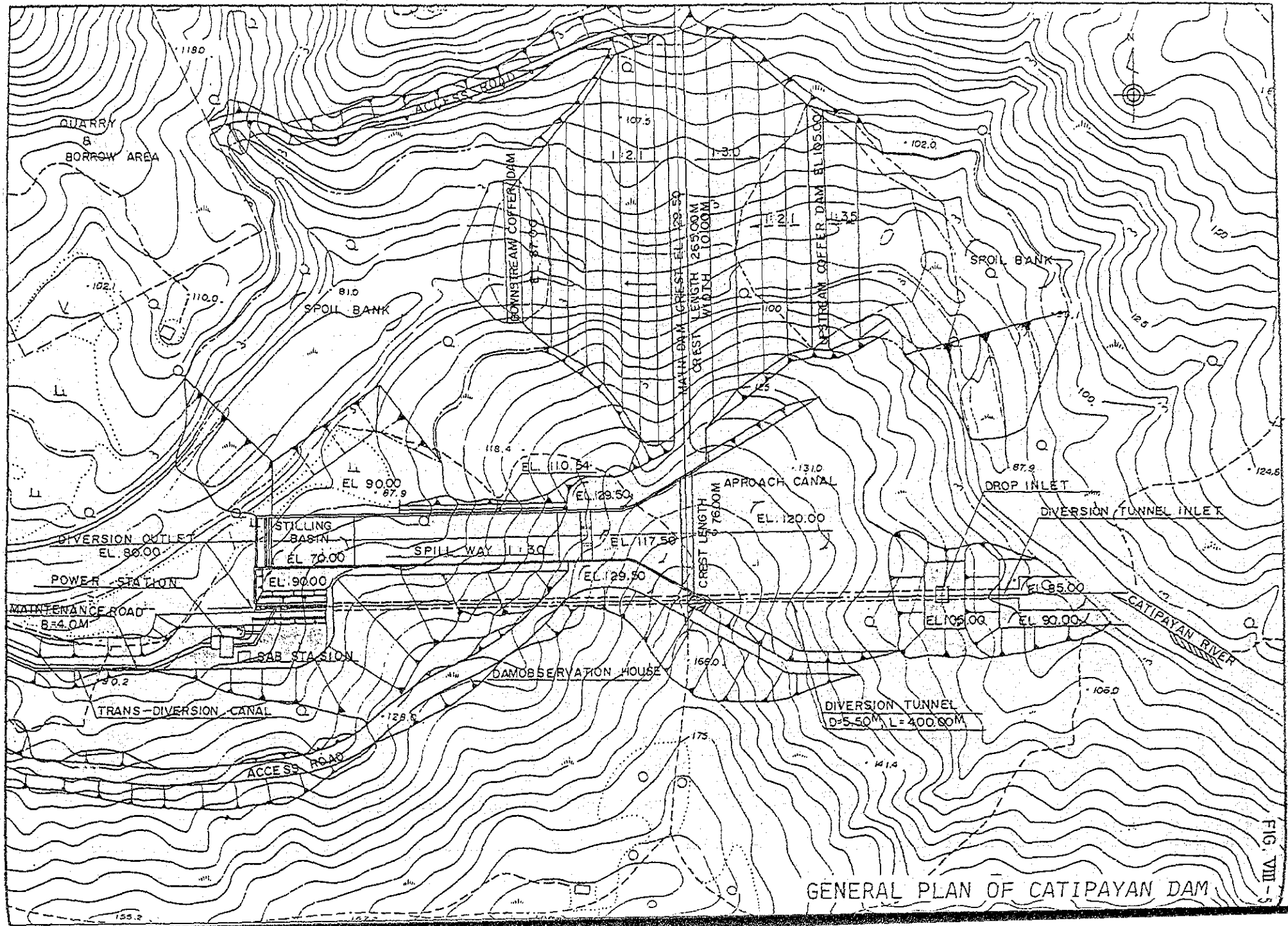


GENERAL PLAN OF CATIPAYAN DAM

FIG. VIII-5

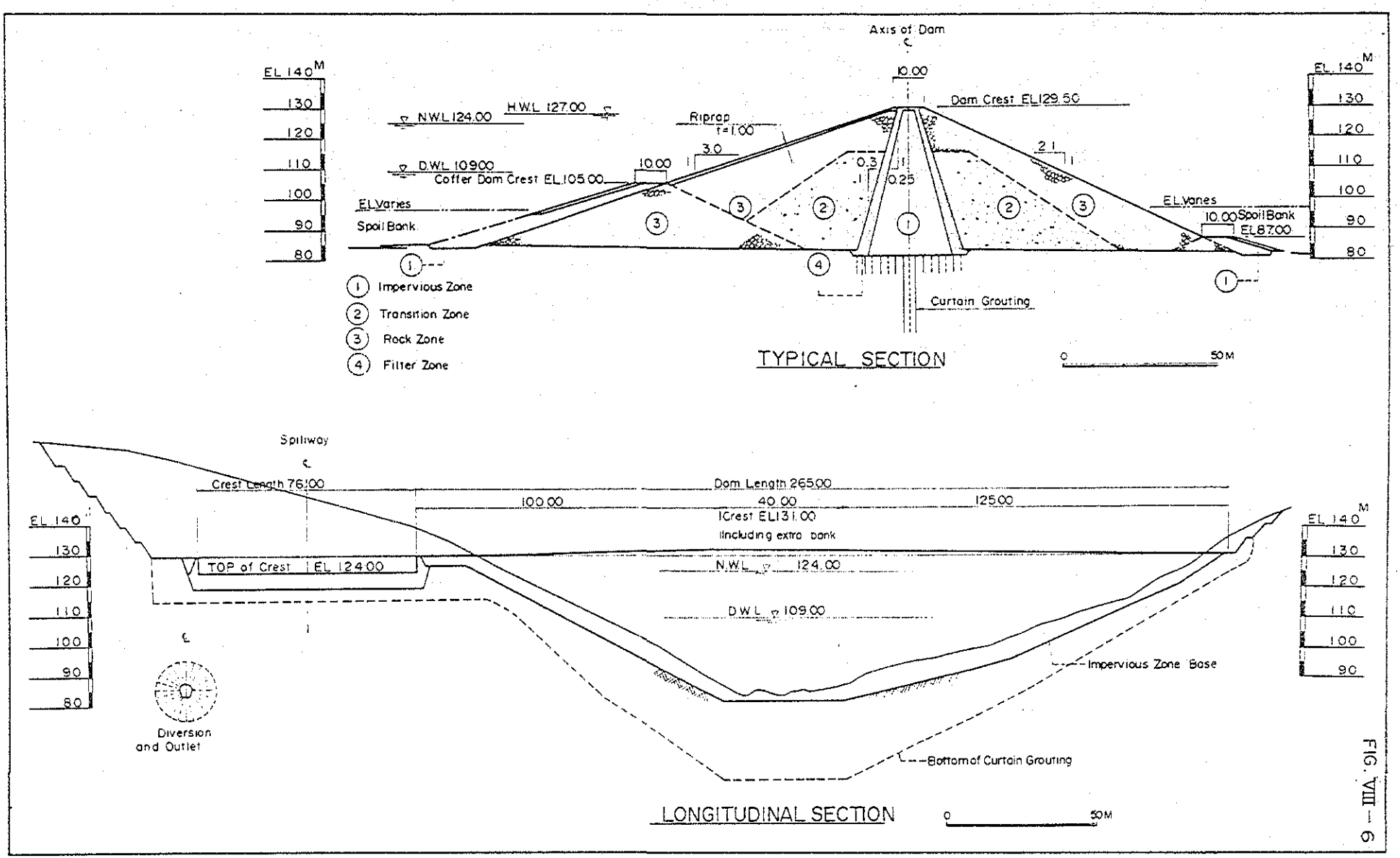
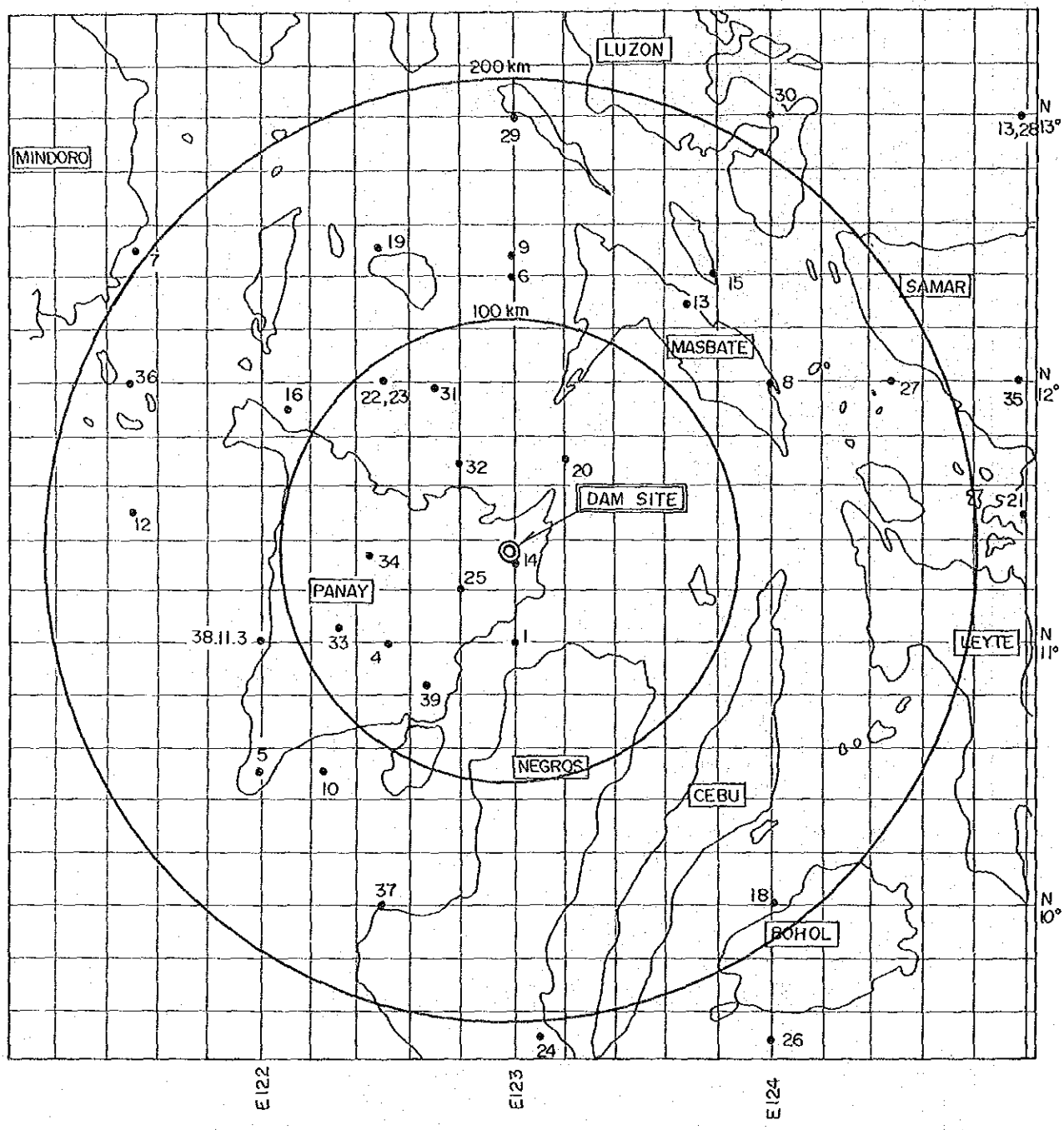

Axis of Dam
EL 140 M
130
120
110
100
90
80
10.00
Dam Crest EL 129.50
N.W.L 124.00
H.W.L 127.00
Riprap
T=1.00
3.0
2.1
0.3
1
1
0.25
D.W.L 109.00
Coffer Dam Crest EL 105.00
10.00
EL Varies
Spoil Bank
EL Varies
10.00 Spoil Bank
EL 87.00
1 Impervious Zone
2 Transition Zone
3 Rock Zone
4 Filter Zone
Curtain Grouting
TYPICAL SECTION
0
50 M
Spillway
Crest Length 76.00
Dam Length 265.00
100.00
40.00
125.00
Crest EL 131.00
Including extra bank
TOP of Crest EL 124.00
N.W.L 124.00
D.W.L 109.00
Impervious Zone Base
Diversion
and Outlet
Bottom of Curtain Grouting
LONGITUDINAL SECTION
0
50M

FIG. VIII - 6

EPICENTER LOCATION MAP

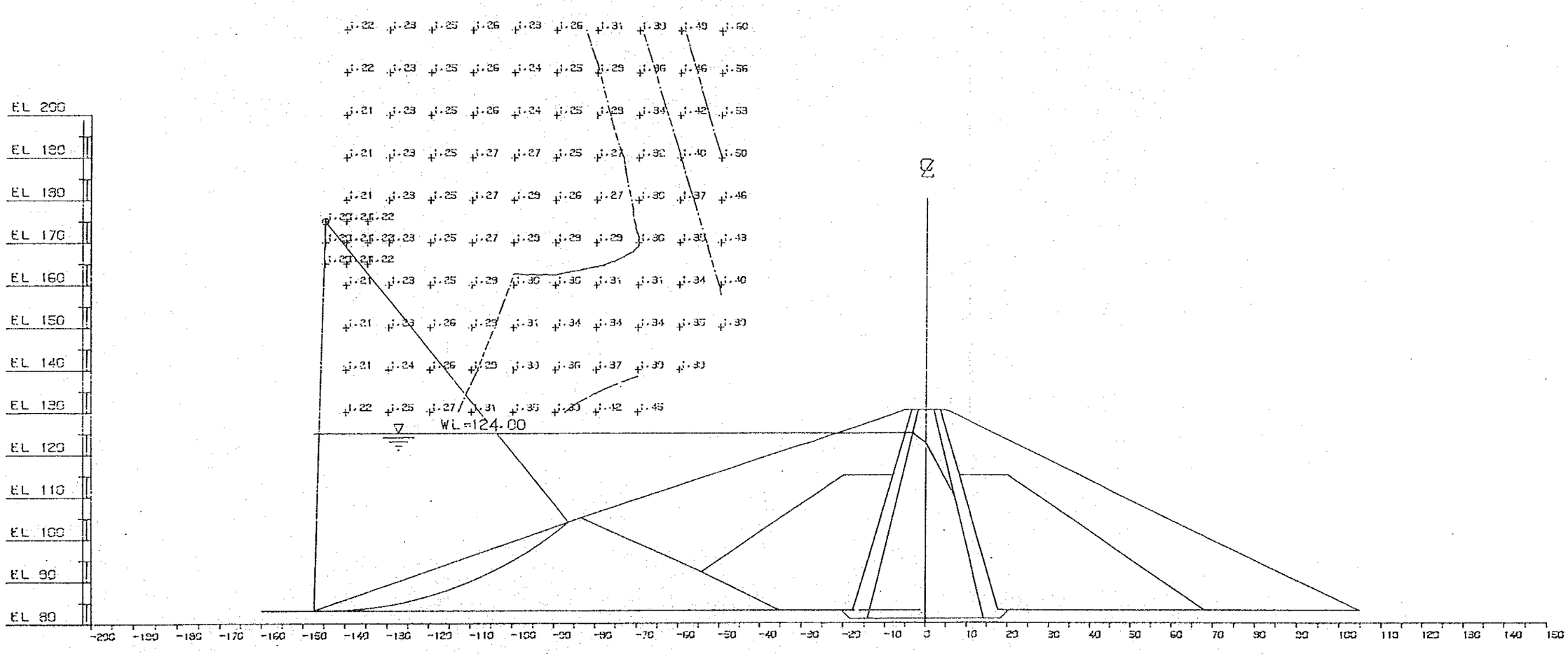


RESULTS OF SLOPE STABILITY ANALYSIS

STABILITY ANALYSIS OF DAM

(1/1000)

CASE	F·W·L
WATER LEVEL	WL=124.00
	K = 0.180
	FS = 1.204

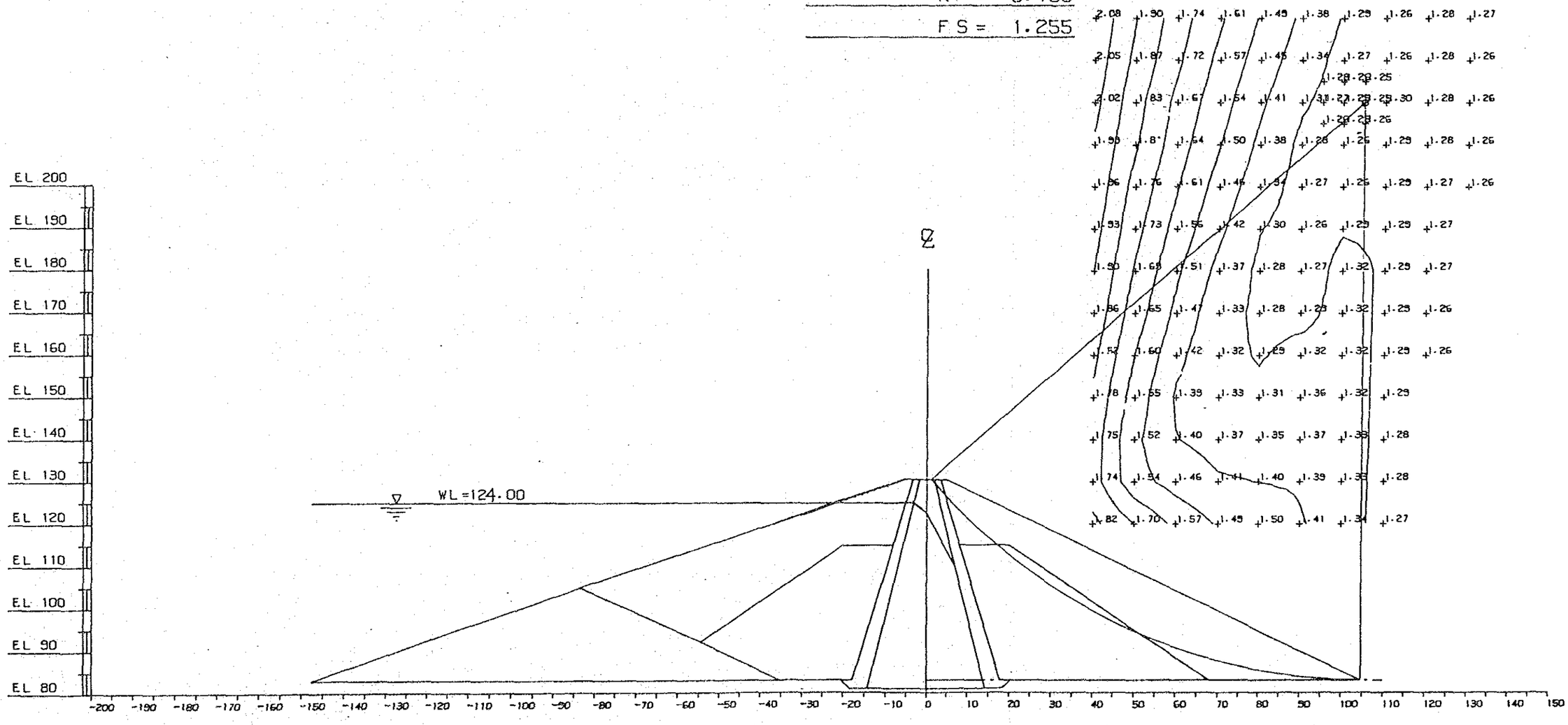


RESULTS OF
SLOPE STABILITY ANALYSIS

STABILITY ANALYSIS OF DAM

(1/1000)

