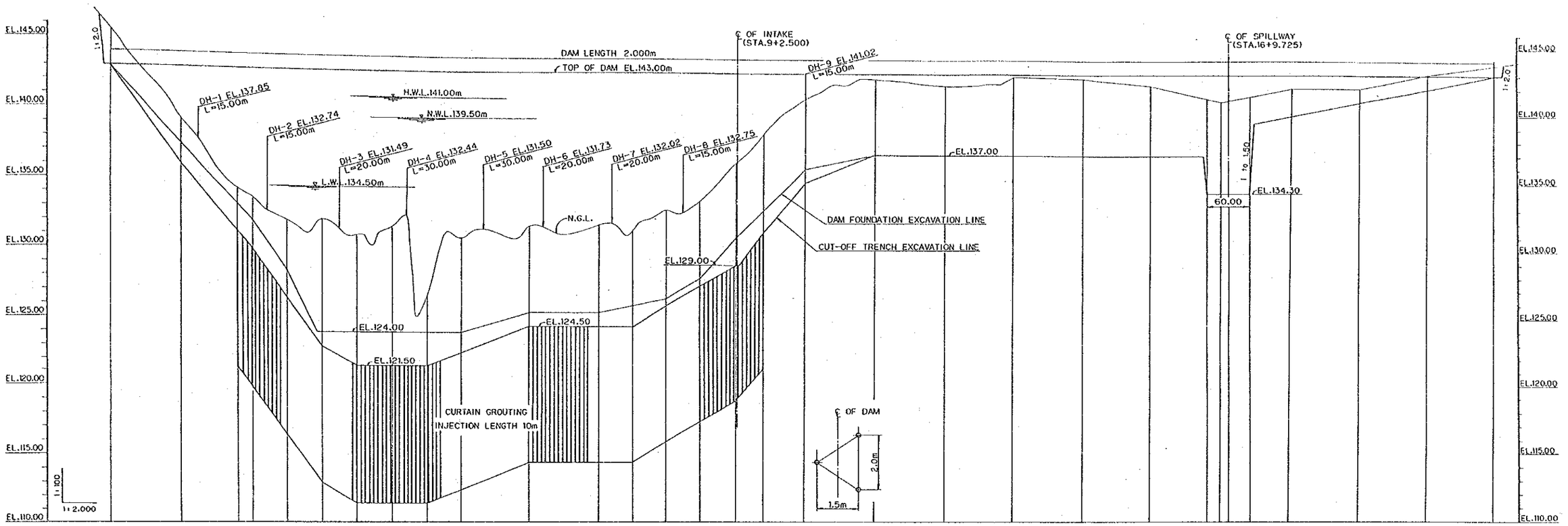
JAPAN INTERNATIONAL COOPERATION AGENCY



TYPICAL CROSS SECTION

0 5 10 15 20m

FEASIBILITY STUDY LAM DOM YAI BASIN IRRIGATION PROJECT	
TYPICAL CROSS SECTION OF DAM	
DRAWING NO. 2	NOVEMBER, 1992
JAPAN INTERNATIONAL COOPERATION AGENCY	

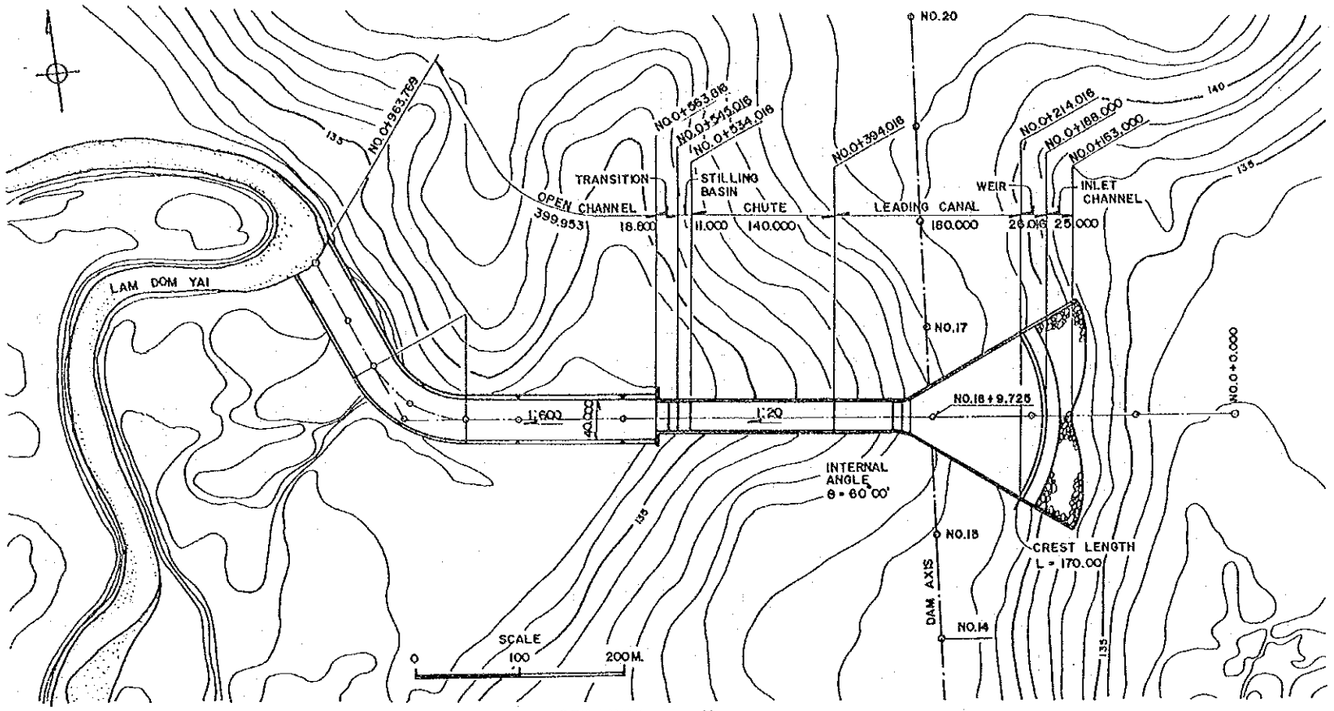


LONGITUDINAL SECTION ALONG DAM AXIS

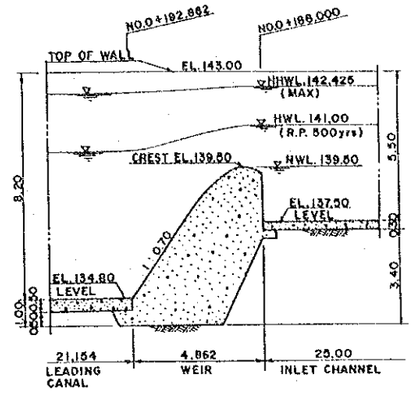
GROUTING TYPE

STATION	0+00.0		1+00.0		1+80.0	2+00.0	2+50.0	3+00.0	3+50.0	4+00.0	4+50.0	5+00.0		6+00.0		7+00.0	7+50.0	8+00.0	8+50.0	9+00.0	9+40.0	10+00.0		11+00.0		12+00.0		13+00.0		14+00.0		15+00.0		15+79.725	15+00.000	15+39.725	16+39.725	17+00.0		18+00.0		19+00.0		20+00.0
DISTANCE	0.00		100.00		80.00	20.00	50.00	50.00	50.00	50.00	50.00	50.00		100.00		100.00	50.00	50.00	50.00	50.00	40.00	60.00		100.00		100.00		100.00		100.00		100.00		79.725	20.275	9.724	30.000	60.275		100.00		100.00		100.00
ACCUMULATED DISTANCE	0.00		100.00		180.00	200.00	250.00	300.00	350.00	400.00	450.00	500.00		600.00		700.00	750.00	800.00	850.00	900.00	940.00	1000.00		1100.00		1200.00		1300.00		1400.00		1500.00		1579.725	1600.000	1609.725	1639.725	1700.00		1800.00		1900.00		2000.00
NATURAL GROUND LEVEL	145.54		139.18		134.24	133.74	132.10	132.20	131.10	131.67	127.89	130.83		131.82		131.86	131.40	132.94	133.60	136.41	138.56	141.02		142.50		142.09		142.75		142.20		142.20		141.20	141.00	141.10	141.40	142.00		142.00		142.10		143.75
DAM FOUNDATION	143.00		137.50		133.20	132.00	128.50	124.00	124.00	124.00	124.00	124.00		125.50		125.50	126.00	126.50	128.00	131.00	133.00	136.00		137.00		137.00		137.00		137.00		137.00		-	-	-	-	140.00		141.00		142.00		143.00
CUT-OFF TRENCH	143.00		136.00		131.25	130.00	126.45	123.00	121.50	121.50	121.50	122.50		124.50		124.50	124.50	126.00	127.50	129.00	131.40	135.00		137.00		137.00		137.00		137.00		137.00		134.30	134.30	134.30	134.30	140.00		141.00		142.00		143.00
GROUTING					121.25	120.00	116.45	113.00	111.50	111.50	111.50	112.50		114.50		114.50	114.50	116.00	117.50	119.00	121.40																								

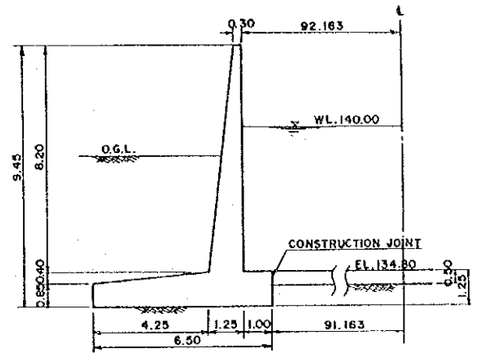
FEASIBILITY STUDY LAM DOM YAI BASIN IRRIGATION PROJECT	
PROFILE OF DAM	
DRAWING NO. 3	NOVEMBER, 1992
JAPAN INTERNATIONAL COOPERATION AGENCY	



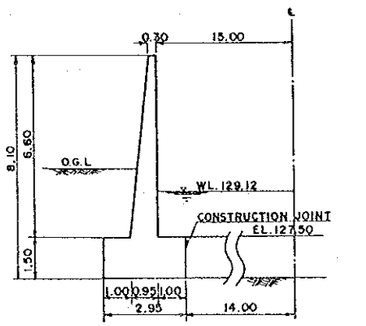
SPILLWAY PLAN



PROFILE OF WEIR



NO.0 +192.862



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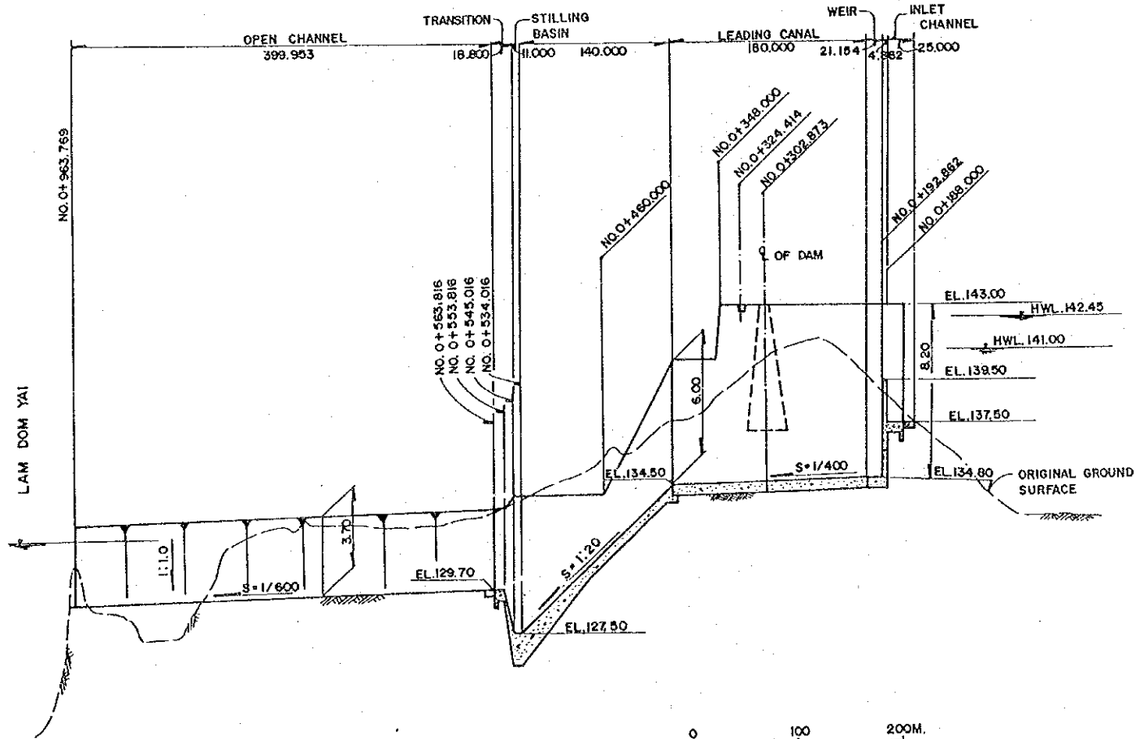
SCALE 0 5 10M.

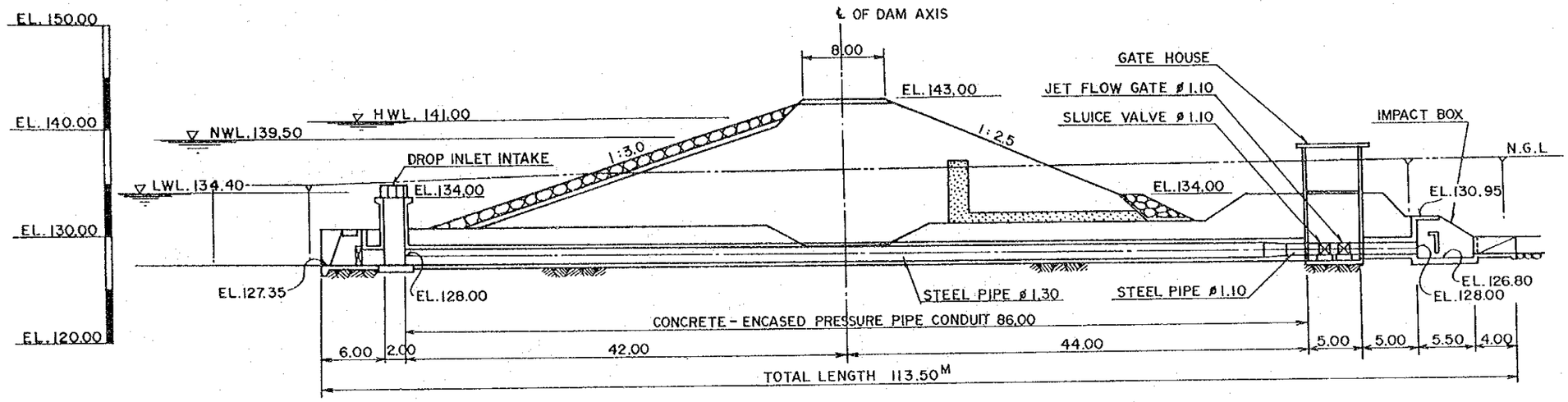


PROFILE OF SPILLWAY

NOTE

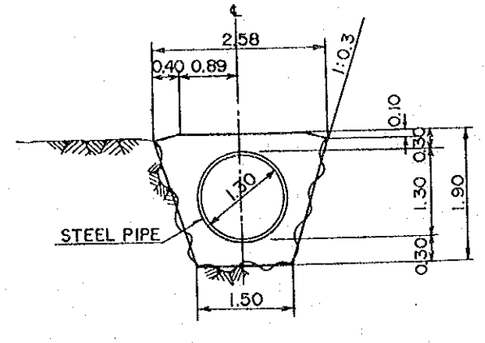
1. ALL DIMENSIONS ARE SHOWN IN METER.

FEASIBILITY STUDY LAM DOM YAI BASIN IRRIGATION PROJECT	
PROFILE AND PLANE OF SPILLWAY	
DRAWING NO. 4	NOVEMBER, 1992
JAPAN INTERNATIONAL COOPERATION AGENCY	



PROFILE OF OUTLET

NOTE : ALL DIMENSION ARE IN METER



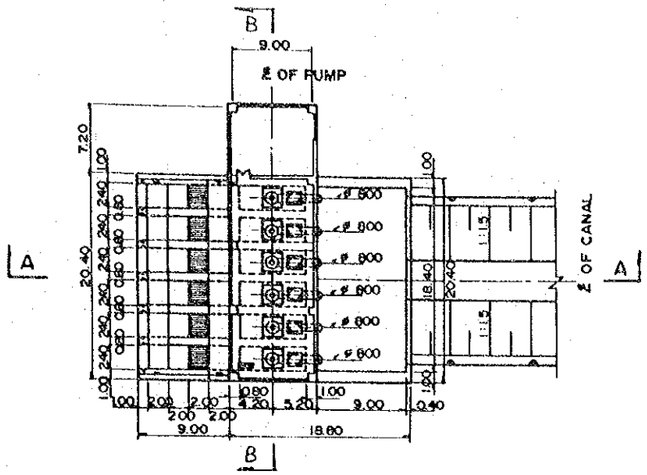
TYPICAL SECTION OF CONDUIT PIPE

FEASIBILITY STUDY
LAM DOM YAI BASIN IRRIGATION PROJECT

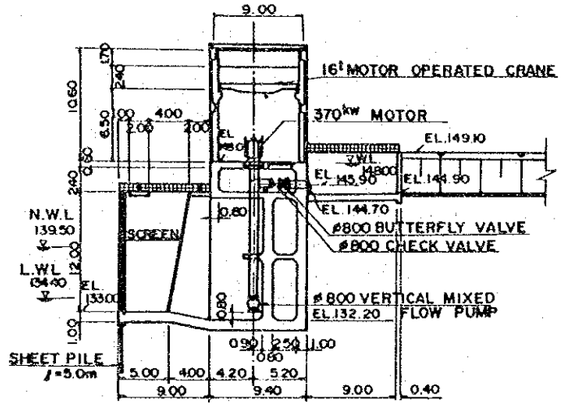
PROFILE OF OUTLET

DRAWING NO. 5 | NOVEMBER, 1992

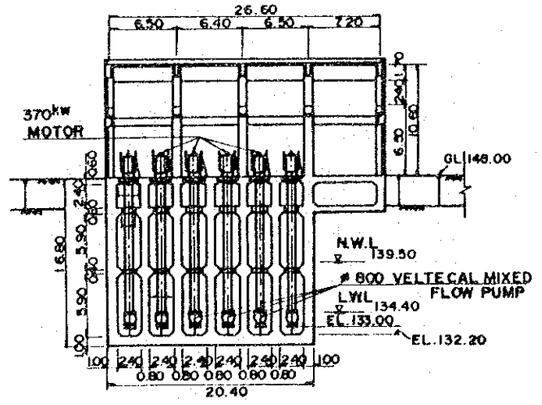
JAPAN INTERNATIONAL COOPERATION AGENCY



PLANE



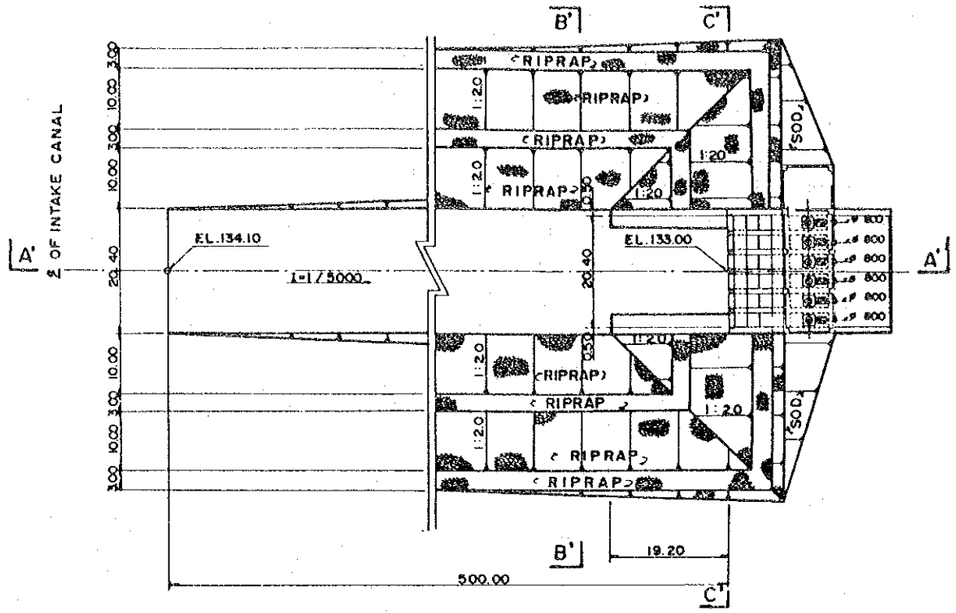
SECTION A-A



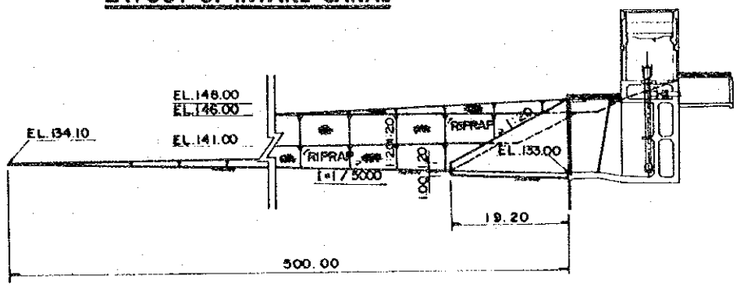
SECTION B-B

PUMP DIMENSION

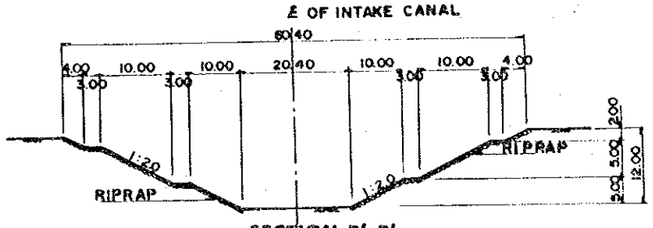
TYPE	VERTICAL MIXED FLOW
BORE	800 mm
CAPACITY	88 m³/min
TOTAL HEAD	16.4 m
MOTOR POWER	370 kw/h
UNIT	6