CASE	F·W·L
WATER LEVEL	WL=124.00
	K = 0.180
	FS = 1.255

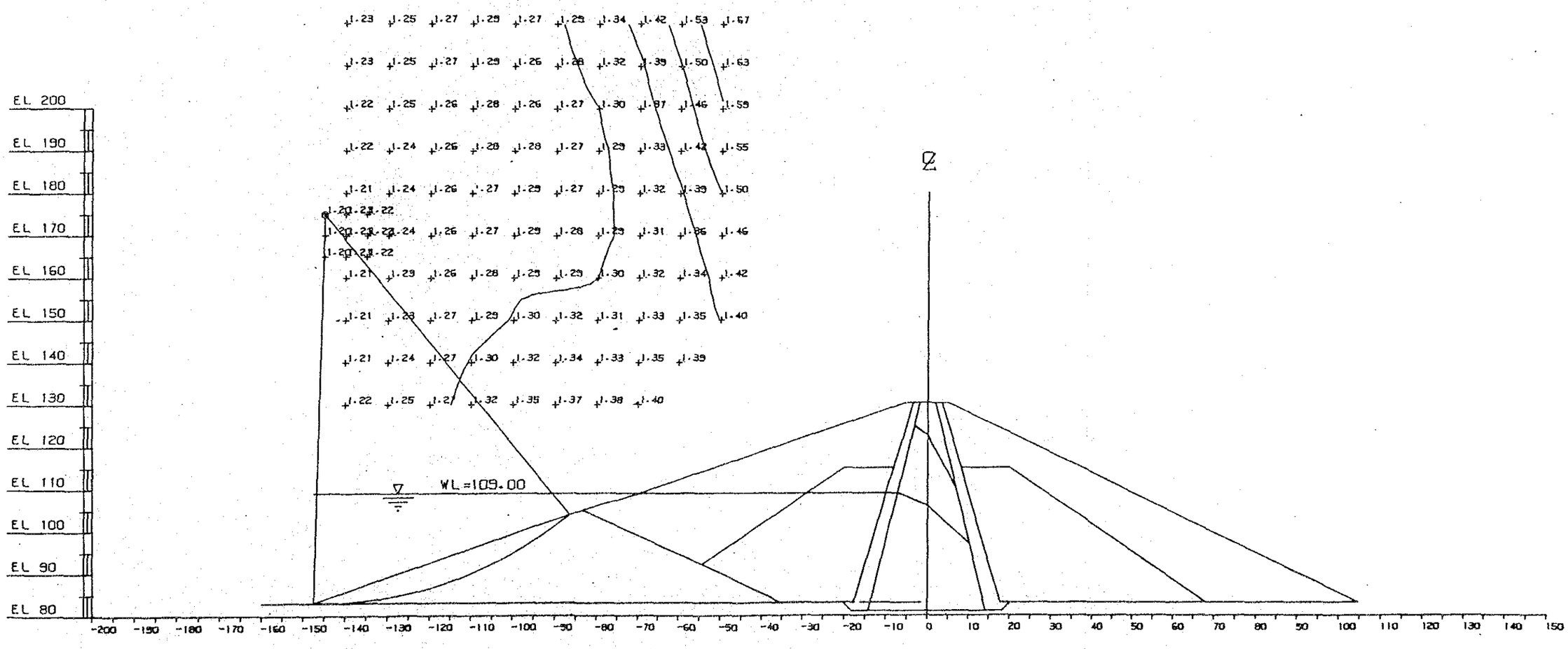


RESULTS OF SLOPE STABILITY ANALYSIS

STABILITY ANALYSIS OF DAM

(1/1000)

CASE	M·W·L
WATER LEVEL	WL=109.00
	K = 0.180
	FS = 1.204

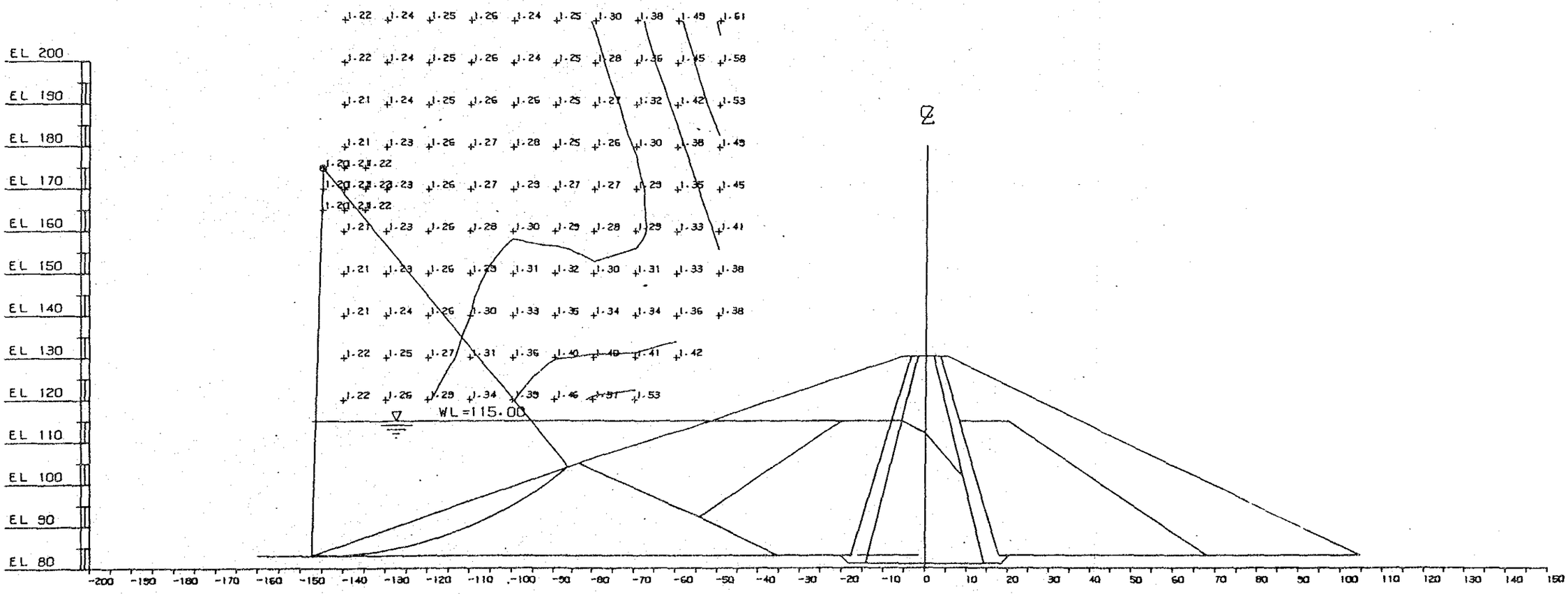


RESULTS OF SLOPE STABILITY ANALYSIS

STABILITY ANALYSIS OF DAM

(1/1000)

CASE	RAPID DRAWDOWN
WATER LEVEL	WL=115.00
	K = 0.180
	FS = 1.204

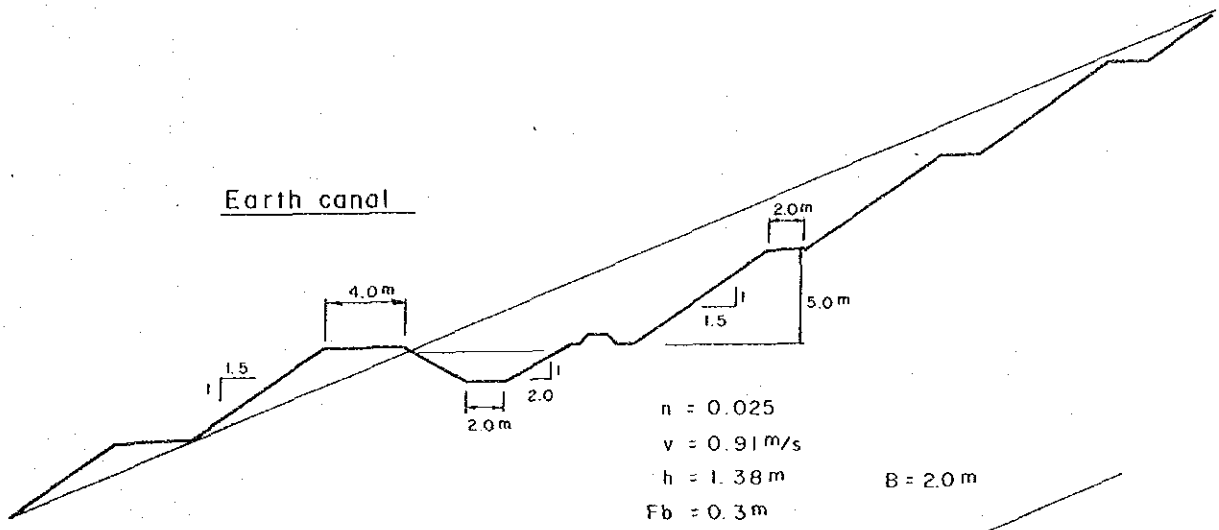


ALTERNATIVE PLAN FOR TRANS-DIVERSION CANAL SECTION

Q = 6.0 m^3/sec

I = 1/1400

Earth canal



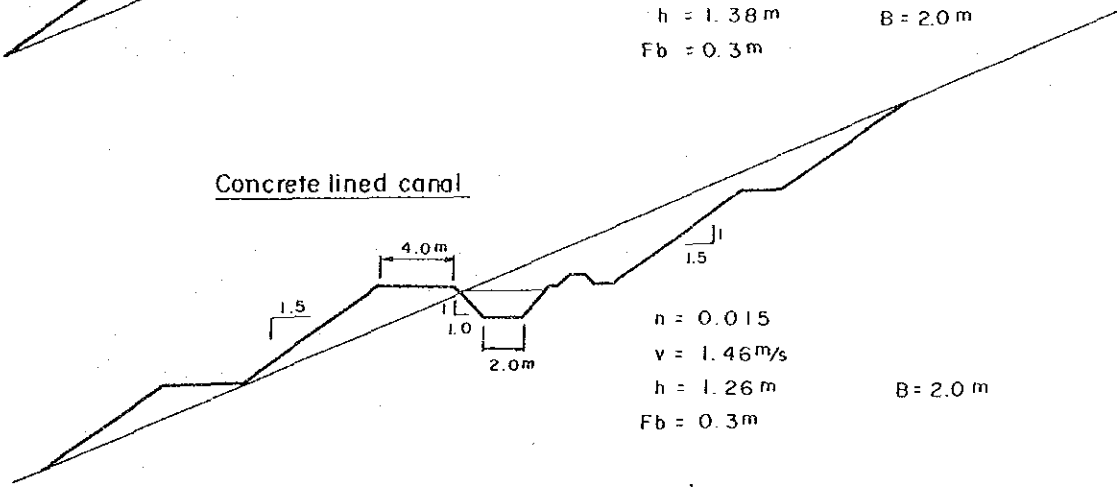
n = 0.025

v = 0.91 m/s

h = 1.38 m B = 2.0 m

Fb = 0.3 m

Concrete lined canal



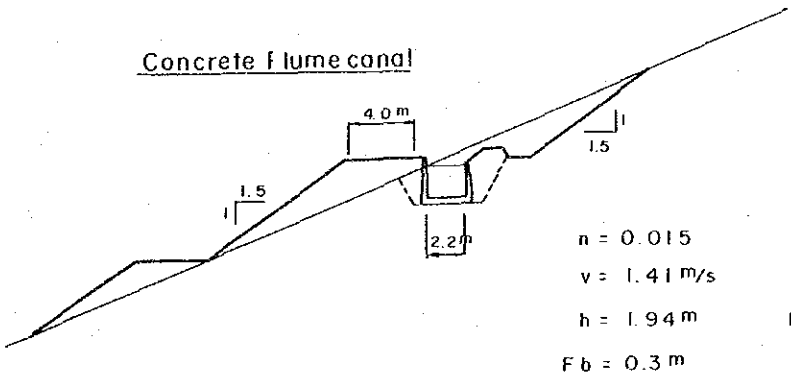
n = 0.015

v = 1.46 m/s

h = 1.26 m B = 2.0 m

Fb = 0.3 m

Concrete flume canal



n = 0.015

v = 1.41 m/s

h = 1.94 m B = 2.2 m

Fb = 0.3 m

APPENDIX IX

RURAL DEVELOPMENT

APPENDIX IX

RURAL DEVELOPMENT

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RURAL DEVELOPMENT

1. ROAD NETWORK PLAN

1.1 Present Road Conditions

The Project area covers about 8,320 ha of gross area consisting of 72 Barangays with a total population of 45,100. Existing roads in the Project area are national, provincial, municipal, barangay and farm roads and the same are illustrated in FIG. IX-1-1 and tabulated in TABLE IX-1-1.

The total length of the 3 national roads in the Project area is 35.4km with a density of 401.7m/km^2. The same are well maintained; however, only about 30% are paved. National road No. 2 runs from south to north connecting Poblacions Ajuy and Sara. From Sara the road which is mostly asphalt paved at a width of 10m, runs east then north out of the Project area to Estancia. Other national roads i.e. No.340 and No.350 are mostly gravel paved, and connect Sara to San Dionisio, Concepcion and Lemery.

Total length of provincial roads is about 11.0km with a density of 124.8m/km^2. All provincial roads are gravel paved, and, as a result, maintenance is poor. In addition, except for newly constructed roads, bridges of the same cannot sustain transport of heavy freight or passage of large vehicles.

Municipal and barangay road networks are sufficient. Maintenance of the same is poor and in many places roads are impassable, while passage of vehicles over the majority of bridges is not possible.

Farm roads in the Project area are distributed at a comparatively high density of 712.6m/km^2. This density, however, includes a large proportion of roads constructed through sugar cane fields, as well as roads between the mountains and rice fields connecting barangay. Actual road conditions in paddy area are poor and the main farm roads are levees. The latter are extremely narrow, following the shape of the field, and thus hinder free passage of farmers, particularly decreasing the efficiency of extraction and transportation of harvested crops.

Different types of motor vehicles registered with the Bureau of Land Transportation serve the nine municipalities of Iloilo including the four Project municipalities. The Project barangay residents make use of tricycles to travel from barangays to the poblacions while jeepneys and buses are used in going to other municipalities. Registered vehicles are tabulated in TABLE IX-1-2.

According to field investigations and studies of topographical maps, existing roads in the Project area are insufficient in both number and function for farming and marketing purposes.

1.2 Basic Policy and Proposed Road Network

As mentioned above, the present condition of the road network in the Project area is considered insufficient and the function of the same will be especially inadequate for operation and maintenance required after Project implementation.

In this Project, therefore, a road network plan has been included as a supplementary component of irrigation development. The main focus is establishment of access roads for O&M roads of planned irrigation facilities and improvement of the farm-to-market connection. Accordingly, main O&M roads will be connected to the national and provincial roads while branch roads will follow irrigation canals in order to increase the effectiveness of farming, transport of post-harvest produce, rural communication and agricultural support services. Scale of maintenance roads will be sufficiently wide to permit passage of vehicles.

On the basis of the considerations mentioned above, the road network plan under the Project is proposed as shown in FIG. IX-1-2.

1.3 Facilities Planning

Major features of the proposed road network plan are shown below and a typical section of the proposed road is presented in VOLUME 4 DRAWINGS.

PROPOSED ROAD NETWORK

unit: km

Item	O&M Roads for Irrigation	Connecting Roads	Total
Main road effective width (4.0m)	98.25[1/]	15.30	113.55
Secondary road effective width (4.0 m)[2/]	12.60	-	12.60
Rehabilitation of existing road	-	6.0	6.0
Total	110.85	21.30	132.15

1/ Includes roads along the Serruco CIS (16,11km)
2/ Cost for 1.0m width is to be included in "Connecting Roads"

Related works for the proposed road network development are:

- Bridge 13 nos
- Pipe road crossing 6 nos

LENGTH AND DENSITY OF ROADS
IN THE PROJECT AREA AND ILOILO PROVINCE

unit: km
m/km^2

	AJUY	CONCEPCION	SAN DIONISIO	SARA	TOTAL	ILOILO
National Roads						
-Length	5.2	2.6	8.3	19.3	35.4	648.0
-Density	253.7	364.1	556.7	423.4	401.7	121.7
Provincial Roads						
-Length	4.8	1.6	-	4.6	11.0	815.0
-Density	234.1	224.1	-	100.9	124.8	153.0
Municipal Roads 1/						
-Length	10.4	4.1	7.6	51.8	73.9	334.0
-Density	507.3	574.2	509.7	1,136.4	838.5	62.7
Barangay Roads 2/						
-Length	12.2	1.3	4.6	23.6	41.7	2,762.3
-Density	595.1	182.1	308.5	517.8	473.2	518.8
Total						
-Length	32.6	9.6	20.5	89.3	162.0	4,558.8
-Density	1,590.2	1,344.5	1,374.9	1,959.2	1,838.2	856.3
Farm Roads						
-Length	17.8	6.1	11.0	27.9	62.8	-
-Density	868.3	854.3	737.8	612.1	712.6	-

note: 1 Farm Road Length is out of Municipal & Barangay Road Lengths

2 1/ More than 2.0m ^{m} in width on map drawn up in 1983

3 2/ More than 1.0m^m in width on map drawn up in 1983

REGISTERED VEHICLES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Private													
L	23	11	13	18	25	18	12	18	16	7	4	3	168
M	11	6	4	7	7	2	5	4	3	4	2	1	56
H							1						1
UV	148	183	14	66	80	103	68	78	55	80	13	30	1,025
T	36	51	30	23	28	28	24	32	27	40	2	5	326
TB													
MC	67	86	117	80	77	67	62	75	57	85	36	26	835
TRL										1			1
TRM													
TRH													
For Hire													
TX													
L	3	2											5
M	13	2					2						17
H													
UV	21	13	22	21	27	31	17	34	13	23	5	7	234
T		1					1		4				6
TB	6	7	4	2	5	5	4	4		5	1	3	46
TC													
TRC													
TRM													
TRH													
Gov't Vehicle													
L						1							1
M													
H													
UV					1			1	1				3
License													
Prof.	152	157	127	121	179	91	99	117	104	124	152	147	1,620
Non-Prof.	18	19	16	13	25		14	6	14	12	9	21	167
Student Per.	43	54	60	53	54								264
Conductor	5	4	2	1		11	2	3	3	2		1	34

1/ SOURCE: LTC in Sara as of 1983

2/ Registration of Sara, Ajuy, Concepcion, San Dionisio, Lemery, Estancia, Balasan, Batad and Carlos are included.