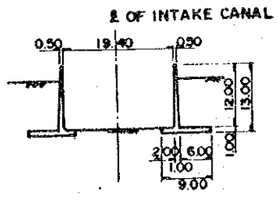
LAYOUT OF INTAKE CANAL



SECTION A'-A'



SECTION B'-B'

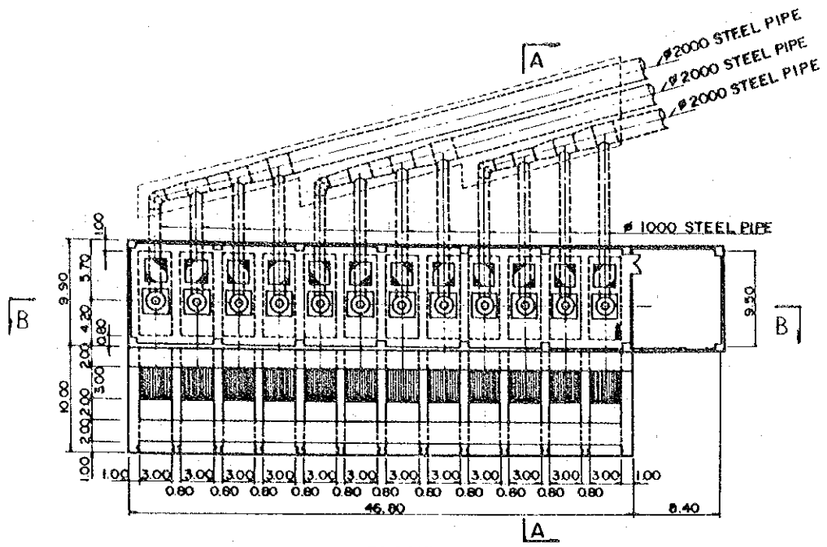


SECTION C'-C'

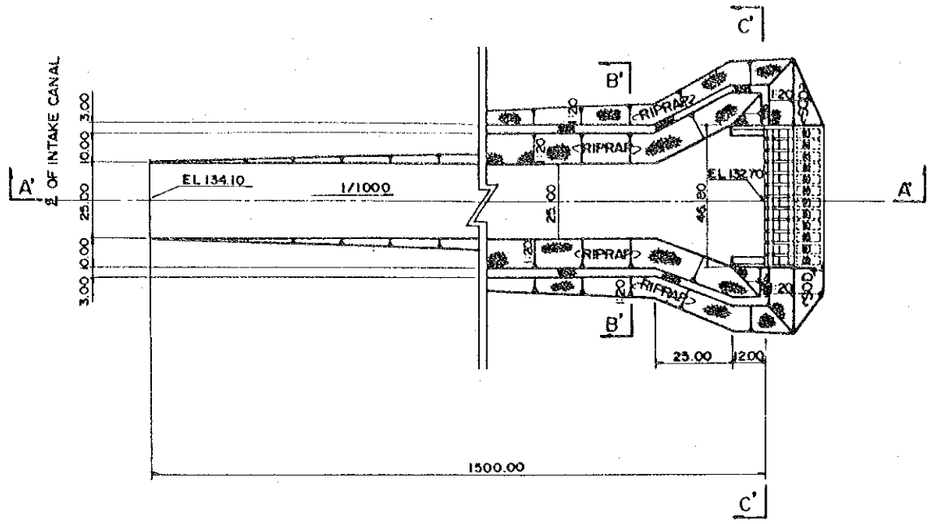
LEFT BANK PUMP STATION

NO SCALE

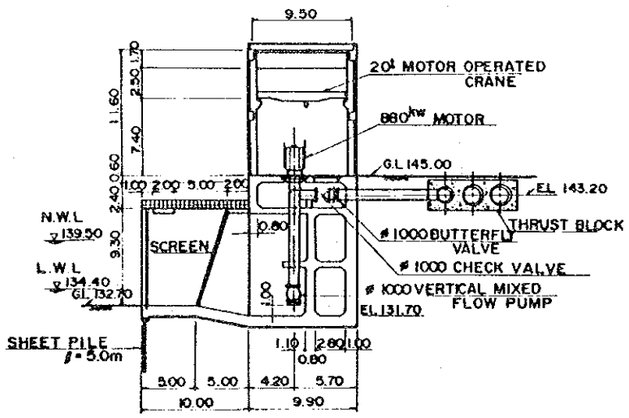
FEASIBILITY STUDY LAM DOM YAI BASIN IRRIGATION PROJECT	
LEFT BANK PUMP FACILITIES	
DRAWING NO. 6	NOVEMBER, 1992
JAPAN INTERNATIONAL COOPERATION AGENCY	



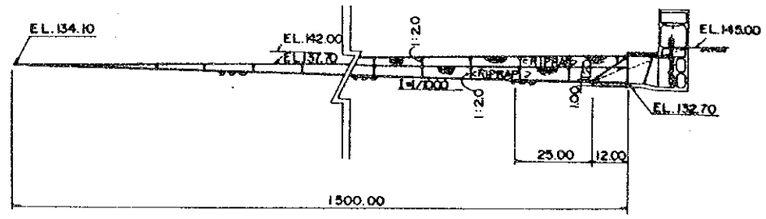
PLANE



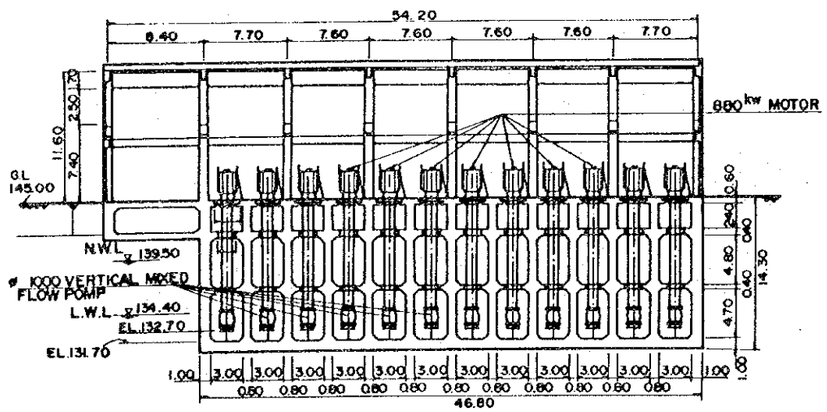
LAYOUT OF INTAKE CANAL



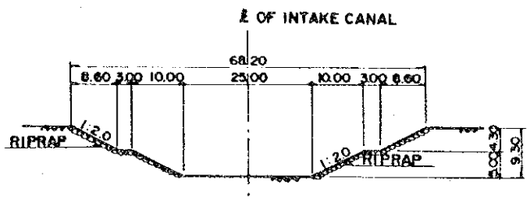
SECTION A–A



SECTION A'–A'



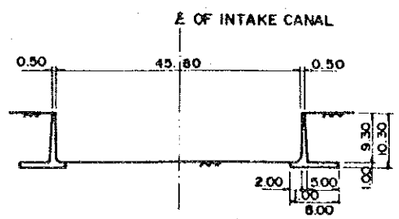
SECTION B–B



SECTION B'–B'

PUMP DIMENSION

TYPE	VERTICAL MIXED FLOW
BORE	1000 mm
CAPACITY	126 m³/min
TOTAL HEAD	28.4 m
MOTOR POWER	880 kw/h
UNIT	12



SECTION C'–C'

RIGHT BANK PUMP STATION

NO SCALE

FEASIBILITY STUDY
LAM DOM YAI BASIN IRRIGATION PROJECT

RIGHT BANK PUMP FACILITIES

DRAWING NO. 7 | NOVEMBER, 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

MUN RIVER

LAM DOM YAI

PHIBUN MANGSAHAN

WARIN CHAMRAP

N

16°80″

16°70″

16°60″

16°50″

16°40″

16°20″

2213

2182

2192

2171

24

R-6-2

R-6

R-6-1

R-5-4

R-5-3

R-5-2

R-5-1

R-5

R-4-2

R-4-1

R-4

R-3B

R-3A

R-2-3

R-2-2

R-2-1

R-2

R-1

DET UDOM

HUAI ARI

L-7

L-5

L-2

L-1

LAM SON

LAMDOMYAI DAM SITE

PUMPING STATION

PUMPING STATION

RIGHT BANK MAIN CANAL

LEFT BANK MAIN CANAL

NAH YUN

105°00″

105°10′

105°20′

OUTLINE OF CANAL SYSTEMS.

	NAME	Q (cu.m/sec)	L (km)
RIGHT BANK	MAIN	3.76~25.20	44.00
	R-1	3.28	10.00
	R-2	9.93	0.50
	R-2-1	9.21	10.00
	R-2-2	3.98	8.75
	R-2-3	4.18	12.00
	R-2-4	1.01	5.00
	R-3A	3.62	20.50
	R-3B	1.05	5.00
	R-4	8.24	0.50
	R-4-1	3.98	18.50
	R-4-2	4.26	12.50
	R-5	7.29	8.00
	R-5-1	0.55	8.50
	R-5-2	6.90	6.75
	R-5-3	0.53	6.25
	R-5-4	0.65	2.75
	R-6	5.64	3.00
	R-6-1	2.31	8.95
	R-6-2	2.29	8.75
LEFT BANK	MAIN	0.99~8.80	67.40
	L-1	1.34	6.00
	L-2	3.72	12.90
	L-5	2.90	9.20
	L-7	2.08	4.10

LEGEND

	BASIN BOUNDARY
	MAIN CANAL
	LATERAL CANAL
	PIPE LINE(L=4.0km)
Ⓟ	PUMPING STATION
	CHECK CULVERT
○	HEAD REGULATOR
	DAM
2213	ROADS
	RIVERS