3/ L: 1,600 cc M: 1,600cc H: Six Pistons
UV: Utility/Vehicle (Jeepney) T: Truck TB: Tractor Hire
MC: Motorcycle TRL: Trailer TX: Taxi

EXISTING ROAD & PROPOSED ROAD NETWORK

(SCALE 1: 50,000)

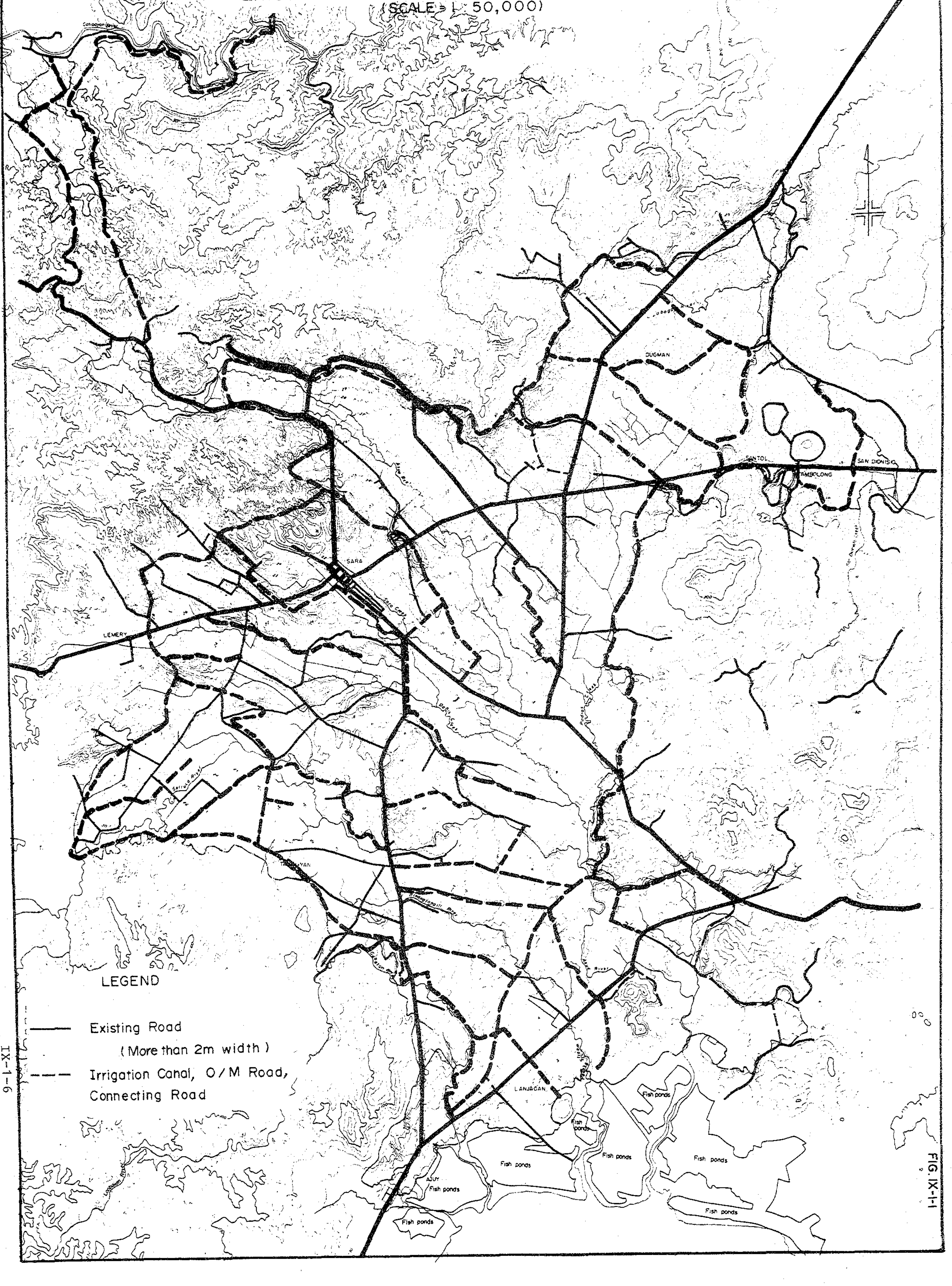


FIG. IX-1-1

2. INTEGRATED COMMUNITY CENTER

2.1 Needs of Community Center

From the barangay survey conducted by the Team, domestic water supply shortage especially in the dry season in rural portions of the Project area was found to be a serious problem for local residents. This situation is due to limitation of tubewell water utilization by drawdown of the groundwater level in the dry season especially from March to May.

Under the Project, 13 barangays will be supplied with domestic water through the Sara waterworks system as discussed in 4 DOMESTIC WATER SUPPLY. Other barangays, however, will continue to have domestic water shortage problems in dry season even after Project implementation. In view of basic human needs and equal social service provision in the area under the Project, every barangay is in need of a water supply system.

The Project therefore proposes facilities which will provide domestic water by effectively utilizing irrigation facilities. In addition to the provision of domestic water, agricultural and rural development components are also incorporated in the Project to create a center for the local people referred to as the Integrated Community Center.

2.2 Functions and Proposed Facilities

The main purpose of the proposed Integrated Community Center is provision of domestic water supply to rural areas. In addition, the following items are also included in the Center in consideration of present and with Project conditions in the area.

Item		Function
- Shallow wells	:	Stable supply of domestic water
- Multipurpose pond	:	Recharge of groundwater for shallow wells
	:	Water supply for livestock
	:	Washing and bathing
	:	Fire fighting
	:	Barangay community space for appropriate irrigation water operation

- Multipurpose yard : Rice drying space.
  : Agricultural input and trading center
  : Sports and recreation

As for domestic water, a supply of 100ℓ/day/person is planned. The objective population allocation for the Integrated Community Center and the Sara waterworks are as shown in the following table.

OBJECTIVE POPULATION FOR DOMESTIC WATER SUPPLY

Unit: person

MUNICIPALITY	POPULATION IN THE PROJECT AREA	SARA WATERWORKS		I.C.C. OBJECTIVE POPULATION
		OBJECTIVE POPULATION	OBJECTIVE POPULATION IN THE PROJECT AREA	
Ajuy	11,300	-	-	11,300
Concepcion	1,700	-	-	1,700
San Dionisio	3,900	-	-	3,900
Sara	28,200	20,300	(17,700)	10,500
Total	45,100	20,300	(17,700)	27,400

Accordingly for domestic water supply under Integrated Community Center, 100ℓ/day/person for the population of 27,400 was adopted for the plan. Out of this daily domestic water supply, potable water required was assumed at 15ℓ/day/person and based on this amount one shallow well is planned for every 250 persons. Two shallow well units will be installed in each Center; thus one Center has a maximum potable water supply capacity of 500 persons. One multipurpose pond will be provided in every Center with a capacity of 150m^3. This capacity allows storage of a 5-day water supply.

Dimensions of the multipurpose yard were determined based on rice drying capacity in the Project area after project implementation. A multipurpose yard is also planned in the area under the Sara Waterworks System. Accordingly, the 18 barangays under the Sara Waterworks System will be equipped only with multipurpose yards.

The typical layout of an Integrated Community Center is presented in FIG. IX-2-1, while major features of facilities are presented below.

MAJOR FEATURES OF INTEGRATED COMMUNITY CENTERS

ITEM	DESCRIPTION
1. Shallow well	Two units per ICC, 250 persons/well
2. Multipurpose pond	10m x 10m 1.5m depth
3. Multipurpose yard	12m x 24m = 288m^2
ICC with shallow wells, a pond and a yard	100 sites
Multipurpose concrete yard	51 sites

2.3 Site Selection and Operation and Maintenance

In this study, detailed location selection of the Integrated Community Centers was not carried out. A standard for site selection of the Center in the later detailed study stage is presented below. Operation and maintenance standards are also presented.

Standards for Site Selection

Sites should fulfill the following criteria:

a) Water can be supplied to the pond from the proposed irrigation canals;

b) Water from the pond can be drained into drainage canals or creeks and rivers to avoid discharge into irrigation canals as much as possible;

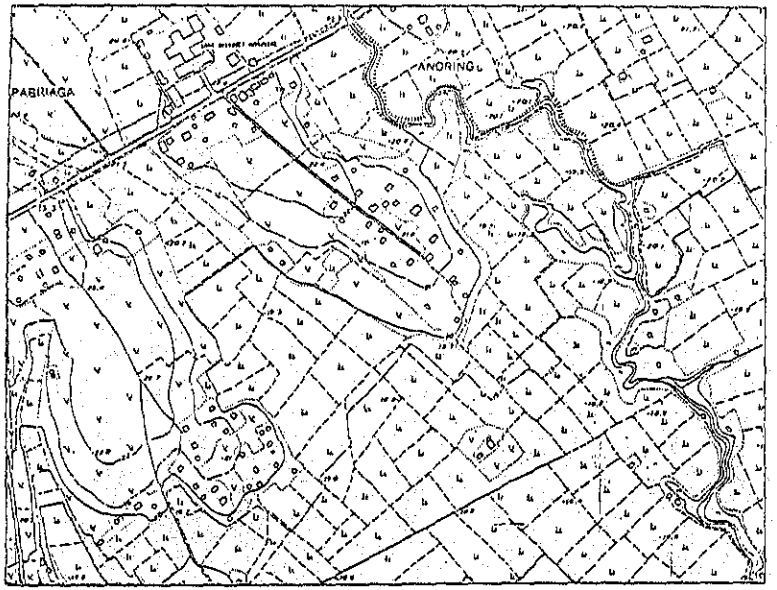
c) The center of barangay and farm houses is nearby; and,

d) The proposed road network is sufficiently accessible.

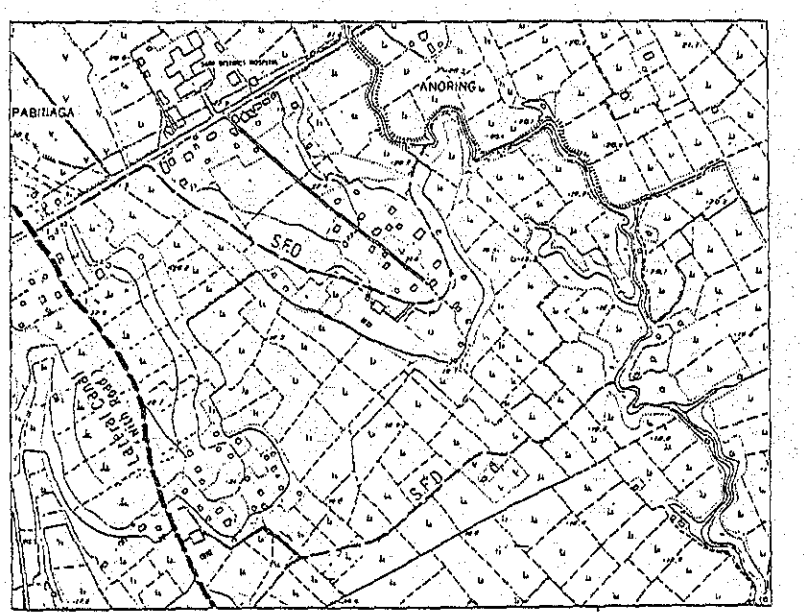
Operation and Maintenance Standards

The O&M works required include:

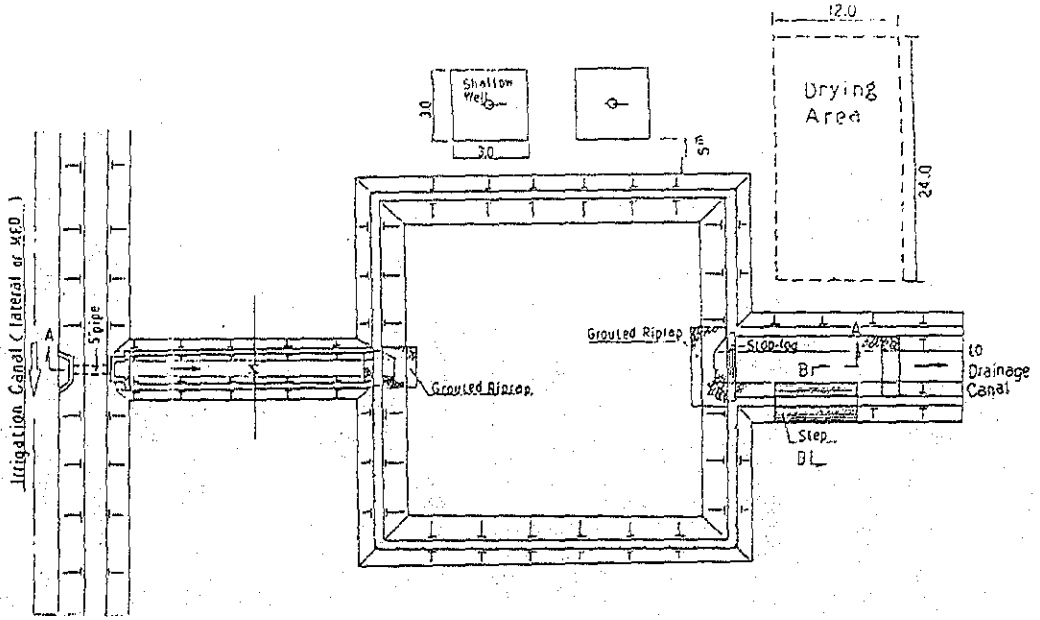
a) Cleaning the Center at least once a year;
b) Preventing animals from entering the pond and ensurance that animals are washed downstream of the bathing spot; and,
c) Control of discharge at an inlet from irrigation canals.



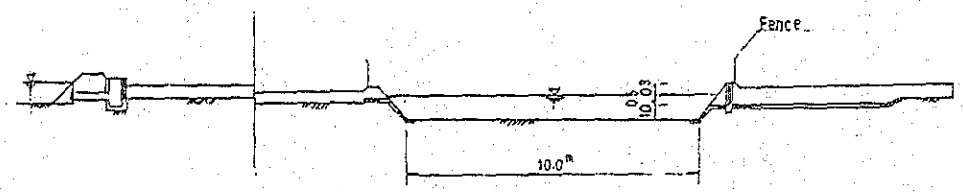
Without Project



With Project



PLAIN



SECTION "A-A

SECTION "B-B"

TYPICAL LAYOUT OF INTEGRATED COMMUNITY CENTER

Fig. IX-2-1

3. HYDROPOWER GENERATION

3.1 Present Electrification Conditions

Studies for national status of power development in the country were made and are presented in APPENDIX IV as SOCIOECONOMY. Present electrification conditions in Iloilo Province and in the Project area are presented hereinafter.

3.1.1 Provincial Status of Electricity

The province of Iloilo as well as Panay and Visayan Islands were simultaneously programmed for power development by NPC as early as 1973. Construction of the power plant in the province of Iloilo was started at the end of 1977. It was composed of four (4) 7.3MW units with a total generating capacity of 29.2MW to serve the entire province of Iloilo as well as part of the province of Aklan and Capiz.

Providing the electrification needs of the entire province are two electric cooperatives (ILECO I & II) and the private owned electric company, Panay Electric Company (PECO). ILECO-I has a coverage of 15 municipalities, ILECO-II covers 28 municipalities in the province while PECO serves the city of Iloilo and its surrounding district.

The electrification program target is to energize all the barangay in the province by 1985. As of 1982 about 69% of total barangays in the province had already been energized serving about 26.4% out of a total 165,601 potential consumers in 43 municipalities. In 1982, the electric cooperatives purchased a total of 74,250MWh from NPC power sales, and costs are as shown in TABLE IX-3-1.

3.1.2 Electrification Conditions in the Project Area

Electricity for the Project area is generated by four generators located in Dingle and transmitted through Duenasu an Passi to the four Project municipalities as shown in FIG. IX-3-1.

ILECO II serves the Project area on a cooperative system. However, only portions along the national road have electricity and it is reported that only about 10% of total households have been electlrified. The status of electrified households is shown in TABLE IX-3-2 and FIG. IX-3-2 while power rates are presented in TABLE IX-3-3.

3.2 Basic Considerations

Present electric consumption of each household is low as discussed above, at an average of 0.2kW and consumption mainly consists of lighting during the evening hours. In addition to the demand for lighting in each household, greater demand will arise after project implementation due to post-harvest activities. Generated power can also be utilized in the 1,600ha fishpond area, located in the southern portion of the Project area, for agitator use. Thus, the electric demand in the Project area will be expanded and the generated energy under the Project is expected to be effectively utilized within the same.

The Project proposes construction of a dam on the Catipayan River to supply stable irrigation water to the Asue River Basin irrigation area. The gross storage capacity of the proposed Catipayan dam has been estimated at 28.2MCM by a 48.5m high dam and the capacity of the trans-diversion canal/tunnel is designed at 6.0m^3/s.

Irrigation water from the Catipayan River will be drawn from the proposed Catipayan dam and trans-diverted through the canal/tunnel with a total length of about 8.2km. Hydropower can be generated utilizing effective heads at 2 sites; namely, at the dam intake and the elevation difference between the Catipayan and Asue basins.

Hydropower development under the Project is basically considered as a supplementary component, and thus it will be subject to the irrigation water diversion plan. Accordingly, the hydropower component is planned so as not to interfere with the irrigation diversion plan. Water which will be used for hydropower generation will therefore be subject to irrigation water requirements. In cases where there is any surplus water in the reservoir however, this water will be effectively utilized for hydropower generation.

The Project area is presently covered by distribution lines under ILECO II from a substation in Pototan located about 60km southwest of the Project area as stated previously. Accordingly, it is necessary to construct a substation to connect generated electricity under the Project to the existing grid, if the present situation continues in future.

However, NEA has an expansion program including construction of a substation in Sara in 1985. Main features of the proposed Sara substation are as follows:

Location	: near Sara Emergency Hospital
Type	: Δ/Y connection
Rated Capacity	: 5 MVA
Rated Voltage	: 69 kV/13.2 - 7.62 kV
Frequency	: 60Hz

Accordingly in this study, the transmission line under the Project is considered from the power stations up to the above Sara substation.