0 5 10km

SCALE

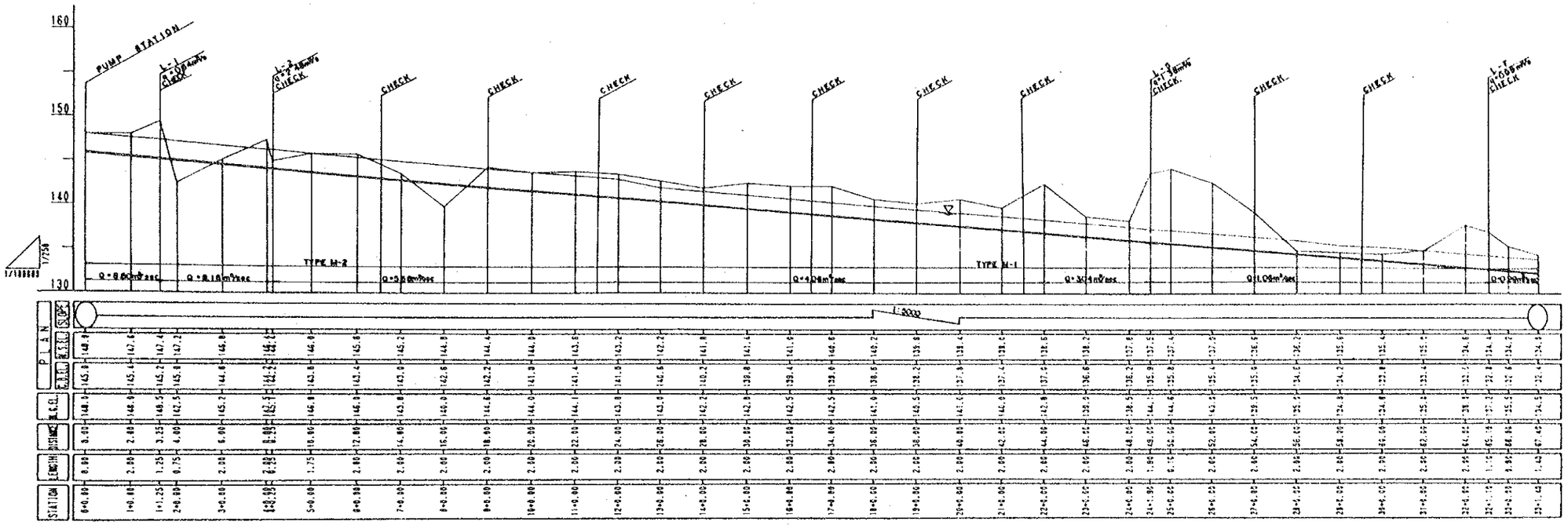
LOCATION MAP OF CANAL SYSTEMS

FEASIBILITY STUDY
LAM DOM YAI BASIN IRRIGATION PROJECT

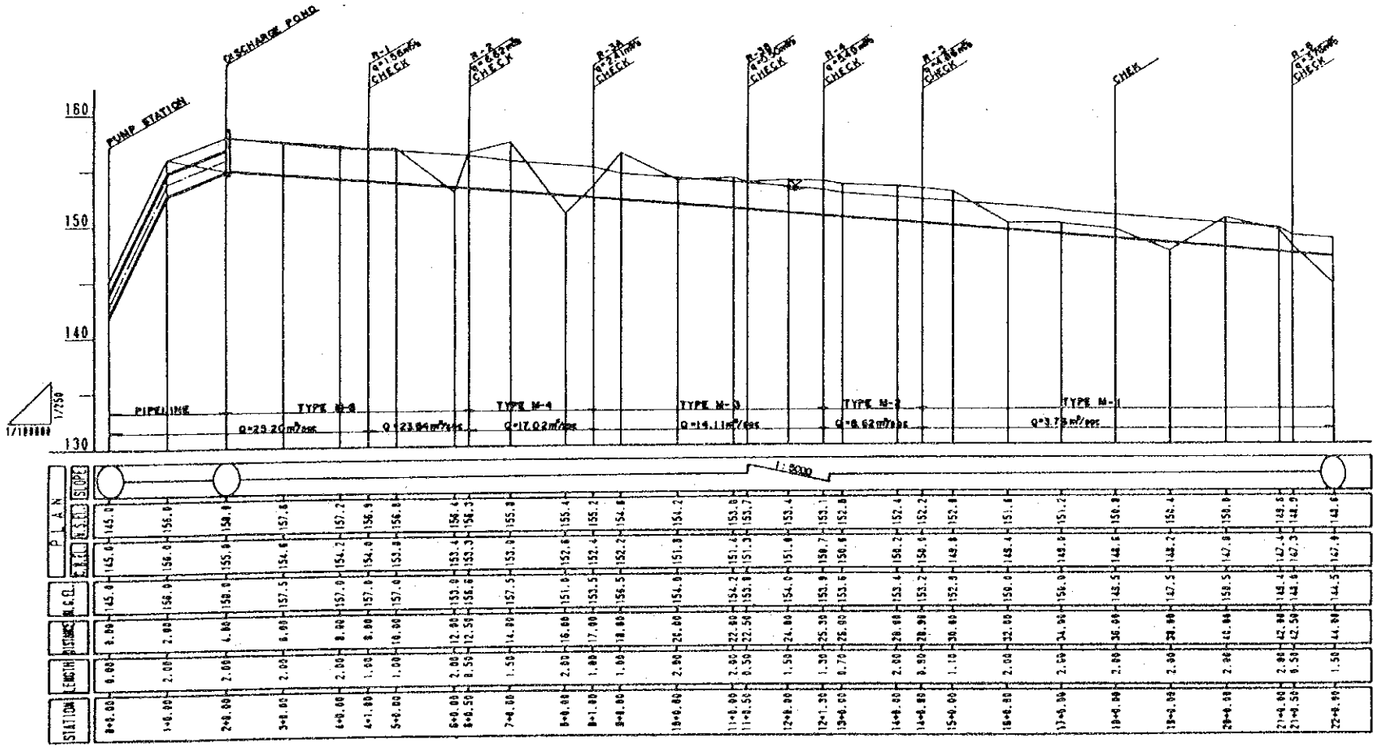
LOCATION MAP OF CANAL SYSTEMS

DRAWING NO. 8 | NOVEMBER, 1992

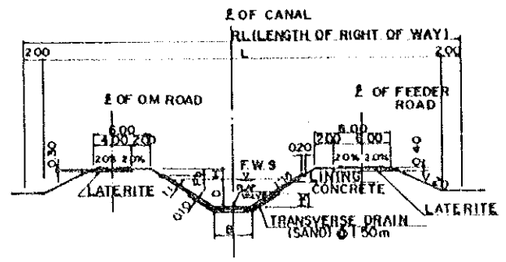
JAPAN INTERNATIONAL COOPERATION AGENCY



PROFILE OF LEFT BANK MAIN CANAL

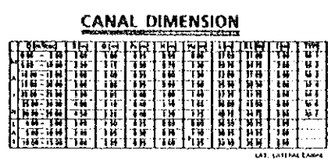


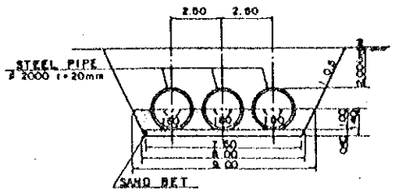
PROFILE OF RIGHT BANK MAIN CANAL



TYPICAL SECTION OF CANAL

CANAL DIMENSION





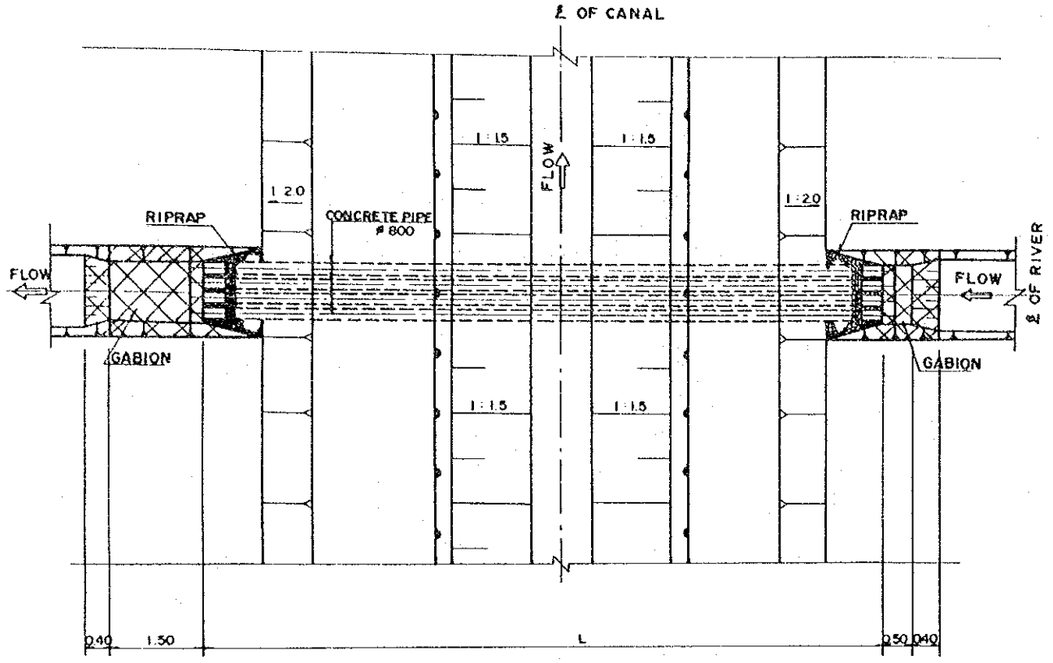
TYPICAL SECTION OF PIPE LINE

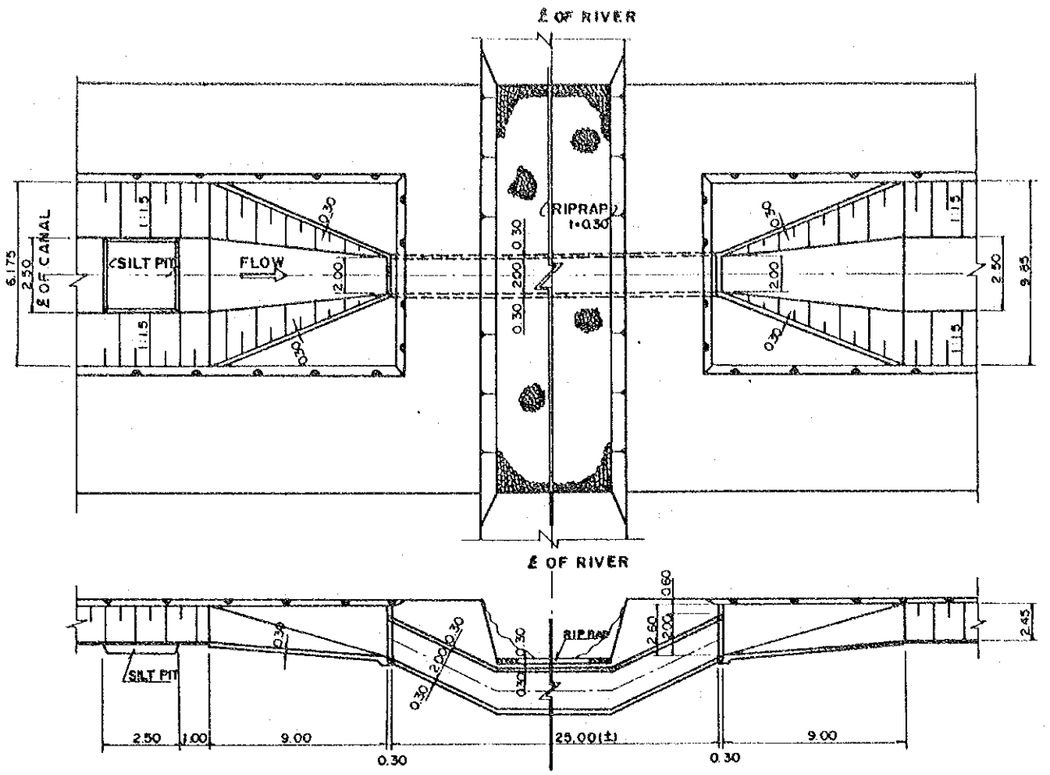
FEASIBILITY STUDY
LAM DOM YAI BASIN IRRIGATION PROJECT

TYPICAL CROSS SECTION AND
PROFILE OF IRRIGATION CANAL

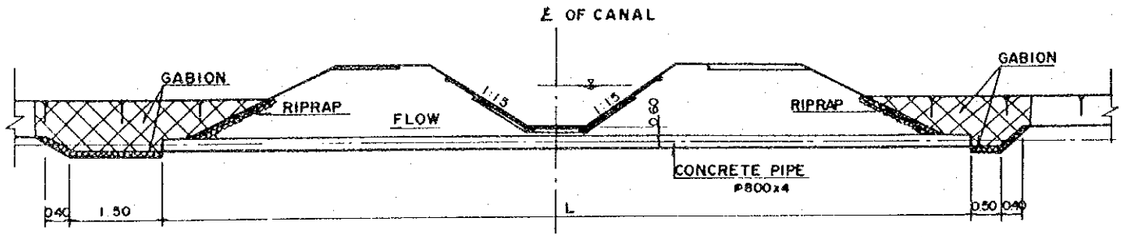
DRAWING NO. 9	NOVEMBER, 1992

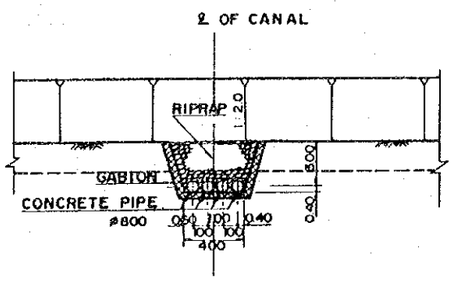
JAPAN INTERNATIONAL COOPERATION AGENCY





$Q \approx 5.00^{m^3/sec} \sim 10.0^{m^3/sec}$

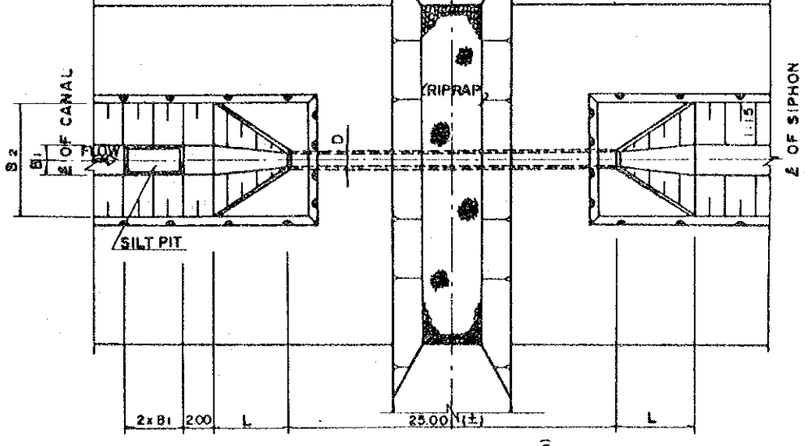


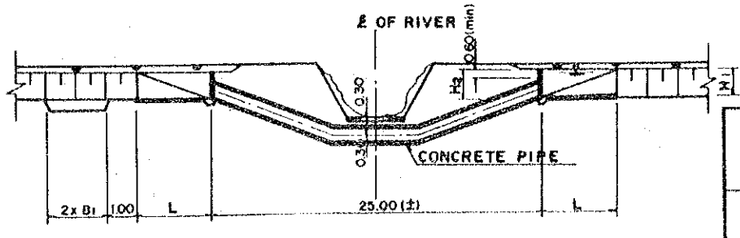


CANAL DISCHARGE m^3/sec	L(m)
10.00 ~ 15.00	47.00
15.00 ~ 20.00	50.00
20.00 ~ 25.00	52.00
25.00 ~ 30.00	53.00
30.00 ~ 35.00	55.00

$Q \approx 10.0^{m^3/sec} \sim 35.0^{m^3/sec}$

Q (m^3/sec)	L (m)	D (m)	B_1 (m)	B_2 (m)	H_1 (m)	H_2 (m)
0.00 ~ 1.00	8.00	0.80	2.00	7.55	1.85	1.85
1.00 ~ 2.00	8.00	1.00	2.00	7.55	1.85	1.85
2.00 ~ 4.00	7.00	1.50	2.00	7.55	1.85	2.10
4.00 ~ 5.00	7.00	1.80	2.00	7.55	1.65	2.40





$Q \approx 1.0^{m^3/sec} \sim 5.0^{m^3/sec}$

RIVER CROSSING

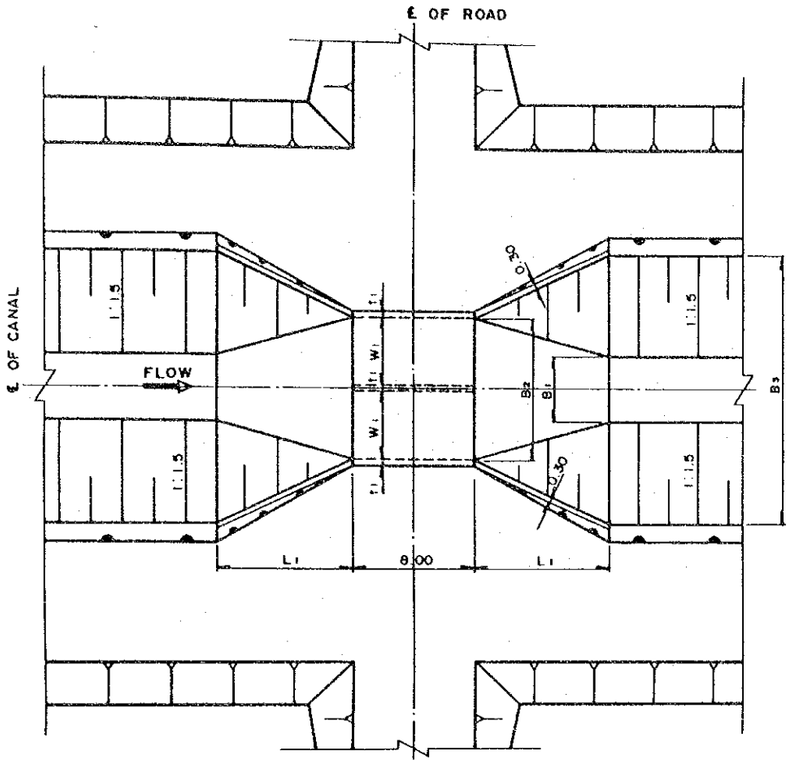
NO SCALE

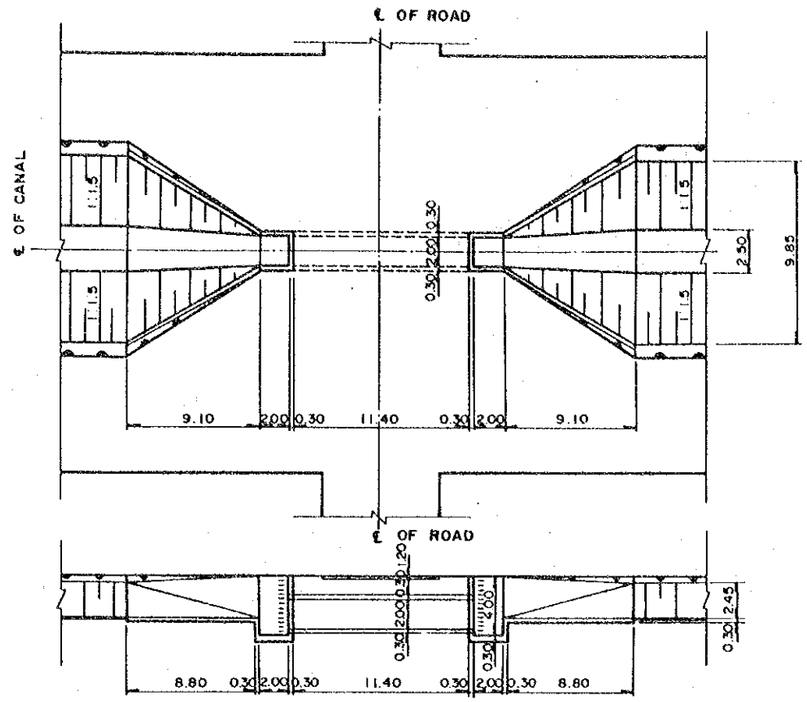
FEASIBILITY STUDY
LAM DOM YAI BASIN IRRIGATION PROJECT

RELATED STRUCTURE
OF IRRIGATION CANAL (1/4)

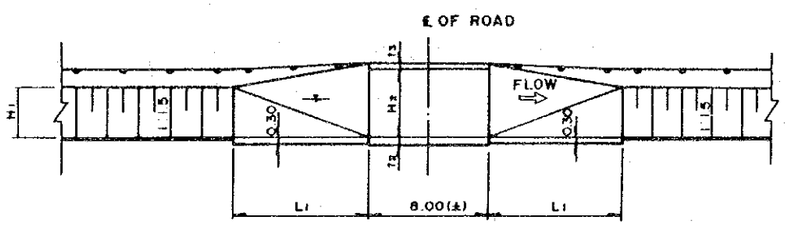
DRAWING NO. 10 | NOVEMBER, 1992

JAPAN INTERNATIONAL COOPERATION AGENCY



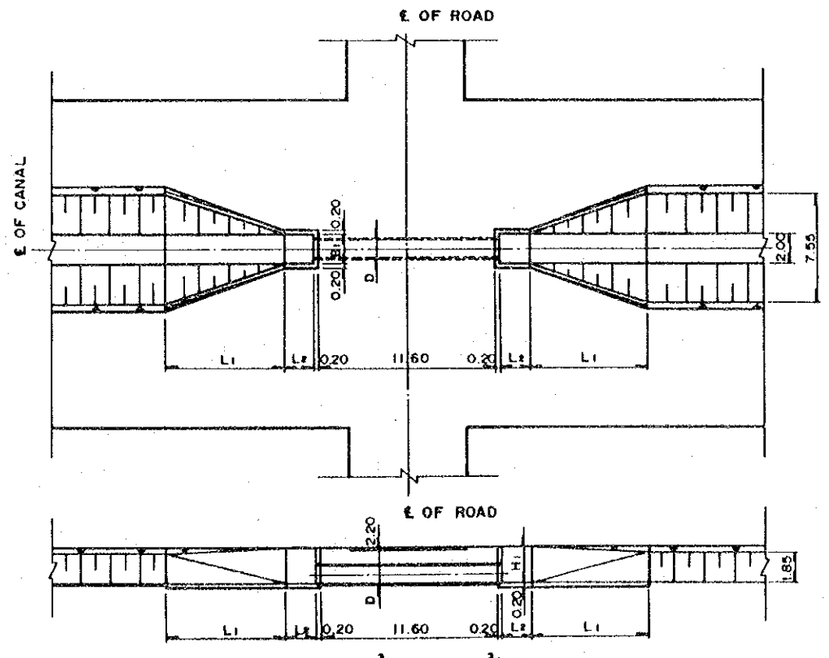


$Q = 5.0^{m^3/sec} \sim 10.0^{m^3/sec}$



Q (m³/sec)	B_1 (m)	B_2 (m)	B_3 (m)	H_1 (m)	H_2 (m)	L_1 (m)	W_1 (m)	t_1 (m)	t_2 (m)	t_3 (m)
10.00 ~ 15.00	3.00	4.30	11.25	2.75	3.20	11.50	2.00	0.30	0.45	0.40
15.00 ~ 20.00	3.00	5.70	12.45	3.15	3.70	11.00	2.70	0.30	0.45	0.40
20.00 ~ 25.00	3.50	7.35	13.55	3.35	3.95	10.00	3.50	0.35	0.45	0.40
25.00 ~ 30.00	4.00	8.40	14.50	3.50	4.20	10.00	4.00	0.40	0.50	0.45
30.00 ~ 35.00	4.50	9.80	15.45	3.65	5.70	9.00	4.70	0.40	0.55	0.50

$Q = 10.0^{m^3/sec} \sim 35.0^{m^3/sec}$



$Q = 1.0^{m^3/sec} \sim 5.0^{m^3/sec}$

Q (m³/sec)	D (m)	L_1 (m)	L_2 (m)	B_1 (m)	H_1 (m)
~1.00	0.80	8.00	1.20	1.20	2.00
1.00 ~ 2.00	1.00	8.00	1.50	1.50	2.20
2.00 ~ 4.00	1.50	7.00	2.30	2.30	2.70
4.00 ~ 5.00	1.80	7.00	2.70	2.70	3.00

ROAD CROSSING

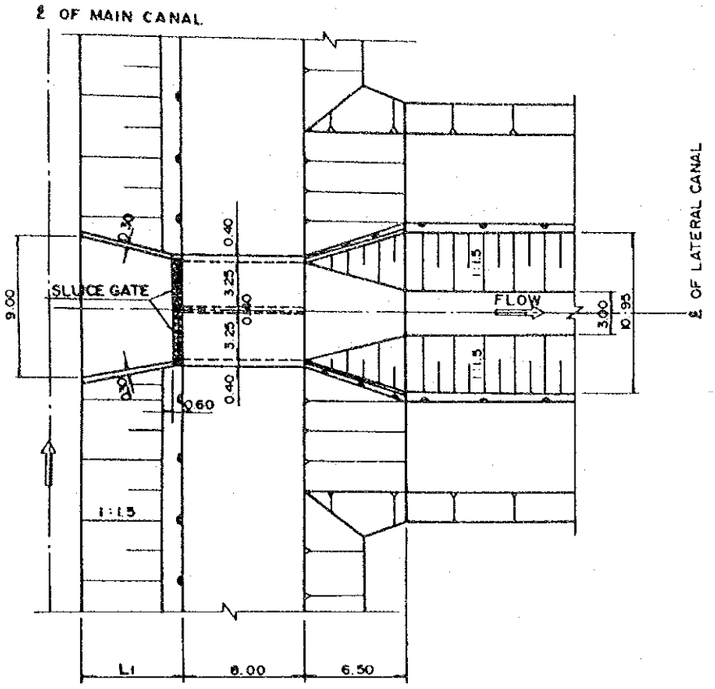
NO SCALE

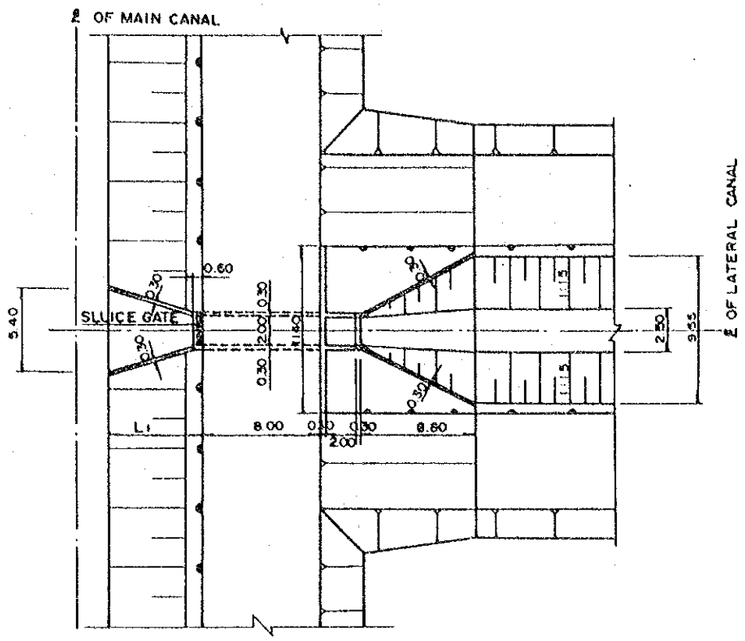
FEASIBILITY STUDY
LAM DOM YAI BASIN IRRIGATION PROJECT

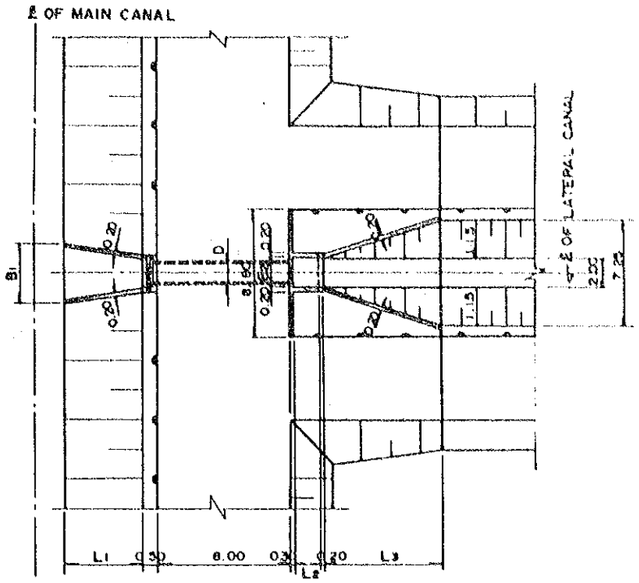
RELATED STRUCTURE
OF IRRIGATION CANAL (2/4)

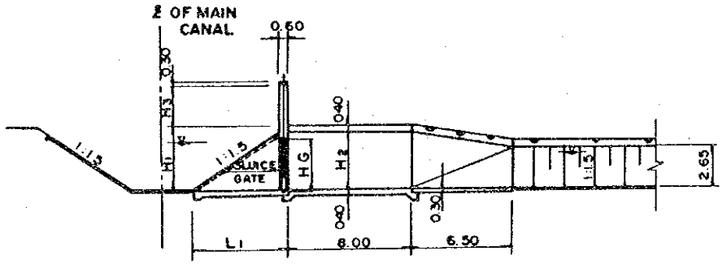
DRAWING NO. 11 | NOVEMBER, 1992

JAPAN INTERNATIONAL COOPERATION AGENCY



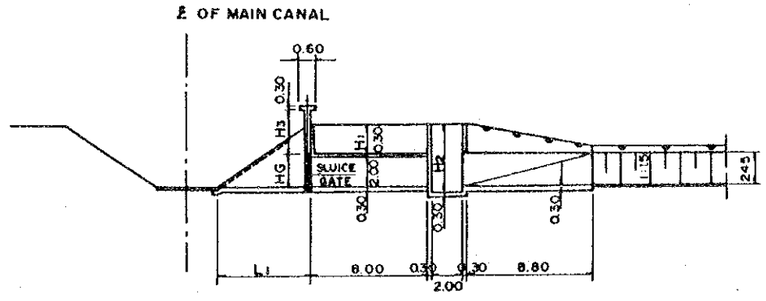






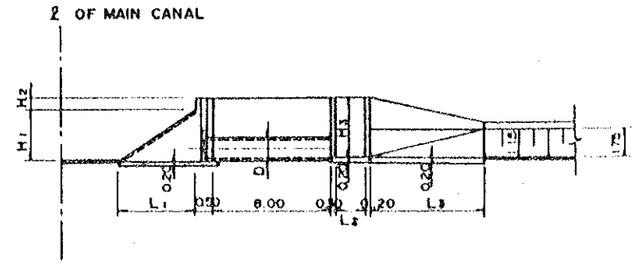
DISCHARGE OF MAIN CANAL (m³/sec)	H_1 (m)	H_2 (m)	H_3 (m)	HG (m)	L (m)
15.00 ~ 20.00	3.70	2.90	2.70	3.00	5.55
20.00 ~ 25.00	3.95	3.15	2.95	3.25	5.93
25.00 ~ 30.00	4.20	3.40	3.20	3.50	6.30
30.00 ~ 35.00	4.45	3.65	3.45	3.75	6.68