3.3 Location and Type

A gross head of 81.6m between the Normal High Water Level (EL.124.0m) of the proposed Catipayan dam and the tailrace water level (EL.42.4m) in the Asue Basin provides 2 sites which are technically possible for hydropower generation. One site is just downstream of the dam which would utilize the head between reservoir water level and water level at the outlet to the trans-diversion canal. The other site would utilize the elevation difference between the end point of the trans-diversion tunnel and the Asue River (FIG. IX-3-3).

A hydropower plant at the dam called the dam site power station under the Project, will be installed utilizing intake facilities for irrigation, and water will be released through the generator to the trans-diversion canal. The hydropower plant scheme on the trans-diversion canal route, called the canal route power station under the Project, includes a head tank at the outlet of the trans-diversion tunnel and a penstock from the same point to the bottom of the mountain.

As discussed previously, power will be generated basically by water released for irrigation and spillover in the case of full reservoir capacity both at the dam site and canal route power stations. The type of generation is thus defined as run-of-river type. As discussed in APPENDIX VI, WATER RESOURCES DEVELOPMENT however, stored water in the Catipayan reservoir can also be effectively utilized for power generation by establishing a limited water level for the hydropower component. In this case, water released from the reservoir for generation only will be lead

through the dam site power station to the canal route power station utilizing the trans-diversion canal/tunnel. This means that the amount of discharge for generation at both stations will always be the same.

3.4 Optimization Study

3.4.1 Installed Capacity

(1) Dam Site Power Station

Basic considerations for the planning of the hydropower plant at the dam site are:

a) the reservoir does not have surcharge capacity for flood control and thus limited water level for flood control is not established;

b) limited water level at the reservoir for hydropower is established, while water released only for hydropower will be limited to that above the same water level; and,

c) spill over from the reservoir can be used for hydropower generation.

Optimum development scale is evaluated in this section on the basis of 5 alternative design hydropower generation capacities. Under the conditions of irrigation diversion water use for hydropower, 2.0, 2.5, 3.0, 3.5 and 4.0m^3/s have been selected as alternative design discharges on the basis of the duration curve. Firm energy cannot be expected because hydropower generation is basically by irrigation water release. Accordingly an optimum installed capacity was evaluated on the basis of annual generated energy (kWh value) without considering kW value.

Annual energy for each design discharge is calculated as shown in FIG. IX-3-4. The figure shown therein indicates that annual energy increases in accordance with increase of design discharge. Increase rate, however, is almost constant when design discharge is more than 3.0m^3/s. On the basis of roughly estimated construction cost, unit construction cost per kWh is shown in FIG. IX-3-5. The result of the above shows that the optimum design discharge is 3.0m^3/s.

(2) Canal Route Power Station

Hydropower generation at the outlet of the trans-diversion tunnel can also be principally defined as a run-of-river plant utilizing irrigation diversion water and elevation difference between the tunnel outlet and the Asue Basin. As discussed previously, surplus reservoir water will be effectively used for hydropower.

However, release of surplus water in addition to the irrigation diversion water requirement may cause flooding in the Asue River. The study of drainage capacity in APPENDIX VII, IRRIGATION AND DRAINAGE revealed that the Asue River has an adequate drainage capacity, except in short periods of high flood. Although during the latter it would be necessary to suspend generation, the hydropower generation plan is based on maximum use of water released from the hydropower plant at the dam.

Optimum development scale of the hydropower plant was determined in the same manner as that of the dam site power station. As the results show in FIG. IX-3-6 and IX-3-7, a design discharge of $3.0m^3/s$ is the optimum scale.

3.4.2 Study on Peak Power Generation

In this section, studies on peak power generation for both dam site and canal route stations are carried out. Considering the fact that all water used for generation at the dam site power station will be led to the canal route power station, only one afterbay dam, downstream of the canal route power station, is required to re-regulate discharge to the irrigation canal.

Additional construction cost has been estimated as tabulated below on the basis of a peak capacity of $3.0m^3/sec$ for 8 hours per day.

ESTIMATED ADDITIONAL COST

Work Item	Quantity	Unit Price ₱	Amount ₱1000	Note
Embankment	31,000m^3	240	7,440	Effective capacity 60,000m^3
Gate	12tom	70,000	840	
Release Canal			- 740	The release canal of the original plan will not be required in this plan
Total			7,540	

Peak power generation at both the dam site and the canal route station would utilize the peak capacity (3.0m^3/s) for 8/hrs day. On this basis total annual energy was roughly estimated at 8,000MWh. Unit construction cost/kWh in this case was thus calculated at ₱6.21/kWh which is not considered a viable alternative to 5.75/kWh of the original plan. Accordingly peak power generation with an afterbay dam is not included in the hydropower development plan.

3.5 Generated Energy

On the basis of the above installed capacity, 10-day generated energy and monthly average output has been calculated for the 20-year period of 1964-83. Conditions adopted for the calculation of generated energy are presented in the table below.

Item	Unit	Dam Site Power Station	Canal Route Power Station
Design discharge	m^3/s	3.0	3.0
Installed capacity	kW	650	750
Intake water level	EL.m	max. 124.0	82.5
Tailwater elevation	EL.m	90.0	42.5
Gross head	m	max. 34.0	40.0
Head loss			
Penstock	m	0.118 x Q^2	0.291 x Q^2
Others	m	1.994	2.054
Overall efficiency		as shown in FIG. IX-3-8	

Generated energy was calculated for the two cases at both the dam site and the canal route power stations. In the first case, only irrigation water release and overflow from the reservoir are used for generation. In the second case, in addition to the above, stored water in the Catipayan reservoir above the limited level for hydropower was established on a monthly basis, in order not to adversely affect the irrigation water supply scheme as discussed in APPENDIX VI WATER RESOURCES DEVELOPMENT. The established limited water levels are presented in the following table.

LIMITED WATER LEVEL (CAPACITY)

Unit: MCM

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22.5	25.0	25.4	26.0	23.5	11.6	17.9	11.7	26.2	18.7	28.2	27.0

The calculated 20-year average annual energy, average output, etc. are tabulated in the following table.

Item	Unit	Dam Site Power Station	Canal Route Power Station
1st Case (Irrigation water release plus spilled water)			
Annual energy	MWh	3002	3461
Average output	kW	342	4415
Plant efficiency	%	53.5	53.4
2nd case (Irrigation water release, spill over plus hydropower release)			
Annual energy	MWh	3225	4112
Average output	kW	368	469
Plant efficiency	%	57.5	63.4

10-day generated energy, average output and other related values as of 1964, which is nearest in value to the 20-year average are presented in TABLE IX-3-4 and FIG. IX-3-9. Reservoir operation studies for the two cases are presented in FIG. VI-12 in APPENDIX VI under WATER RESOURCES DEVELOPMENT.

3.6 Required Facilities

(1) Dam Site Power Station

The dam site power station will be installed utilizing the intake and release facilities and by-pass tunnel of the dam as shown in FIG. IX-3-10. The generator will be installed at the outlet of the by-pass tunnel and water will be led to the generator through a ϕ1,100mm steel pipe which will be diverted from a ϕ1,200mm irrigation water release pipe. Water released from the generator will be lead to the release pond, then diverted to the trans-diversion canal.

If irrigation diversion water exceeds the design discharge of the hydropower plant, excess water will be released through a release pipe which will be installed parallel to the generator pipe. Turbine and release valve will be automatic to regulate discharge to the trans-diversion canal.

Main features and dimensions are presented in the table below.

MAJOR WORK ITEMS OF DAM SITE POWER PLANT

Work Item	Type and Dimensions
1. Leading Pipe	
- Steel pipe	ϕ1,100mm L=30m
2. Turbine and Generator	
- turbine	Cross flow type
	Max. intake water level EL.124.0m
	Min. intake water level EL.109.0m
	Tailrace water level EL. 90.0m
	Max. gross head 34.0m
	Design discharge 3.0m^3/s
	Turbine output 720kW
	Rated speed 215 r.p.m.
- Generator & Transformer	Horizontal shaft synchronous three-phase
	Capacity 730kVA
	Output 650kW
3. Release pond	
- Concrete box	3m x 5m x 2.5m depth

(2) Canal Route Power Station

The canal route power station will be installed in the upstream area of the Asue River basin. Layout is presented in FIG. IX-3-11. A head tank will be installed at the outlet of the trans-diversion tunnel with a capacity of 230m^3 and water level of EL. 82.50m. Elevation of the turbine axis is EL.44.0m, tailrace elevation is 40.0m, and gross head is thus 38.5m. The penstock which connects the head tank and turbine is 1,100-1,200mm steel pipe, 428m long. Discharge will be led to the Asue River by a tailrace canal (a 158m long concrete flume canal).

A spillway will be installed at the head tank to discharge water when irrigation diversion water requirement exceeds generating water requirement, as well as to spill surging water. A cross flow turbine is also proposed for the canal route power station for the same reason mentioned above.

Main features and dimensions are presented in the table below.

MAJOR WORK ITEMS OF CANAL ROUTE POWER PLANT

Work Item	Type and Dimensions
1. Intake Facilities	
- Head Tank	Capacity 230m^3 Two gates 18(L)x2.6(W)x5.0(H)m
- Penstock	Dia 1,200mm L=273m Dia 1,100mm L=155m Total 428.0m
2. Turbine and Generator	
- Turbine	Cross flow type Intake water level EL.82.5m Tailrace water level EL.42.4 Gross head 40.0m Design discharge 3.0m^3/s Turbine output 820kW Rated speed 240r.p.m.

Con't

Work Item	Type and Dimensions
- Generator	Horizontal shaft synchronous three phase Capacity 840kVA Output 750kW Rated speed 900r.p.m.
3. Tailrace Conduit - Concrete flume canal	Width 2.0m L=150m

(3) Transmission Line

As discussed previously a transmission line to connect the two power stations and Sara Substation is proposed under the Project. The proposed alignment of the transmission line is presented in FIG. IX-3-12 and the total length is 10km.

Main features of the proposed transmission line are as follows:

-Total length	10.0km
-Voltage	13.2kV
-Cables	2/0 ACSR
-Insulators	Porcelain
-Support	Wooden pole

3.7 Power Value

For the evaluation of hydropower benefit, the least cost alternative method was adopted in this study. Two alternatives are conceivable for the least cost alternative of the proposed power plant. One is the power buying rate of ILECO II from NPC under the Panay Grid; the other is a construction cost of the same scale as that for the new diesel plant. In order to find the least cost alternative, the costs for each alternative were obtained as provided below.

(1) ILECO II Buying Rate

Based on interviews at ILECO II Iloilo Office, ₱1.60/kWh including fuel cost adjustment (FCA) and foreign exchange (FOREX) was obtained as the buying rate as of Nov. 1984.

(2) Alternative Diesel Plant

The cost for the existing diesel plants under NEA in the Visayas Region are presented below.

CONSTRUCTION COST OF EXISTING DIESEL PLANTS UNDER NEA

	Capacity(kW)	No. of Units	Total Cost 1/
-Siquijor	1,500	3-500	₱18,632,000
-Bantayan	1,500	3-500	₱16,535,000
-Tablas	1,500	3-500	₱17,878,000

1/ cost as of Jan.1983

The average cost of the above three plants was calculated at ₱17.682 million. Assuming the January 1983 peso rate of ₱14.00/US$, construction cost per kW as of Jan. 1983 was estimated at US$842/kW. Further, assuming a US$ price escalation rate of 10% per aunum, construction cost per kW at present value is US$ 1,019/kW.

On the basis of this construction cost, kW and kWh value were estimated as tabulated below.

KW AND KWh ESTIMATED VALUES

Item	Amount
1) kW-value	
Construction cost per kW	US$1,019/kW
Discount rate	10%
Service life	25 years
Capital recovery factor	0.1102
Capital recovery cost	US$112/kW/year
O & M cost ratio	3.5%
O & M cost	US$35.7/kW/year
Adjustment factor	1.180
kW-value	US$174.3/kW/year

con't

Item		Amount
2) kWh-value		
Fixed cost		
(Annual operation hours/Fixed cost ratio)		
600/5,260 x 0.0225		US$0.003/kWh
Fuel cost		
Price of oil		US$0.312/l
Heat value		9,200 kcal/l
Efficiency		29%
Heat rate		2,394 kcal/kWh
Adjustment Factor		1.007
kWh-value		US$0.0818/kWh
		(=₱1.636/kWh)
3) Efficiencies for adjustment factor		
	Hydropower	Diesel
Transmission loss	5%	1%
Forced energy	1%	10%
Auxiliary power use	0.3%	5%
Overhaul	2%	8%

As presented above, the least cost alternative is the power buying rate of the existing ILECO II grid. For the application of this least cost alternative, the kW-value was not considered since the proposed hydropower scheme does not generate firm energy.

TABLE IX-3-1
TABLE IX-3-2

TOTAL POWER BALANCE OF ELECTRIC COOPERATIVES

Cooperative	kWh Purchased	kWh Sold	Power Sale (₱)	Power Cost (₱)
ILECO I	21,444,398	17,199,489	15,309,803.00	11,960,144.00
ILECO II	14,254,290	10,837,250	11,982,883.04	8,117,377.15
PECO	38,551,200[1/]	68,520,096[2/]	75,253,675.22[2/]	21,000,421.00[1/]
TOTAL	74,249,888	96,556,835	102,546,361.26	41,085,942.15

Note: All values for 1982
1/ Includes power from NPC only
2/ Includes power generated by the unit of PECO

Source: ILECO I
ILECO II
PECO

ELECTRIFICATION RATIO AS OF 1983

Municipality	Barangays		Houses		
	Total	No. of Barangays with Connections	Total No. of Households	Connected No.	%
Ajuy	34	7	5,403	282	5.2
Concepcion	25	4	3,662	245	6.7
San Dionisio	29	2	3,386	204	6.0
Sara	42	18	5,120	807	15.8
Total	130	31	17,571	1,538	8.8

ILECO II POWER RATES

As of November 1984

Item	Amount
1. Residential & Public Buildings	
Basic Rate	₱2.28/kWh
Fuel Cost Adjustment	.22
Forex	.16
	₱2.66/kWh
2. Commercial:	
Basic Rate	₱2.33/kWh
Fuel cost Adjustment	.22
Forex	.16
	₱2.71/kWh
3. Industrial	
Basic Rate	₱2.30/kWh
Fuel Cost Adjustment	.22
Forex	.16
	₱2.68/kWh
4. Street Lights (Mercury Vapor Lamps)	
125 watts	₱106.20 (Bulb/month)
175 -do-	₱143.64 (-do-)
Flourescent Lamps	₱ 30.00 (-do-)

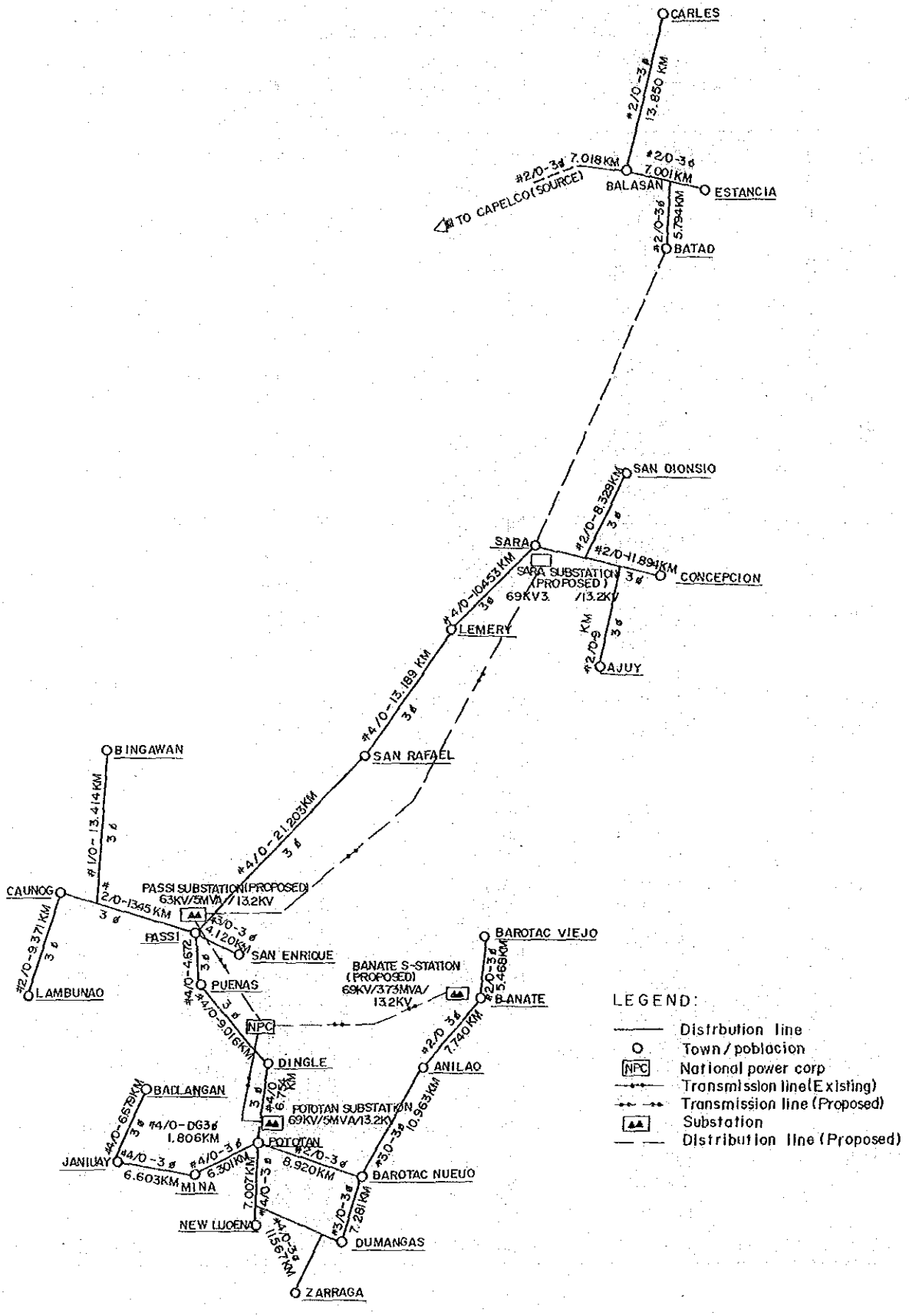
Note: The FCA and FOREX are charges being imposed by the National Power Corporation (NPC) which the COOP cannot absorb and are passed on to the consumers as an additional charge. The FCA (Fuel Cost Adjustment) is being charged by the NPC to offset the additional cost of generating power due to increases in the price of oil, efficiency of generating set, etc. The FOREX (Foreign Exchange) is being charged by the NPC to cover the additional payments they must make for their foreign loans due to the devaluation of the Peso against the US dollar.
The power buying rate from NPC as of November,1984 is 1.60/kWh including FCA and FOREX.

10-DAY GENERATED ENERGY

		Dam Site Power Station		Canal Route Power Station	
		Average Output (kW)	Generated Energy (MWh)	Average Output (kW)	Generated Energy (MWh)
Jan.	1	626.970	150.473	741.030	177.847
	2	263.027	26.126	330.147	79.235
	3	0.000	0.000	0.000	0.000
	T	287.096	213.599	345.541	257.082
Feb.	1	113.883	27.332	143.919	34.541
	2	140.059	33.614	176.860	42.446
	3	0.000	0.000	0.000	0.000
	T	87.566	60.946	110.613	76.987
Mar.	1	0.000	0.000	0.000	0.000
	2	97.825	23.478	122.454	29.389
	3	0.000	0.000	0.000	0.000
	T	31.556	23.478	39.501	29.389
Apr.	1	0.000	0.000	0.000	0.000
	2	0.000	0.000	0.000	0.000
	3	0.000	0.000	0.000	0.000
	T	0.000	0.000	0.000	0.000
May.	1	609.826	146.358	741.030	177.847
	2	599.187	143.805	741.030	177.847
	3	605.576	159.872	741.030	195.632
	T	604.886	450.035	741.030	551.326
Jun.	1	597.788	143.469	741.030	177.847
	2	578.258	138.787	741.030	177.847
	3	577.654	138.638	741.030	177.847
	T	584.567	420.888	741.030	533.541
Jul.	1	597.761	143.463	741.030	177.847
	2	603.382	144.812	741.030	177.847
	3	584.226	154.236	741.030	195.632
	T	594.772	442.510	741.030	551.326
Aug.	1	575.766	138.184	741.030	177.847
	2	575.835	138.200	741.030	177.847
	3	577.180	152.376	741.030	195.632
	T	576.290	428.760	741.030	551.326
Sep.	1	0.000	0.000	0.000	0.000
	2	219.770	52.745	276.325	66.318
	3	573.390	137.614	693.794	166.510
	T	264.387	190.358	323.373	232.829
Oct.	1	621.171	149.081	741.030	177.847
	2	622.049	149.292	741.030	177.847
	3	618.344	163.243	741.030	195.632
	T	621.451	461.616	741.030	551.326
Nov.	1	0.000	0.000	0.000	0.000
	2	644.012	154.563	741.030	177.847
	3	644.012	154.563	741.030	177.847
	T	429.341	309.126	494.020	355.694
Dec.	1	639.526	153.486	741.030	177.847
	2	433.253	103.981	517.849	124.284
	3	182.192	48.099	221.962	58.598
	T	410.707	305.566	484.851	360.729
Average/Total		376.467	3306.880	461.243	4051.560

Fig. IX-3-1

ILECO II LINE DIAGRAM



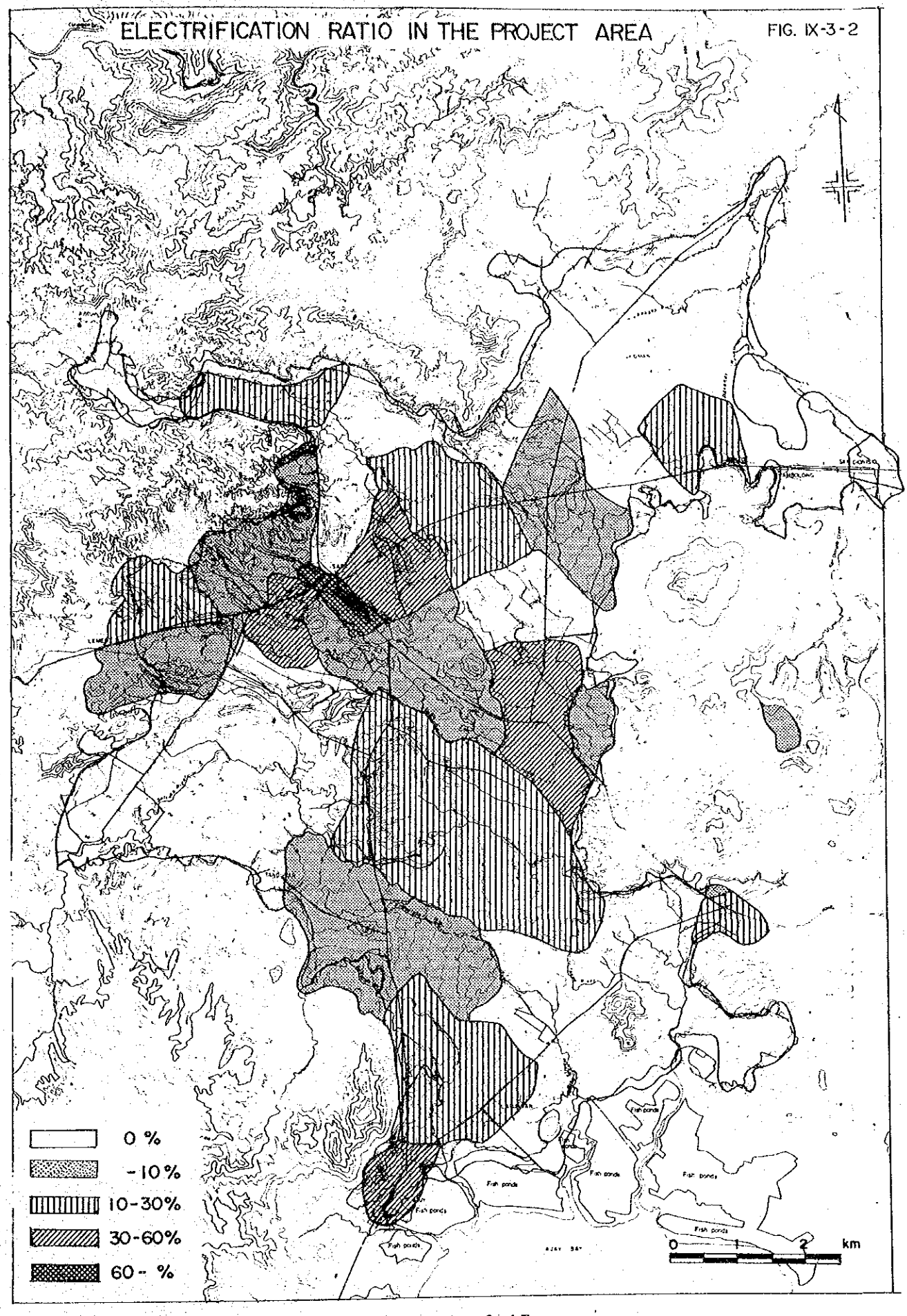

ELECTRIFICATION RATIO IN THE PROJECT AREA
FIG. IX-3-2
0 %
-10%
10-30%
30-60%
60- %
Fish ponds
0
1
2
km

FIG. IX-3-3

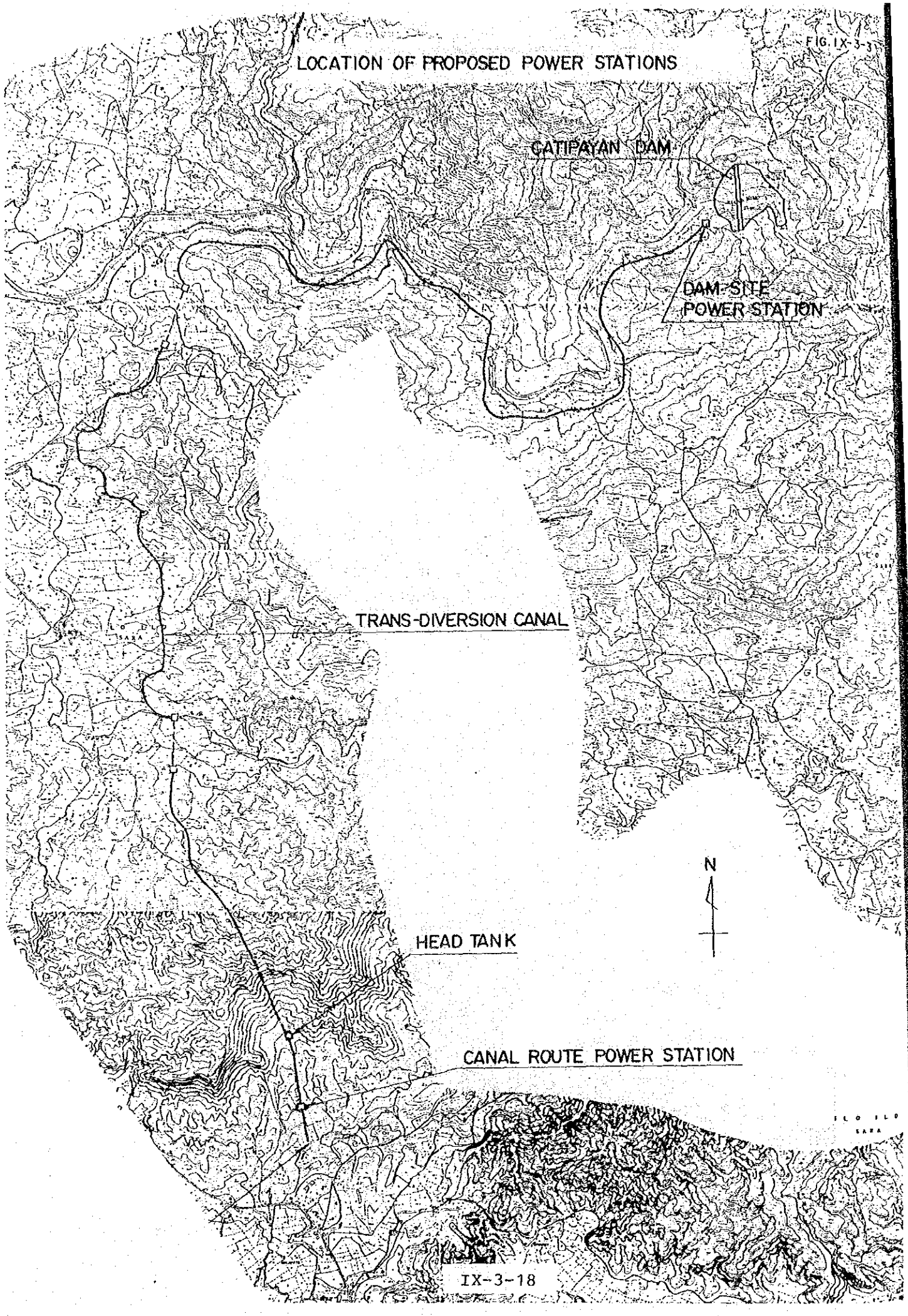
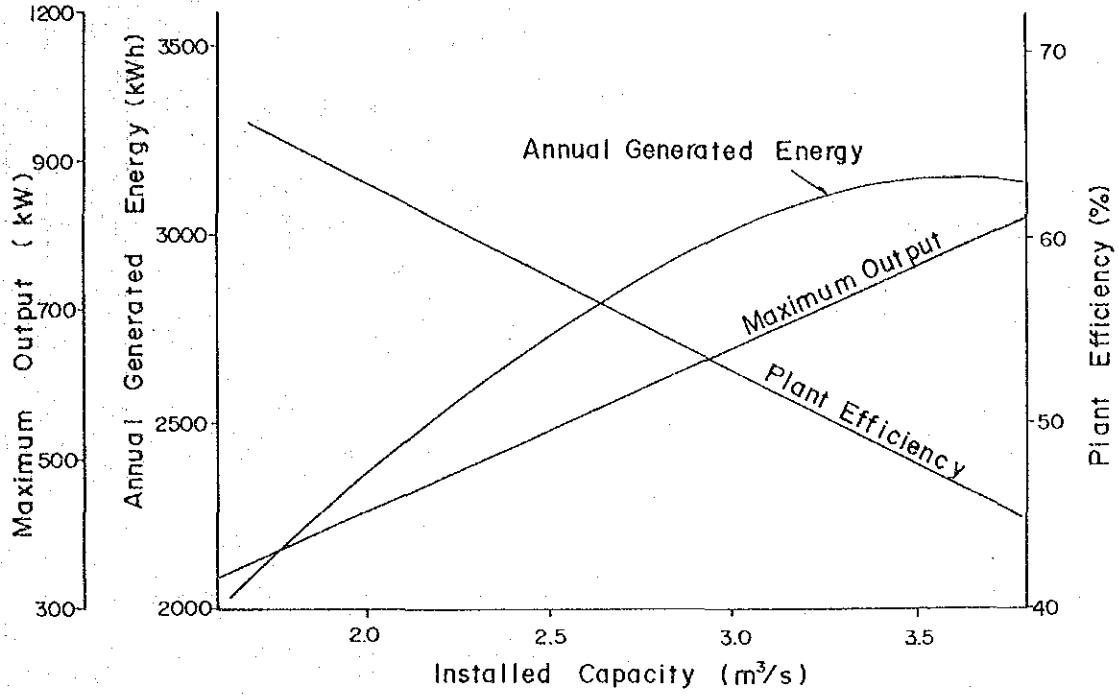

LOCATION OF PROPOSED POWER STATIONS
CATIPAYAN DAM
DAM-SITE POWER STATION
TRANS-DIVERSION CANAL
N
HEAD TANK
CANAL ROUTE POWER STATION

FIG. IX-3-4
FIG. IX-3-5

INSTALLED CAPACITY-GENERATED ENERGY FOR DAM SITE POWER STATION



CONSTRUCTION COST PER kW AND kWh FOR DAM SITE POWER STATION

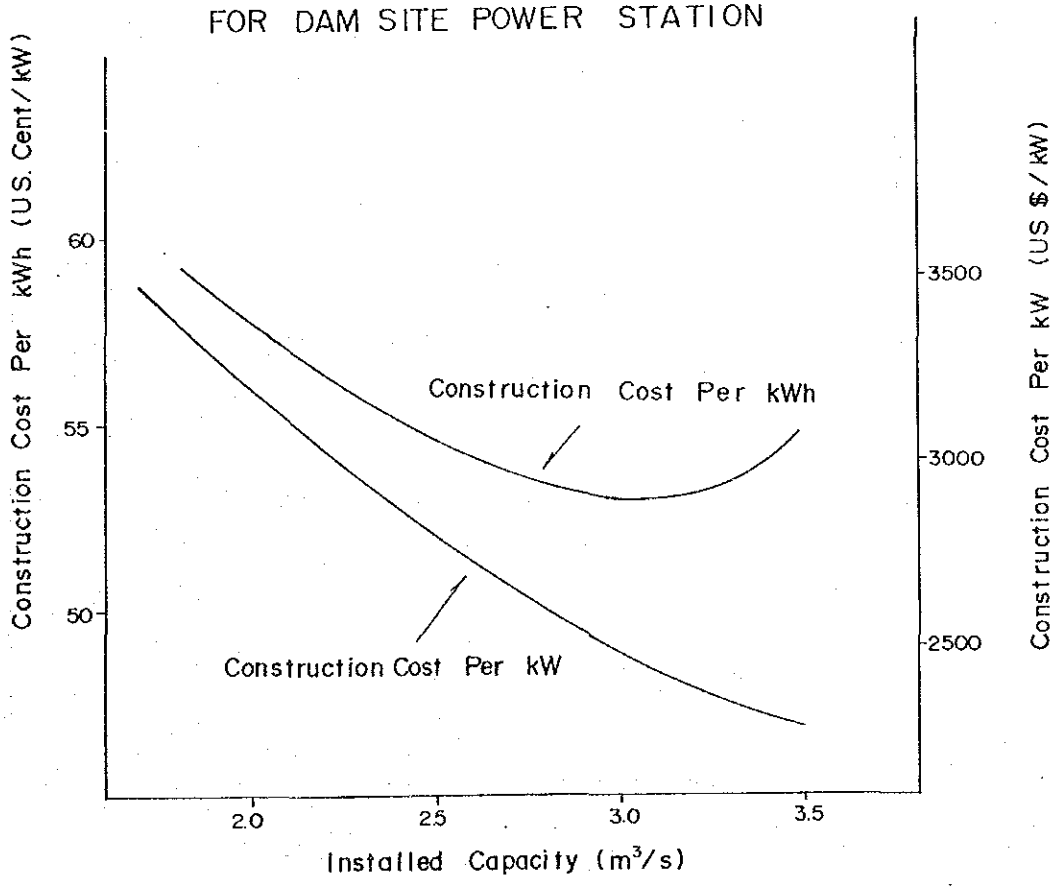
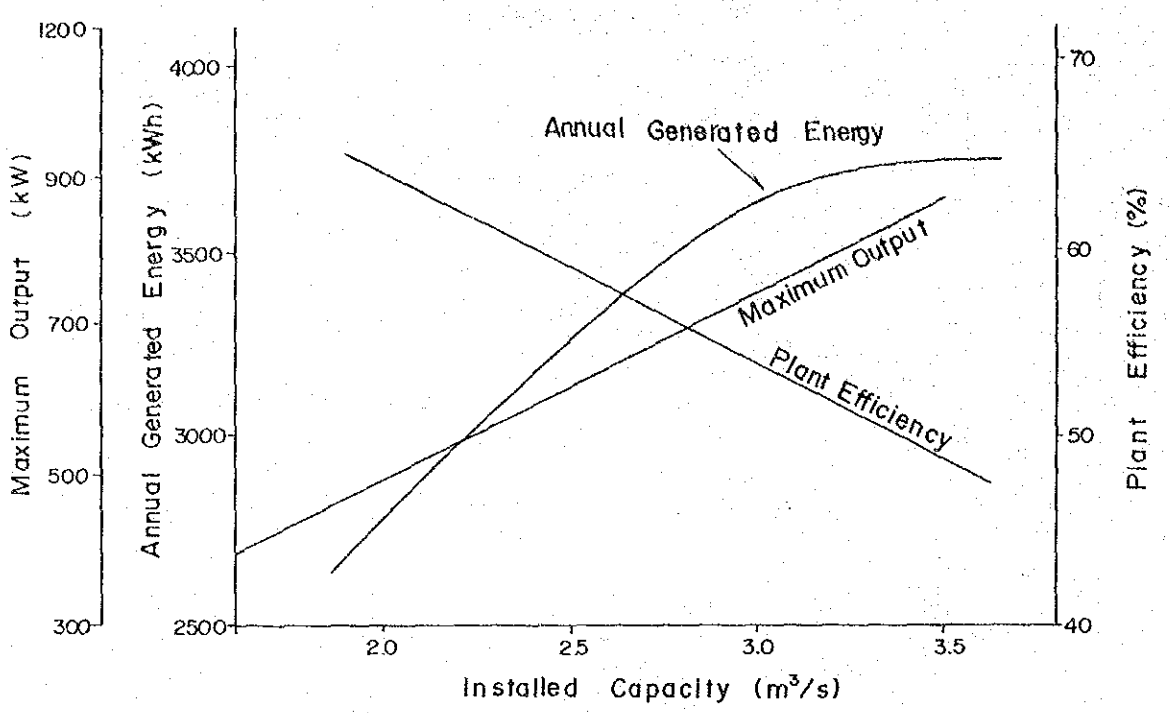