Q = 10.0m³/sec ~ 15.0m³/sec



DISCHARGE OF MAIN CANAL (m³/sec)	D (m)	L_1 (m)	L_2 (m)	L_3 (m)	H_1 (m)	H_2 (m)	H_3 (m)	B_1 (m)	B_2 (m)
~ 5.00	1.00	2.80	1.50	8.00	1.87	0.33	2.20	2.00	1.50
5.00 ~ 10.00	1.80	3.78	2.70	7.00	2.52	0.33	2.85	3.60	2.70
10.00 ~ 15.00	1.80	4.30	2.70	7.00	2.87	0.33	3.20	3.60	2.70
15.00 ~ 20.00	1.80	5.05	2.70	7.00	3.37	0.33	3.70	3.60	2.70
20.00 ~ 25.00	1.80	5.43	2.70	7.00	3.62	0.33	3.95	3.60	2.70
25.00 ~ 30.00	1.80	5.80	2.70	7.00	3.87	0.33	4.20	3.60	2.70
30.00 ~ 35.00	1.80	6.18	2.70	7.00	4.12	0.33	4.45	3.60	2.70

Q = 5.0m³/sec ~ 10.0m³/sec



DISCHARGE OF MAIN CANAL (m³/sec)	H_1 (m)	H_2 (m)	H_3 (m)	HG (m)	L (m)
10.00 ~ 15.00	0.60	2.90	2.40	2.20	4.35
15.00 ~ 20.00	1.10	3.40	2.40	2.20	5.10
20.00 ~ 25.00	1.35	3.65	2.40	2.20	5.48
25.00 ~ 30.00	1.60	3.90	2.40	2.20	5.85
30.00 ~ 35.00	1.85	4.15	2.40	2.20	6.23

Q = 1.0m³/sec ~ 5.0m³/sec

HEAD REGULATOR

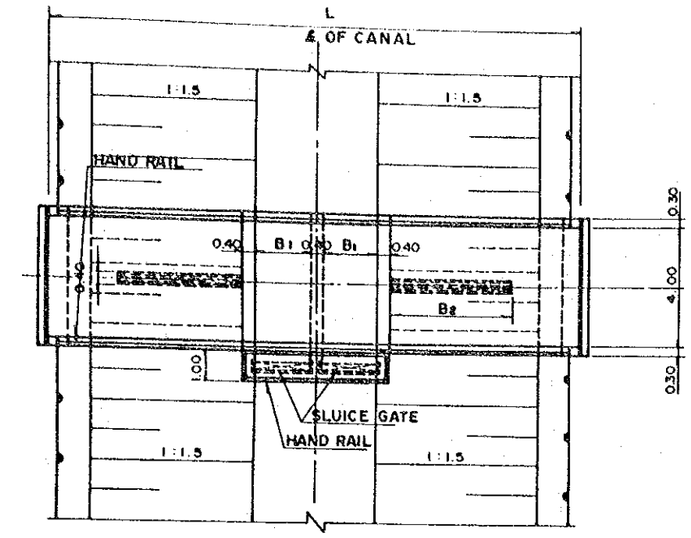
NO SCALE

FEASIBILITY STUDY
LAM DOM YAI BASIN IRRIGATION PROJECT

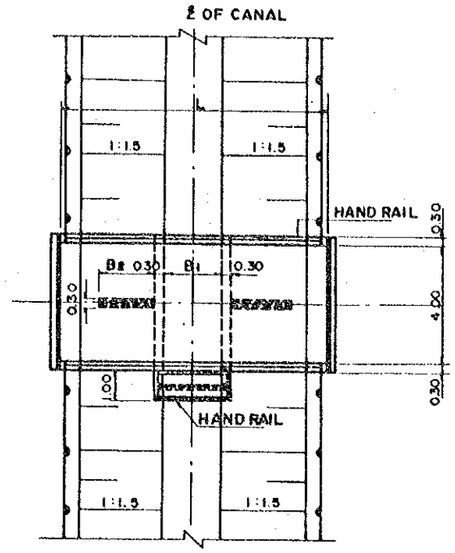
RELATED STRUCTURE
OF IRRIGATION CANAL (3/4)

DRAWING NO. 12 | NOVEMBER, 1992

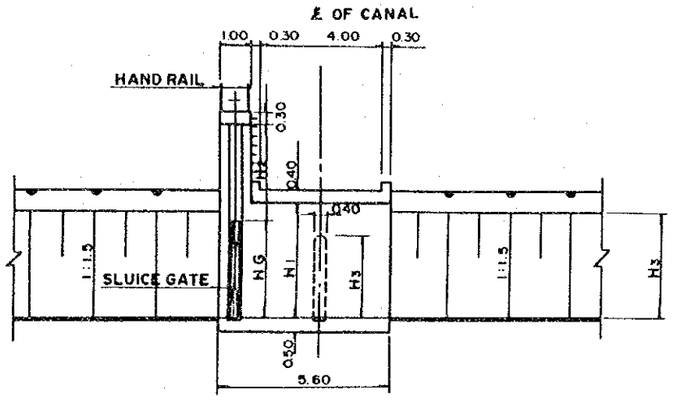
JAPAN INTERNATIONAL COOPERATION AGENCY



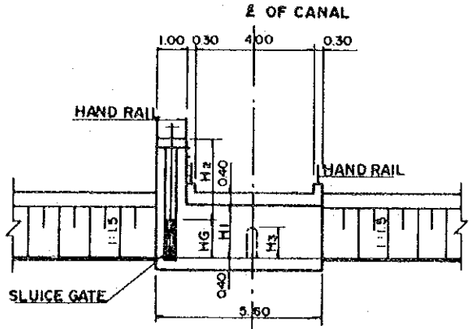
PLANE



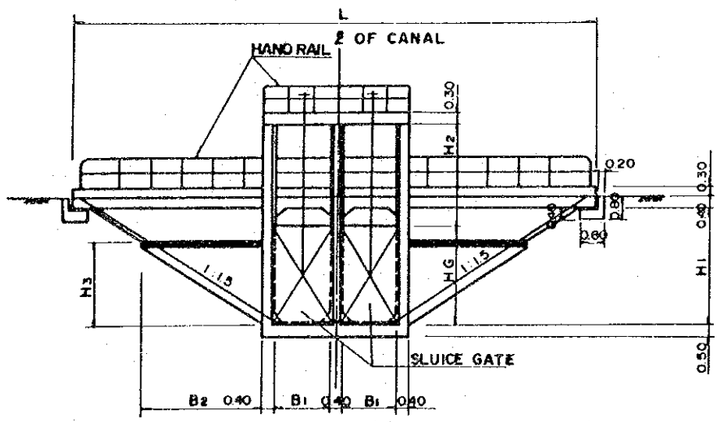
PLANE



PROFILE



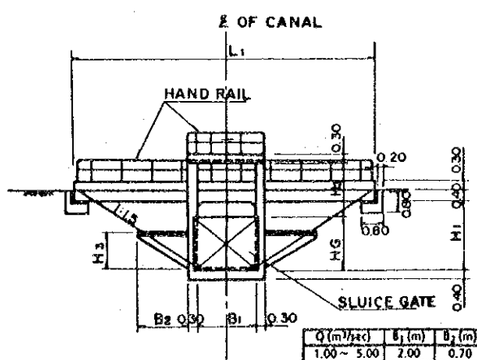
PROFILE



SECTION

Q (m³/sec)	B1 (m)	B2 (m)	H1 (m)	H2 (m)	H3 (m)	HG (m)	L (m)
10.00 ~ 15.00	1.30	2.75	2.80	2.60	1.70	2.50	13.60
15.00 ~ 20.00	1.30	3.50	3.30	3.00	2.20	2.90	15.10
20.00 ~ 25.00	1.55	3.88	3.55	3.15	2.45	3.05	16.35
25.00 ~ 30.00	1.80	4.25	3.80	3.30	2.70	3.20	17.60
30.00 ~ 35.00	2.05	4.63	4.05	3.45	2.95	3.35	18.85

$Q = 10.0^{m^3/sec} \sim 35.0^{m^3/sec}$



SECTION

Q (m³/sec)	B1 (m)	B2 (m)	H1 (m)	H2 (m)	H3 (m)	HG (m)	L (m)
1.00 ~ 5.00	2.00	0.70	1.80	1.80	1.25	1.70	9.00
5.00 ~ 10.00	2.50	1.35	2.45	2.30	1.70	2.20	11.45