FIG.IX-3-6
FIG.IX-3-7

INSTALLED CAPACITY - GENERATED ENERGY FOR CANAL ROUTE POWER STATION



CONSTRUCTION COST PER kW AND kWh FOR CANAL ROUTE POWER STATION

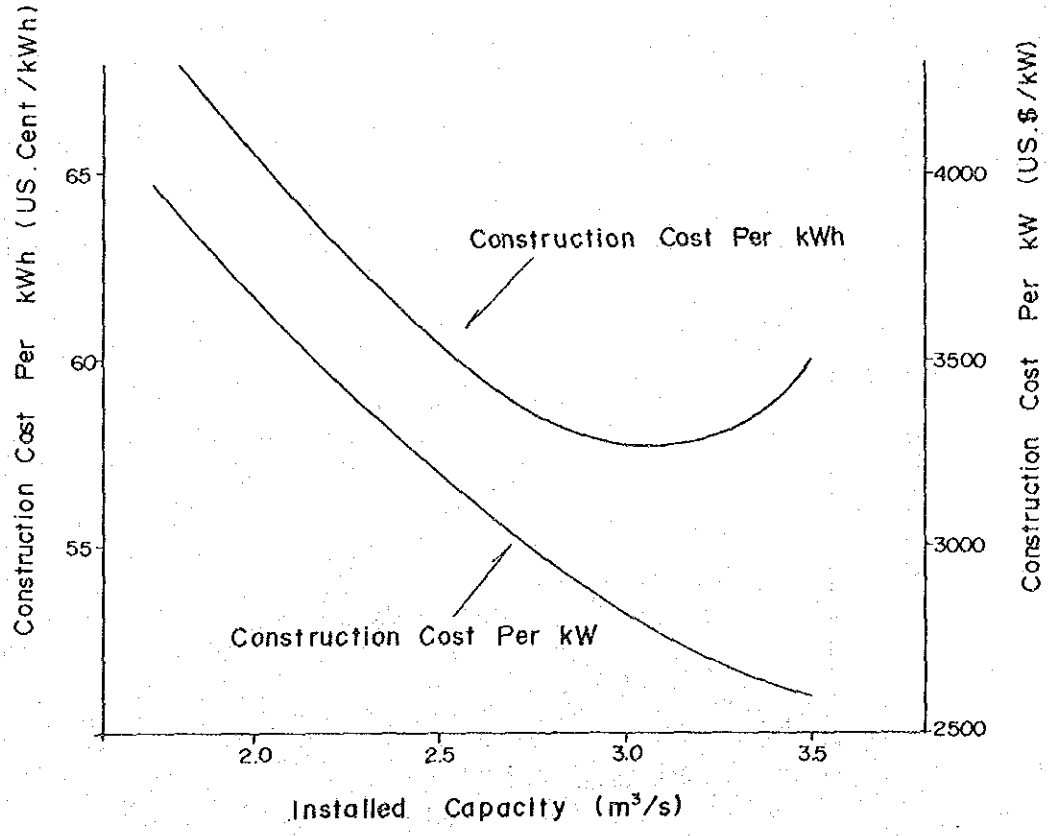
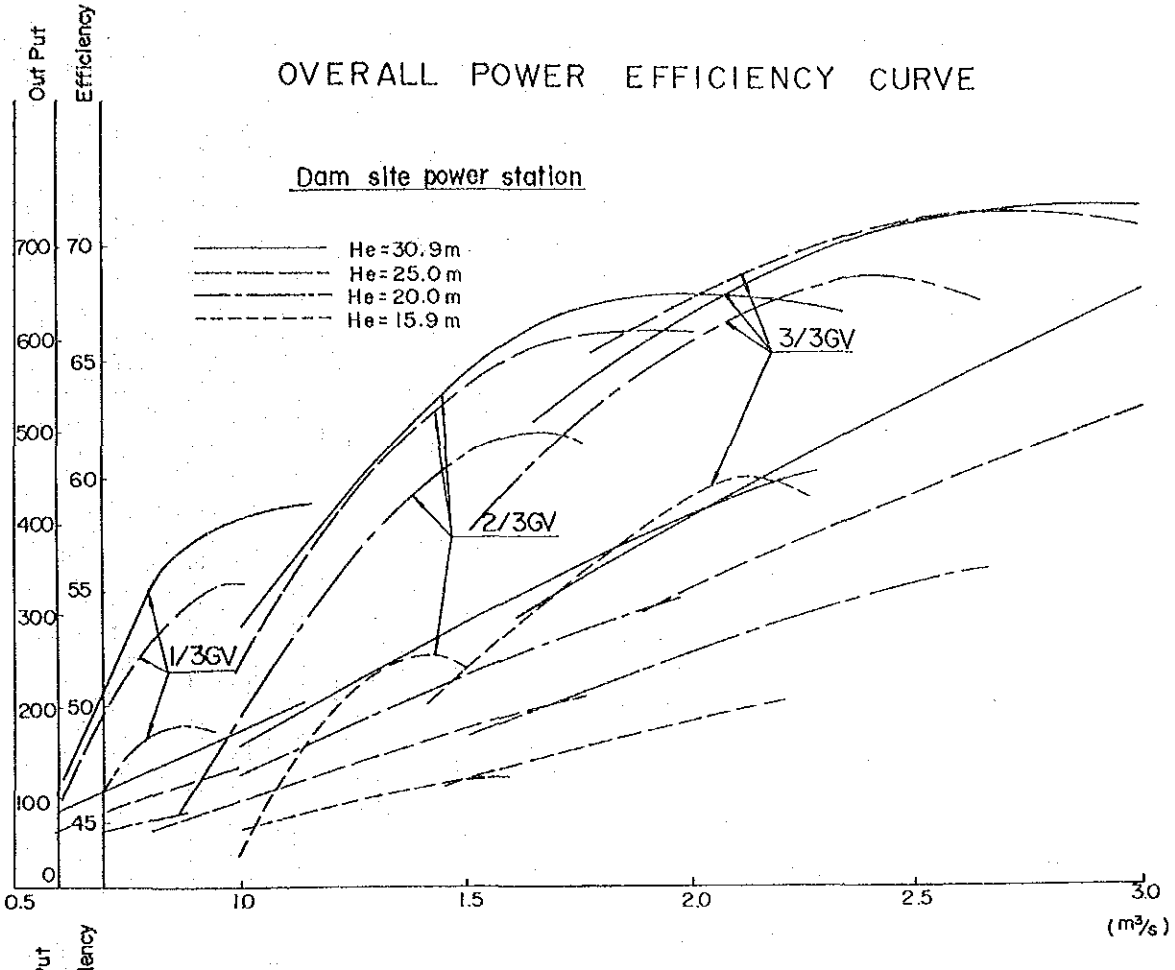


FIG. IX-3-8

OVERALL POWER EFFICIENCY CURVE



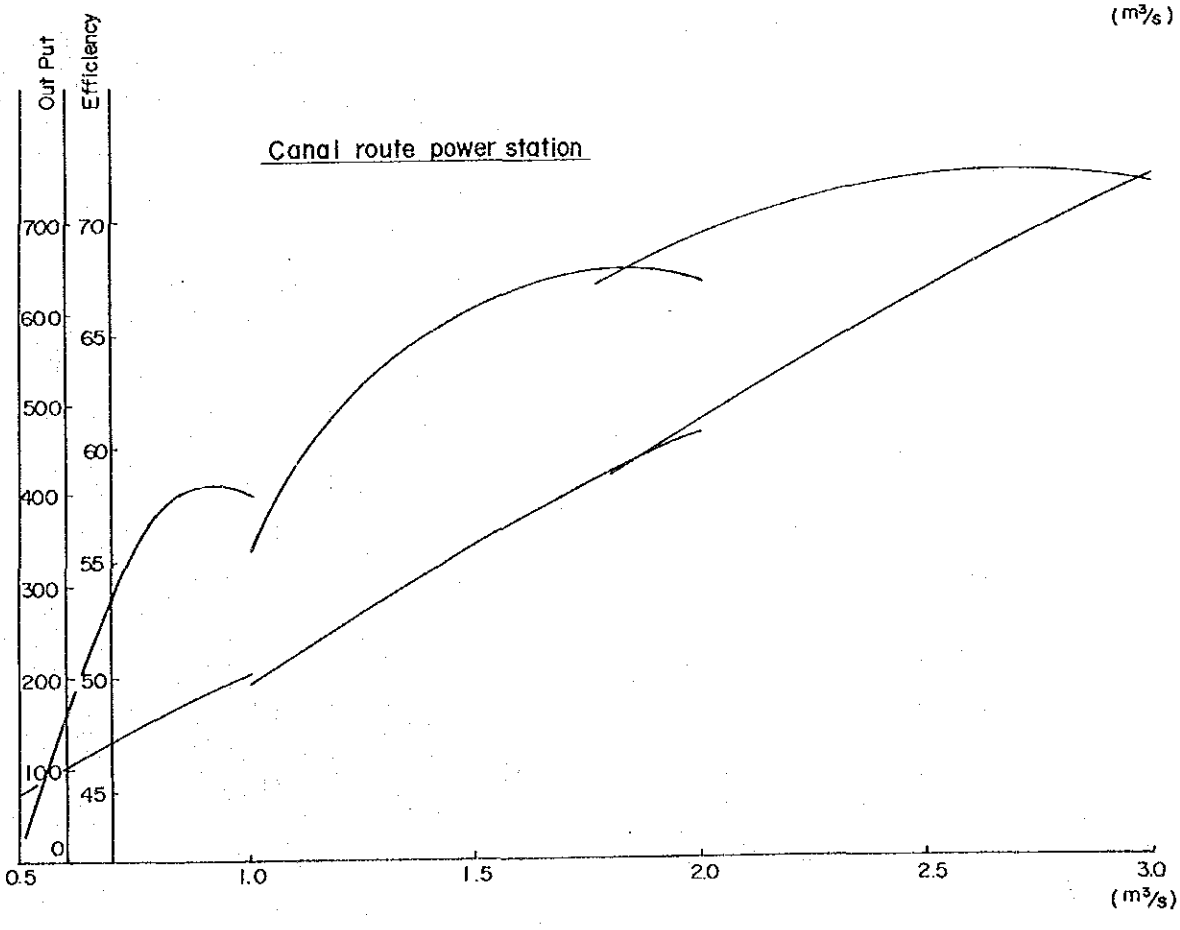
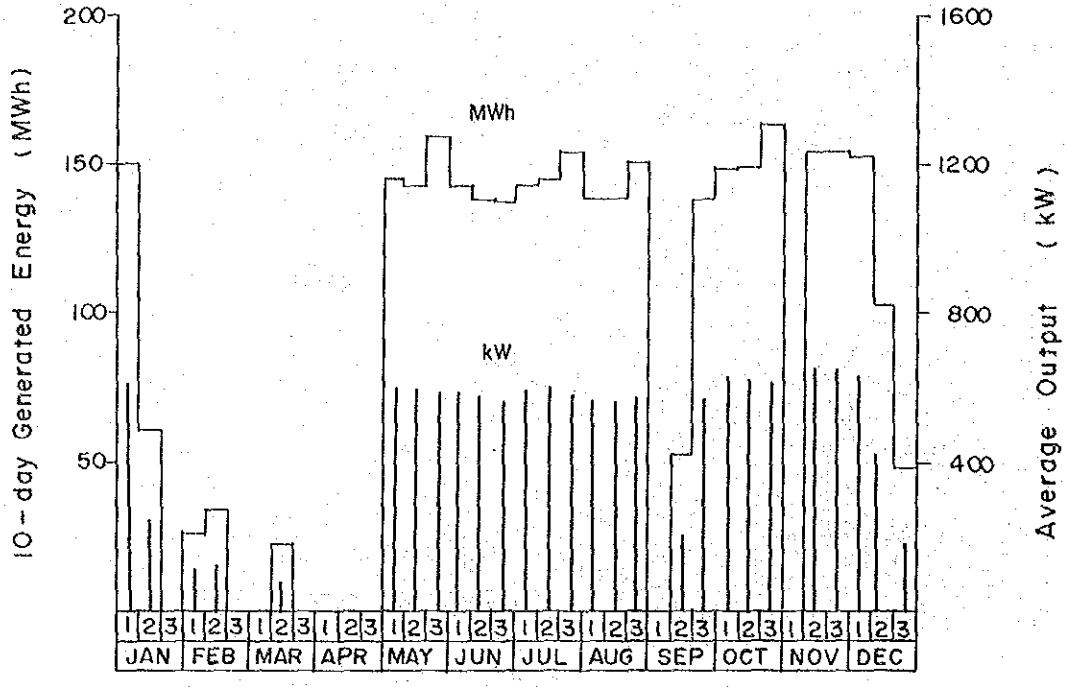
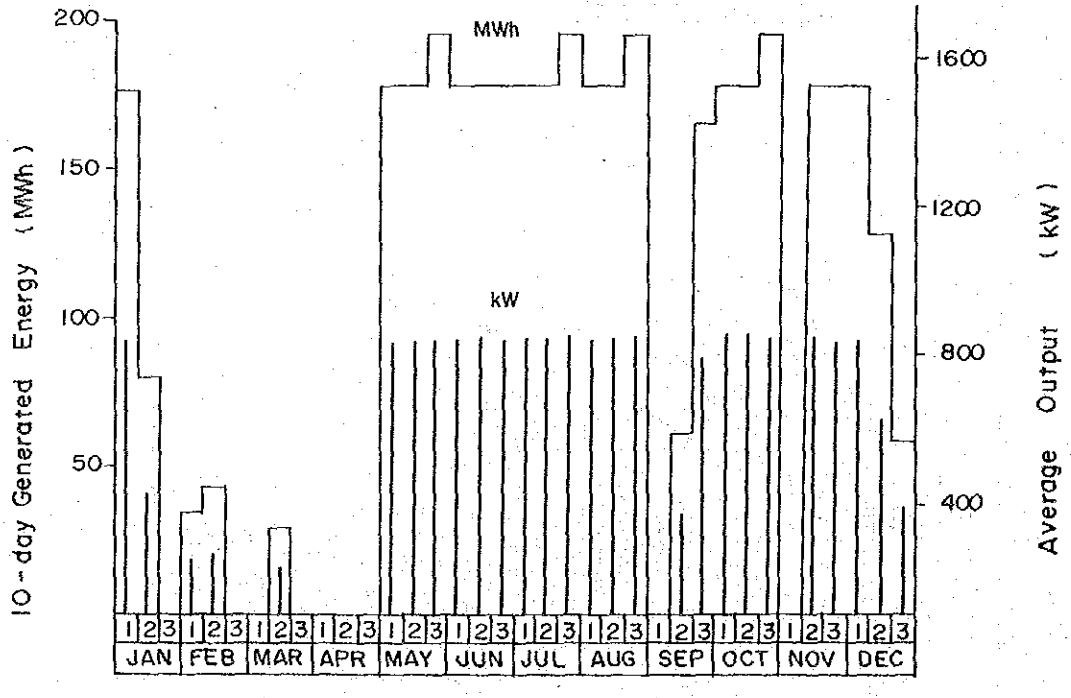


FIG. IX-3-9

10-DAY GENERATED ENERGY AND OUTPUT

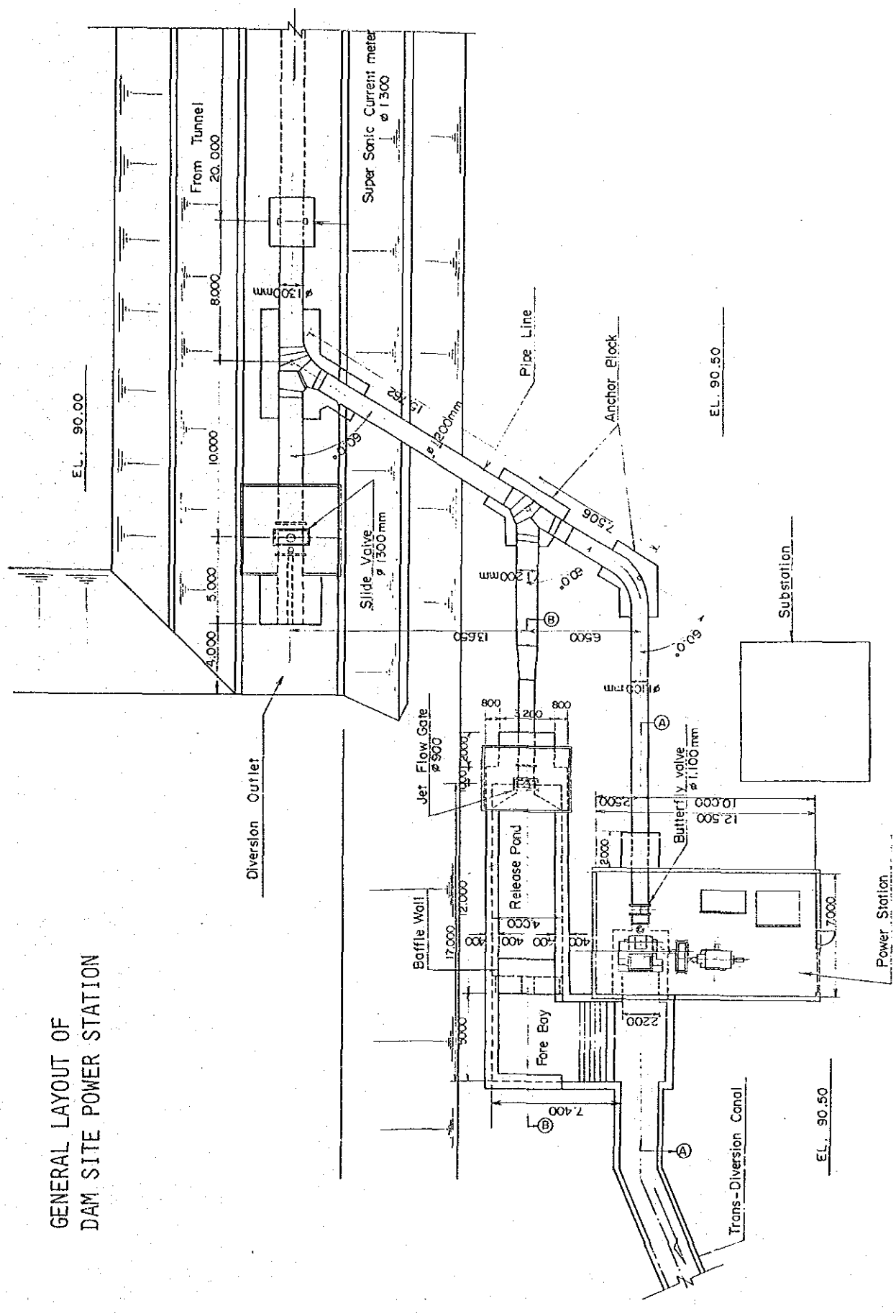


Dam Site Power Station



Canal Route Power Station

Fig. IX-3-10


GENERAL LAYOUT OF
DAM SITE POWER STATION
From Tunnel
20.000
8.000
10.000
5.000
4.000
EL. 90.00
Super Sonic Current meter
ø 1300
Slide Valve
ø 1300mm
Diversion Outlet
Pipe Line
Anchor Block
EL. 90.50
Substation
Jet Flow Gate
ø 900
Butterfly valve
ø 1,100 mm
Release Pond
Baffle Wall
Fore Bay
Power Station
Trans-Diversion Canal
EL. 90.50

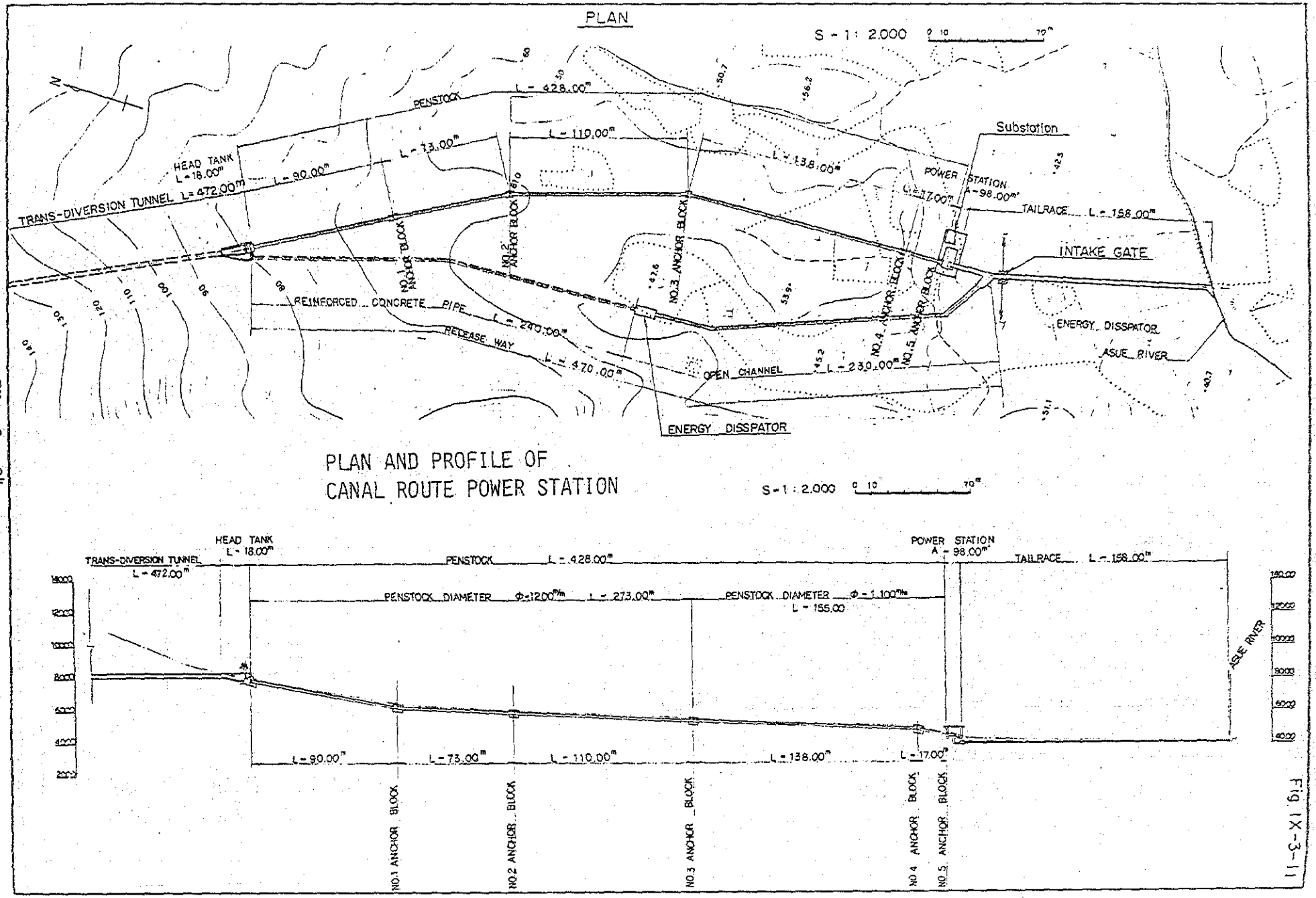
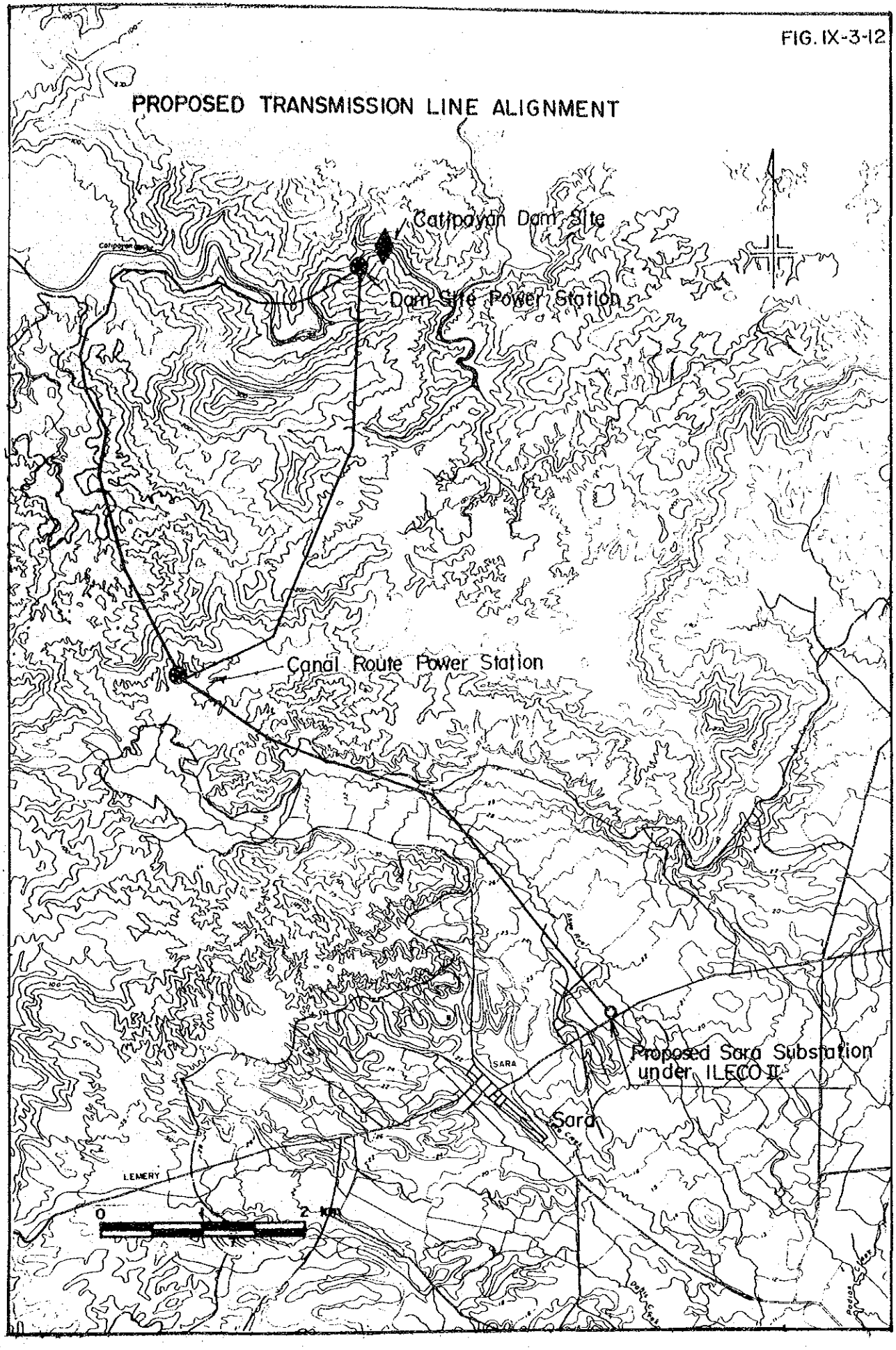

PLAN
S - 1 : 2,000
0 10 70m
N
PENSTOCK L = 428.00m
L = 110.00m
L = 73.00m
L = 90.00m
HEAD TANK L = 18.00m
TRANS-DIVERSION TUNNEL L = 472.00m
L = 138.00m
POWER STATION A = 98.00m
L = 17.00m
Substation
TAILRACE L = 158.00m
INTAKE GATE
NO.1 ANCHOR BLOCK
NO.2 ANCHOR BLOCK
NO.3 ANCHOR BLOCK
NO.4 ANCHOR BLOCK
NO.5 ANCHOR BLOCK
REINFORCED CONCRETE PIPE L = 240.00m
RELEASE WAY L = 470.00m
OPEN CHANNEL L = 230.00m
ENERGY DISSPATOR
ASUE RIVER
PLAN AND PROFILE OF
CANAL ROUTE POWER STATION
S - 1 : 2,000 0 10 70m
HEAD TANK L = 18.00m
TRANS-DIVERSION TUNNEL L = 472.00m
PENSTOCK L = 428.00m
POWER STATION A = 98.00m
TAILRACE L = 158.00m
PENSTOCK DIAMETER Φ = 12.00m/m L = 273.00m
PENSTOCK DIAMETER Φ = 1.100m/m L = 155.00
L = 90.00m
L = 73.00m
L = 110.00m
L = 138.00m
L = 17.00m
NO.1 ANCHOR BLOCK
NO.2 ANCHOR BLOCK
NO.3 ANCHOR BLOCK
NO.4 ANCHOR BLOCK
NO.5 ANCHOR BLOCK
ASUE RIVER

Fig. IX-3-11

FIG. IX-3-12


PROPOSED TRANSMISSION LINE ALIGNMENT
Catipoyan Dam Site
Dam Site Power Station
Canal Route Power Station
Proposed Sara Substation
under ILECO II
SARA
Sara
LEMERY
0
1
2 km

4. DOMESTIC WATER SUPPLY

4.1 Present Conditions

Domestic water for the Project area and surrounding residents is supplied by waterworks systems in the few areas around the poblacions of each municipality. In the majority of areas, however, domestic water supply is dependent on groundwater, springs or rain water. In many barangays, communal artesian wells with hand pumps have been set-up while near the mountains, springs and open dug wells are common.

Each poblacion in the four municipalities concerned in the Project has its own simple waterworks system. None of these systems however, are equipped with water purifier facilities and spring or reservoir water is distributed without treatment by Level II and Level III gravity systems, standards for which were designated by the Water Resources Council.

Details of the said Council's standards are as follows:

Level 1:	Drilled pump wells Dug wells Artesian wells	1 point source for 20 or more houses
Level 2:	Barangay waterworks system serving only one barangay	
Level 3:	Municipal waterworks system serving the municipality and neighboring barangays	

The number of households receiving domestic water supply from each facility is 225 households or 4.2% of total households in Ajuy, 412 households or 11.3% in Concepcion, 197 households or 5.8% in San Dionisio, and 940 households or 18.4% in Sara as shown in TABLE IX-4-1. Present water charges in each municipality are presented in TABLE IX-4-2. Demand is increasing in each area; however, with the exception of Ajuy, corresponding increases in water supply facilities have not occured, and development of new water supply is desirable (TABLE IX-4-3).

In the case of the Sara waterworks system, which has a large number of recipient households, water is supplied by gravity systems from two reservoirs each having a capacity of 80,000 gallons; however the majority of recipients frequently lack water supply during the day in the dry season due to decreased water level in the reservoir.

4.2 Basic Considerations

In this Project the domestic water supply plan is considered secondary to the irrigation development plan and will be designed so as to effectively utilize the proposed irrigation facilities.

Based on study of topographical conditions and location of the irrigation facilities of the four existing waterworks systems, the following can be concluded:

a) The waterworks systems in Ajuy, Concepcion and San Dionisio are all outside the Project area and, due to the distance from the main irrigation facilities, gravity water conveyance is not economically feasible.

b) The waterworks system in Sara is located in the central northern part of the Project area, and its existing reservoir and pipeline are very near to the proposed main irrigation facilities.

c) A plan for improvement and expansion of the Sara waterworks system is presently being formulated in order to fulfill increased demand and supplement water shortages during the dry season. One constraint to this plan, however, is lack of an available water source.

In the Project, the Sara waterworks system improvement plan will be reinforced and a plan for supplementation of the present water shortage will be formulated, although the plan will not include water supply to each household. Domestic water supply to rural areas in the Project area will also be realized through the Integrated Community Center as discussed previously.

4.3 Water Supply Plan

4.3.1 Objective Area

The existing waterworks system and the presently proposed expanded system by Local Water Utilities Administration (LWUA) of Sara cover all 18 barangays (including 3 poblacions) as tabulated below and illustrated in FIG. IX-4-1.

- Area presently served

  Aguirre, Anoring, Aposaga, Aspera, Bato, Domingo, Juaneza, Pasig, Poblacion (3)

- Area proposed

  Aporogista, Devera, Labigan, Padios, Preciosa, Salcedo, Zerrudo

A domestic water supply scheme under the Project is planned for all the above presently served and proposed expanded areas.

4.3.2 Target Year and Population

The target year was determined on the basis of population projections as analysed in APPENDIX IV SOCIOECONOMY. As the analysis shows, the rate of population increase will asymptotically have a constant value of 1.38 around the year 2003. Accordingly the target year for water supply to the Sara waterworks was determined for the year 2003. The projected population in the 18 barangays for the target year was assumed at 20,300 persons. Out of this target population, 17,700 persons live in the Project area while the remainder live outside.

- Target Year: 2003 year
- Population: 20,300 persons

4.3.3 Proposed Water Supply Capacity

Present water consumption per day per person for each municipality was obtained as in the table below.

Unit: ℓ/day/person

MUNICIPALITY	CONSUMPTION	REMARKS
Ajuy	95	as of 1980
Concepcion	no data	
San Dionisio	60 gallons/household nearly equal 42	assumed on average 5.73 persons/household
Sara	100	based on interview survey

According to the above data, the amount of water supply is between 40 to 100ℓ/day/person. For project planning accordingly, 100 ℓ/day/person was adopted as a conservative value. The projected water supply capacity under the expanded Sara waterworks system was thus estimated at 2,030m^3/day (0.0235m^3/sec.) multiplying the population by the above unit value.

Considering that the existing reservoirs have a total capacity of 606m^3/day (0.0070m^3/sec.), the additiononal supplementary capacity for the Project was calculated at 1,424m^3/day (0.0165m^3/sec.) River discharge at the reservoirs in the most critical drought (April 1983) was 0.0122 m^3/sec from the catchment areas of 2.092 and 0.700km^2 multiplying the same by the specific discharge of the Asue River (0.438m^3/sec/100km^2). The existing capacity of 0.0070m^3/sec therefore seems reasonable.

As discussed in APPENDIX VI WATER RESOURCES DEVELOPMENT, an additional capacity of 0.3MCM will be required in the proposed Catipayan reservoir in case the domestic water supply component is included within the Project.

4.4 Facilities Planning and Preliminary Design

Facilities required for the scheme include a diversion device for intake from the irrigation diversion canal, and a pipeline equipped to control discharge of intake water from the diversion point to the existing waterworks pipeline. General layout and profile of the proposed waterworks are presented in FIG. IX-4-2.

(1) Diversion Device

Water intake will be divided from the head tank installed at the inlet of the penstock.

(2) Pipeline

The Hazen and Williams Formula was utilized in the pipeline study as follows:

Diameter: 150mm Discharge: 0.0165m^3/s

Distance: 1,500m Maximum Hydrostatic Head: 45.0m

Proposed Hydraulic Gradient: 5.922%

Velocity: 0.94m/sec

$$I = 10.666\ c^{-1.85} \cdot D^{-4.87} \cdot Q^{1.85} = 5.922 \times 10$$

$$V = 0.35464 \cdot C \cdot D^{0.63} \cdot I^{0.54} = 0.94$$

where Q: Discharge 0.0165m^3/sec

D: Diameter 0.15m

C: Coefficient of Discharge 140

(3) Cleaning Facilities

Installation of equipment which can remove debris such as sand and weeds is planned just before connection with the existing pipeline. The existing waterworks system's cleaning facilities require rehabilitation. If water quality was good, no problem would arise; however, as water is introduced via open canals, the possibility of contamination increases.

4.5 Alternative Study

In this section, comparative studies for alternative plans versus the proposed plan which utilize the irrigation facilities were carried out to confirm the appropriateness of incorporating the domestic water supply component in the present Project. The alternative plan for the study is to develop additional water resources by construction of a reservoir, independently to the Project scheme, at the existing Sara waterworks intake point.

The results of detailed studies presented hereinafter showed that the proposed scheme requires the least construction cost and it was concluded that the domestic water supply scheme can be beneficially incorporated in the Project.

COST COMPARISON

unit: million pesos

PROPOSED PLAN	ALTERNATIVE PLAN
2,749 1/	5,952

1/ includes allocated cost of dam and trans-diversion canal/tunnel

For this alternative, it is necessary to study locations of reservoirs which have sufficient amount of water and head. The total construction length of the same should be shorter than the proposed plan for economic feasibility. The number of reservoirs will thus be greater than in the proposed plan and the same should be constructed near the existing pipeline system. In order to reduce construction costs, the total length of new pipeline should be minimal.

However, based on the topographical map, these catchment areas are small and suitable alternative reservoir sites to replace existing reservoirs are difficult to find. For this reason, rehabilitation and reconstruction of existing reservoirs will be adopted for study in planning water volume and available intake.

(1) Study Poicy

There are two existing reservoirs (Agbadiang and Cabatongas); however, improvement of both reservoirs is not economical. Accordingly, a plan for development of new water resources should be formulated including expansion of the existing Agbadiang reservoir which has a wider watershed area than the Cabatongas reservoir.