$Q = 1.0^{m^3/sec} \sim 10.0^{m^3/sec}$

CHECK CULVERT

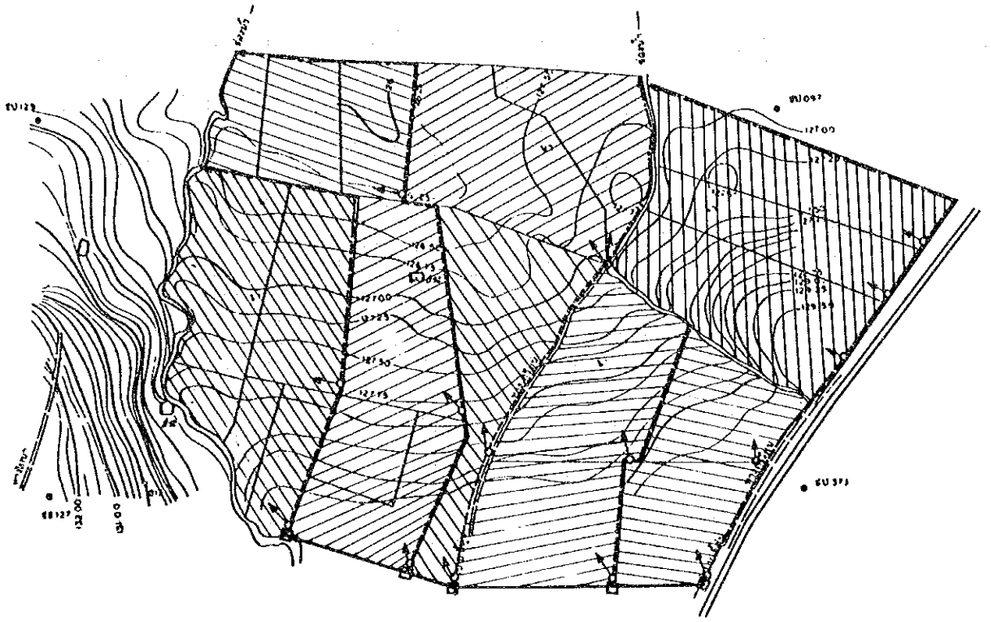
NO SCALE

FEASIBILITY STUDY
LAM DOM YAI BASIN IRRIGATION PROJECT

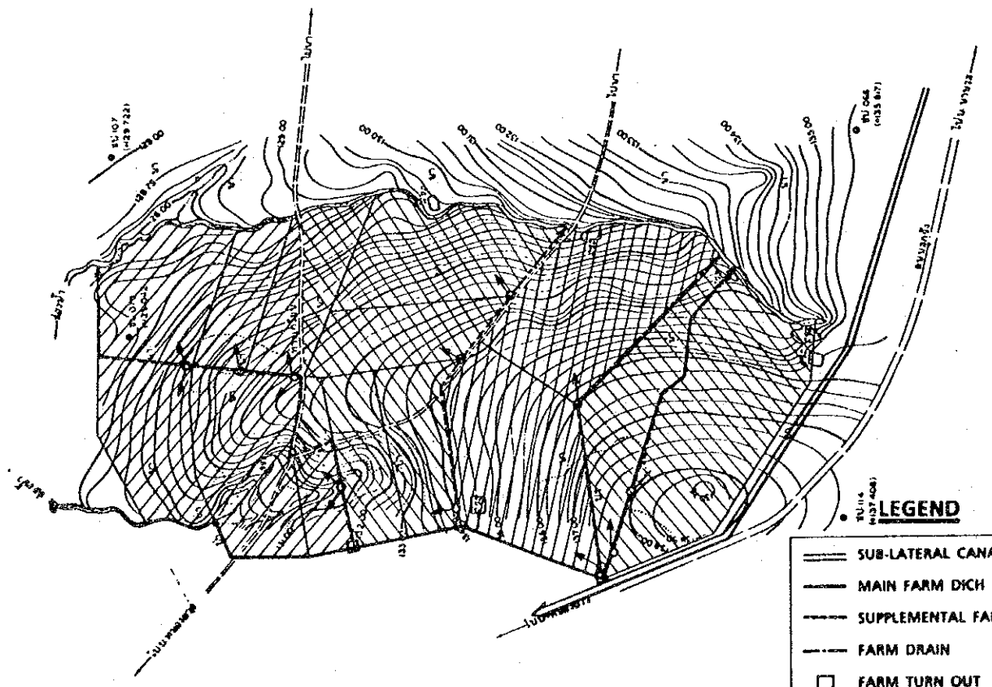
RELATED STRUCTURE
OF IRRIGATION CANAL (4/4)

DRAWING NO. 13 | NOVEMBER, 1992

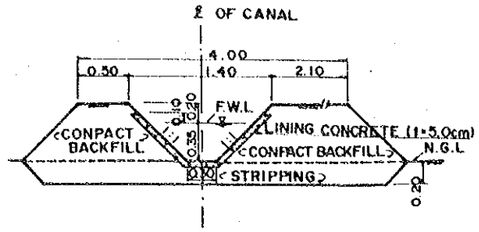
JAPAN INTERNATIONAL COOPERATION AGENCY



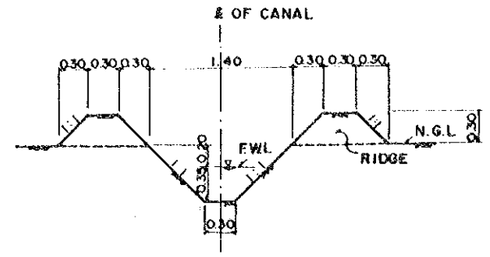
TYPICAL LAYOUT OF ON-FARM FACILITIES (A)



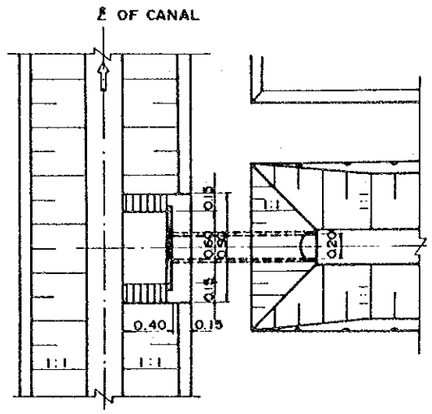
TYPICAL LAYOUT OF ON-FARM FACILITIES (B)



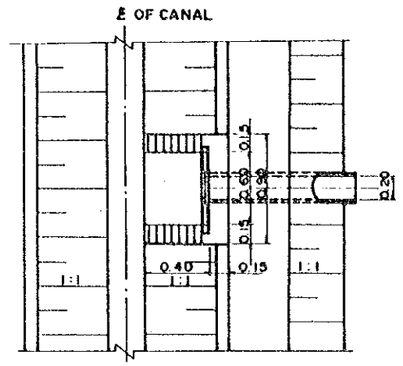
MAIN & SUPPLEMENTAL FARM DICH

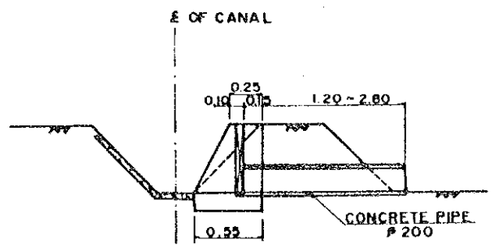


FARM DRAIN



FARM TURN OUT



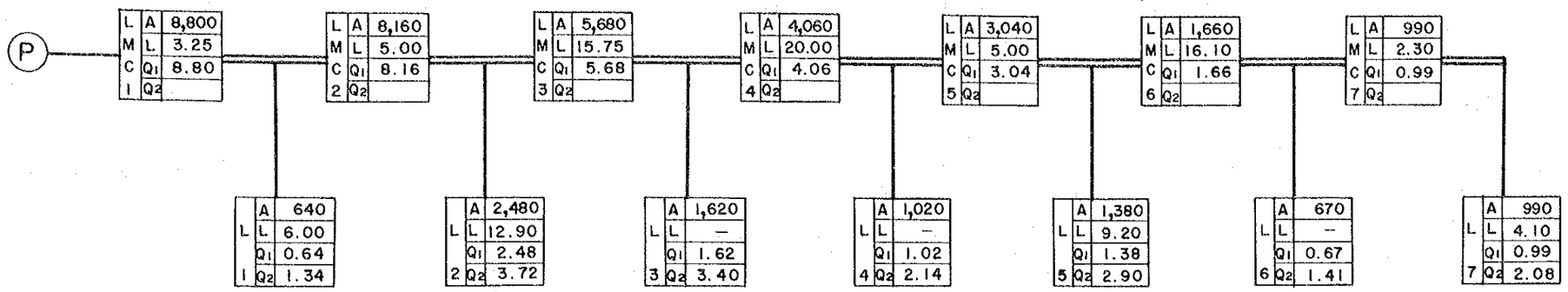


FARM INLET

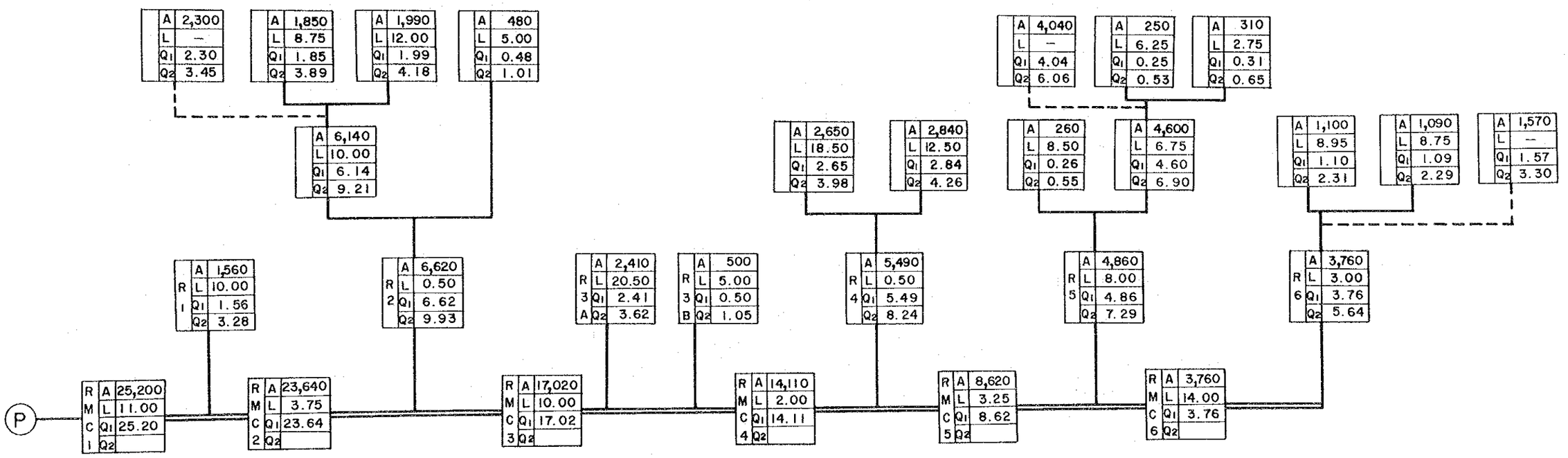
ON-FARM FACILITIES

NO SCALE

FEASIBILITY STUDY LAM DOM YAI BASIN IRRIGATION PROJECT
TYPICAL DESIGN OF ON-FARM FACILITIES
DRAWING NO. 14
JAPAN INTERNATIONAL COOPERATION AGENCY



LEFT BANK AREA



RIGHT BANK AREA

LEGEND

A	AREA	ha
L	CANAL LENGTH	km
Q1	DESIGNED DISCHARGE OF MAIN CANAL	cu.m/s
Q2	DESIGNED DISCHARGE OF LATERAL CANAL	cu.m/s

MAIN CANAL ═══

LATERAL CANAL ———

FEASIBILITY STUDY
LAM DOM YAI BASIN IRRIGATION PROJECT

DIAGRAM OF PROPOSED
IRRIGATION SYSTEM

DRAWING NO. 15 | NOVEMBER, 1992

JAPAN INTERNATIONAL COOPERATION AGENCY