As for the water supply plan, 1968 was designated as the standard year with a 5-year return period.

Discharge at Agbadiang reservior (BQ)

Discharge at Agbadiang is calculated based on the specific discharge of the Asue River (AQ) as follows:

Agurre: Catchment Area = 9.48 km^2

Agbadiang: - do - = 2.092 km^2

$$BQ = AQ \times \frac{2.092}{9.49}$$

Water Requirement (NQ)

In examination of supplementary water volume, it is necessary to reduce the discharge of the Cabatongas reservoir from BQ.

Newly proposed supplementation	0.0165m^3/s
Discharge provided from Agbadiang reservoir	0.035m^3/s
Discharge provided from Cabatongas reservoir	0.0035m^3/s
	0.0235m^3/s

Lack of Water (LQ)

A difference between BQ and SQ, lack of water for water supply will occur when BQ is less than NQ ---- LQ.

Capacity of Reservoir (RQ)

It is necessary to ensure sufficient volume at the Agbadiang reservoir to compensate for accumulative water shortage.

(2) Result of study

On the basis of the study results shown in TABLE IX-4-4, required capacity of the reservoir and embankment volume are 44,000m^3 and 39,680m^3, respectively. The required construction cost was estimated at ₱5,952 million from the embankment volume multiplied by the unit cost of 150/m^3. Therefore, construction cost to the alternative study was more costly than for the proposed plan as mentioned in the cost comparison.

WATER SUPPLY RATIO AS OF 1983

	AJUY	CONCEPCION	SAN DIONISIO	SARA	TOTAL OR AVERAGE
Number of Barangays					
-Total	34	25	29	42	130
-With Connection	3	1	2	11	17
Number of Households	5,403	3,662	3,386	5,120	17,571
Houses Connected					
-Total Number	225	412	197	940	1,774
(faucet)		(100)		(570)	
-%	4.2	11.3	5.8	18.4	10.1
-In Poblacion					
Number	198	412	197[1/]	572	1,379
-%	3.7	11.3	5.8	11.2	7.8

1/ Marked number includes a part of Barangay Santol.

TABLE IX-4-2

DOMESTIC WATER CHARGES

Unit: ₱

MUNICIPALITY		WATER CHARGES
Sara	Domestic	7.00/month (below 20 m^3) 0.40/m^3 in excess of 20 m^3
	Commercial	9.00/month (below 20 m^3) 0.50/m^3 in excess of 20 m^3
	Industrial	11.00/month (below 20 m^3) 0.60/m^3 in excess of 30 m^3
Ajuy	Residential	10.00/month (below 10 m^3) 0.80/m^3 (11 - 20 m^3)) 1.00/m^3 (21 - 30 m^3)) 1.20/m^3 (31 - 50 m^3)) - excess charge 1.50/m^3 (above 50 m^3))
	Commercial	15.00/month (below 10 m^3) 1.40/m^3 (11 - 20 m^3)) 1.80/m^3 (21 - 30 m^3)) 2.30/m^3 (31 - 50 m^3)) - excess charge 3.00/m^3 (above 50 m^3))
San Dionisio		5.00/month 1/
Concepcion		10.00/month 1/

Note: 1/ The charge is the same irrespective of the quantity used because there is no meter.

TABLE IX-4-3

CAPACITY OF EXISTING DOMESTIC WATER SUPPLY

	AJUY	CONCEPCION	SAN DIONISIO	SARA	TOTAL
Capacity (m^3/day)	678	50	160	606	1,494
Number of Households	225	412	197	940	1,774
Capacity/ Households (m^3/day)	3.01	0.121	0.81	0.64	0.84
Population	30,397	21,121	19,410	28,838	99,766
Households	5,403	3,662	3,386	5,120	17,571
Population Households	5.63	5.77	5.73	5.63	5.68
Capacity/ Person (ℓ/day)	534.6	21.0	141.4	113.7	147.9

Source: Capacity Data excluding Ajuy from SOCIOECONOMIC PROFILE
Capacity Data of Ajuy from Municipal Development Plan.

TABLE IX-4-4

WATER BALANCE OF ALTERNATIVE RESERVOIR

Unit : MCM

		AQ	BQ	NQ	LQ	RQ
1968						
Jan	1	0.1341	0.0296	0.0173	0.0123	0
	2	0.1003	0.0221	0.0173	0.0049	0
	3	0.0912	0.0201	0.0190	0.0011	0
Feb	1	0.0792	0.0175	0.0173	0.0002	0
	2	0.0757	0.0167	0.0173	-0.0006	-0.0006
	3	0.0671	0.0148	0.0156	-0.0007	-0.0013
Mar	1	0.0703	0.0155	0.0173	-0.0018	-0.0031
	2	0.0671	0.0148	0.0173	-0.0025	-0.0056
	3	0.0702	0.0155	0.0190	-0.0035	-0.0091
Apr	1	0.0602	0.0133	0.0173	-0.0040	-0.0131
	2	0.0569	0.0125	0.0173	-0.0047	-0.0178
	3	0.0536	0.0118	0.0173	-0.0055	-0.0233
May	1	0.0506	0.0112	0.0173	-0.0061	-0.0294
	2	0.0486	0.0107	0.0173	-0.0066	-0.0360
	3	0.0503	0.0111	0.0190	-0.0079	-0.0439 1/
Jun	1	0.1154	0.0255	0.0173	0.0082	-0.0357
	2	0.0981	0.0216	0.0173	0.0044	-0.0313
	3	0.1090	0.0240	0.0173	0.0068	-0.0245
Jul	1	0.3019	0.0666	0.0173	0.0493	0
	2	0.2606	0.0575	0.0173	0.0420	0
	3	0.2625	0.0579	0.0190	0.0389	0
Aug	1	0.2249	0.0496	0.0173	0.0323	0
	2	0.8117	0.1791	0.0173	0.1618	0
	3	0.4887	0.1078	0.0190	0.0888	0
Sep	1	0.3040	0.0671	0.0173	0.0498	0
	2	0.3613	0.0797	0.0173	0.0625	0
	3	0.2641	0.0583	0.0173	0.0410	0
Oct	1	0.2611	0.0576	0.0173	0.0403	0
	2	0.9038	0.1955	0.0173	0.1822	0
	3	0.5045	0.1113	0.0190	0.0923	0
Nov	1	0.3171	0.0700	0.0173	0.0527	0
	2	0.3916	0.0864	0.0173	0.0691	0
	3	0.5333	0.1177	0.0173	0.1004	0
Dec	1	0.3059	0.0675	0.0173	0.0502	0
	2	0.2422	0.0534	0.0173	0.0362	0
	3	0.2018	0.0445	0.0190	0.0255	0

Note AQ: Asue discharge (9.48 km^2) BQ: Agbadiang discharge (2.092 km^2)
NQ: Water Requirement LQ: Surplus/Deficit RQ: Required Capacity
1/ Required effective storage capacity (0.0439 MCM)

FIG. IX-4-1

BARANGAY COVERAGE OF SARA WATERWORKS SYSTEM

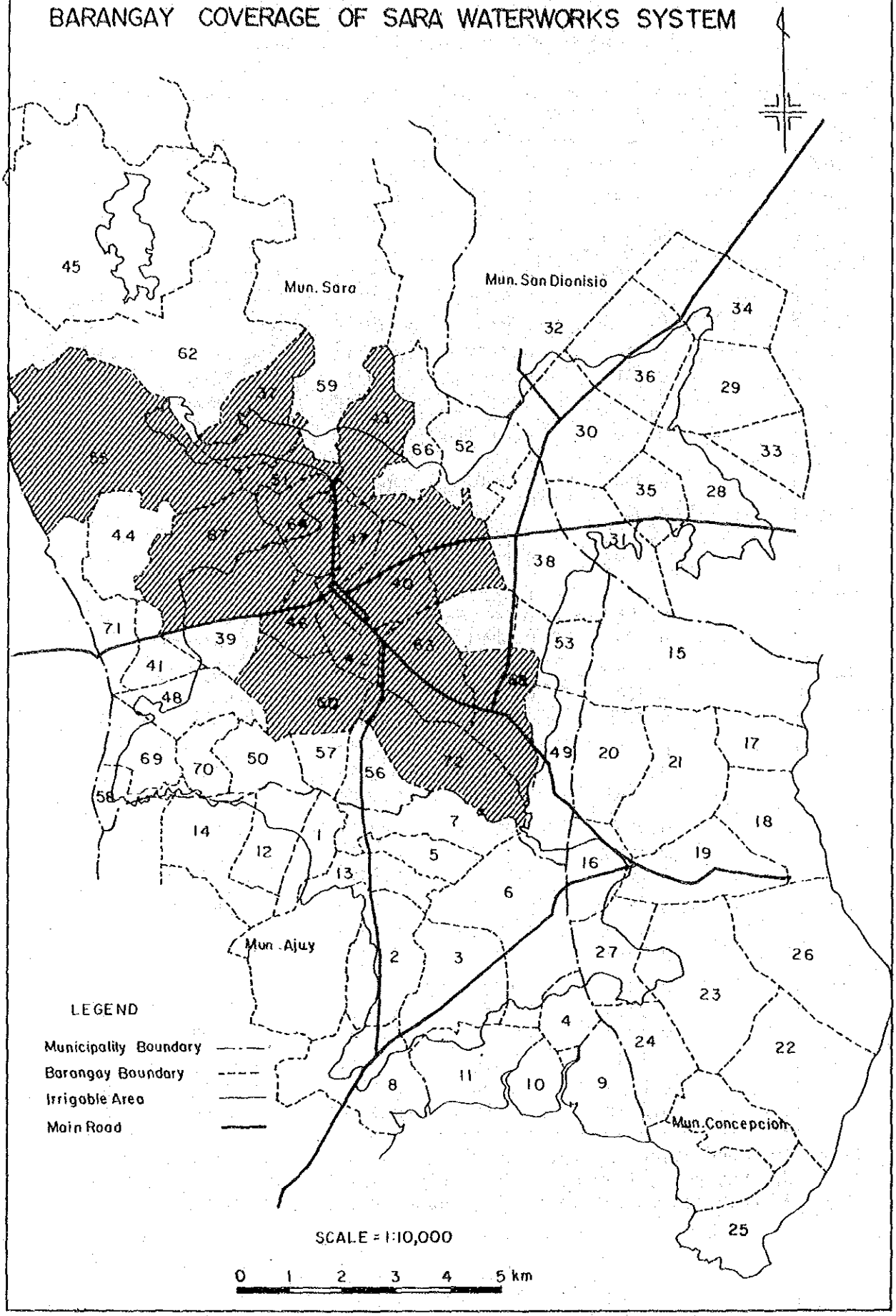
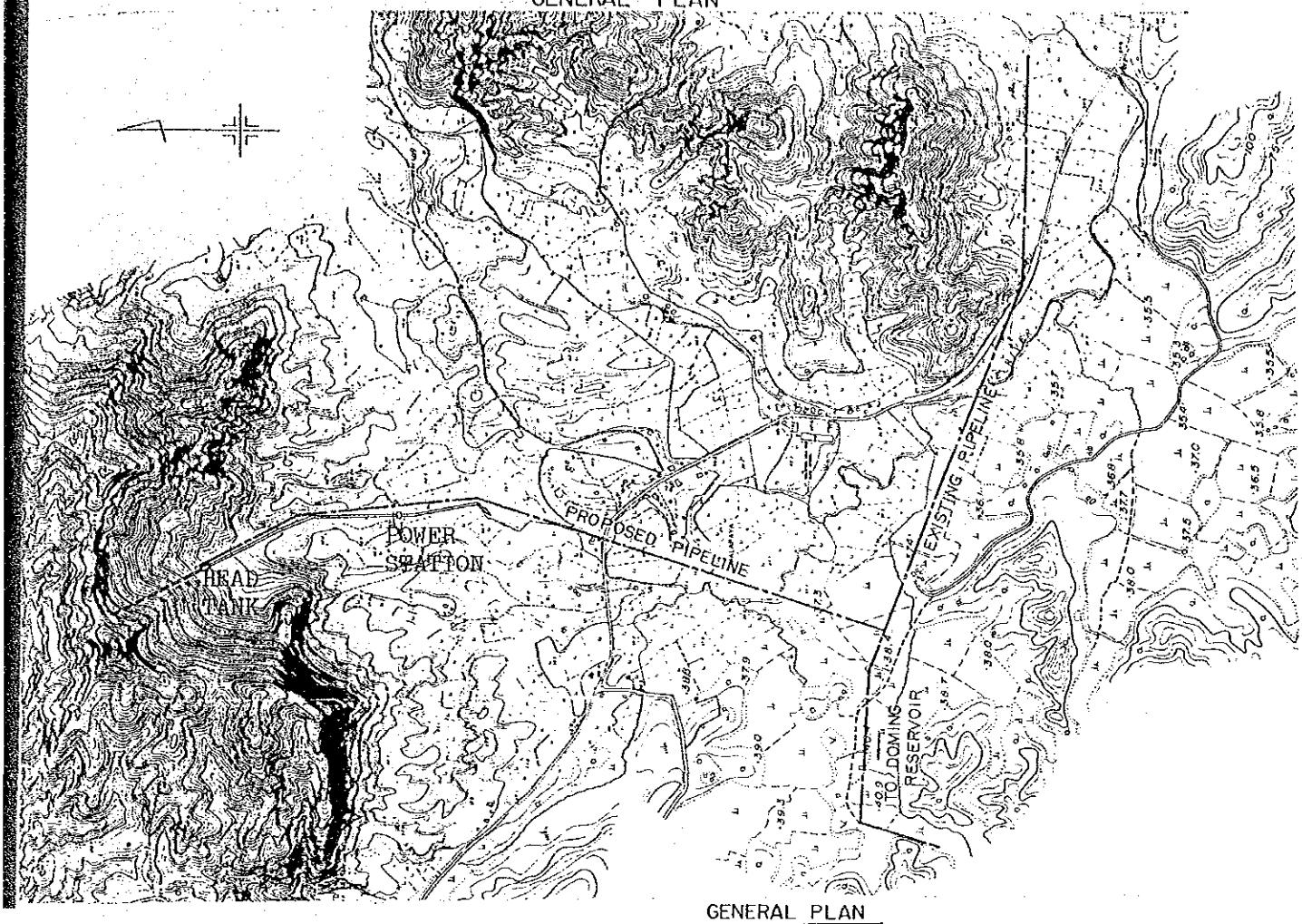


FIG. IX-4-2

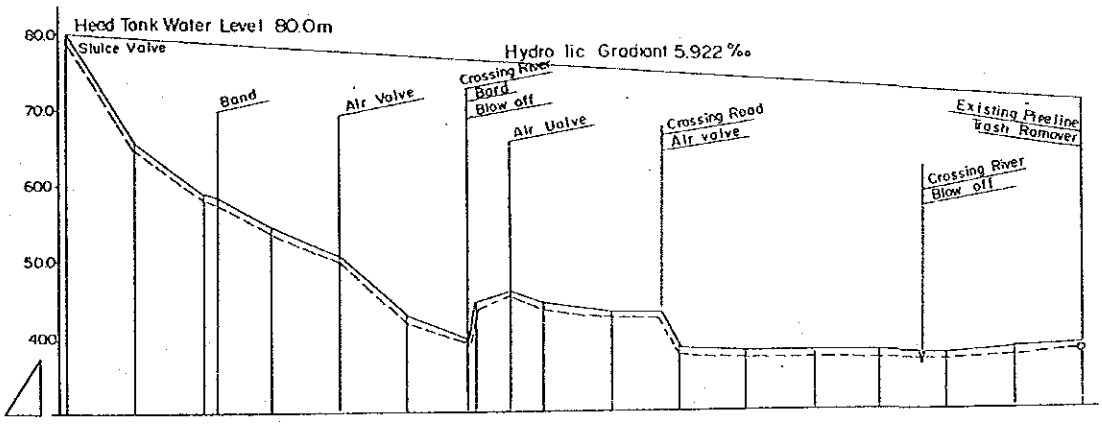
GENERAL PLAN AND PROFILE OF PROPOSED DOMESTIC WATER SUPPLY PIPELINE

GENERAL PLAN



GENERAL PLAN

PROFILE



PVC φ150 L=1500.0 m

STATION	Length (m)	Elevation (m)	Pipe Elevation (m)	Hydraulic Elevation (m)	Pipe Diameter (m/m)
NO. 0	0	80.0	79.0	80.0	
NO. 1	100	65.0	64.0	79.41	
NO. 2	200	58.5	57.5	78.82	
+ 20	220	58.0	57.0	78.70	
NO. 3	300	54.0	53.0	78.22	
NO. 4	400	50.4	49.4	77.63	
NO. 5	500	42.5	41.5	77.04	
+ 90	580	38.5	43.0	76.51	
NO. 6	600	44.0	43.0	76.45	
+ 50	650	45.7	44.7	76.15	
NO. 7	700	44.0	43.0	75.85	
NO. 8	800	43.0	42.0	75.26	
+ 70	870	42.8	41.8	74.85	
NO. 9	900	38.2	37.2	74.67	
NO. 10	1000	37.5	36.5	74.08	
NO. 11	1100	37.7	36.7	73.49	
NO. 12	1200	37.5	36.5	72.89	
+ 60	1260	36.0	35.0	72.54	
NO. 13	1300	37.3	36.3	72.30	
NO. 14	1400	37.9	36.9	71.71	
NO. 15	1500	38.4	37.4	71.12	

APPENDIX X

ORGANIZATION AND MANAGEMENT

APPENDIX X

ORGANIZATION AND MANAGEMENT

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APPENDIX - X

ORGANIZATION AND MANAGEMENT

1. FUNCTION AND ORGANIZATION OF NIA

The organization of NIA is depicted in FIG. X-1. NIA is responsible for investigation, planning, design, construction, procurement, operation and maintenance for all foreign assisted and locally funded national irrigation projects. NIA is also responsible for communal irrigation systems, except for operation and maintenance.

NIA's regional offices (RIO) are established in each of the 12 regions of the Philippines to implement mainly locally funded national projects. The same are also responsible for activities carried out by the Provincial Irrigation Offices (PIO) established in most provinces. The major role of the Provincial Irrigation Offices is to provide technical assistance for planning, designing and construction supervision of communal irrigation projects, and to observe and maintain the local hydro-meteorological stations under the supervision of RIO.

The irrigation technician of the PIO provides technical assistance to irrigators' associations for appropriate supervision and for O & M activities.

2. ORGANIZATION FOR OVERALL DEVELOPMENT

2.1 Project Execution

The Project aims at river basin agricultural development with irrigation as the main component and supplementary components for rural development. The components incorporated into the Project are as follows:

- Irrigation and drainage
- Road network
- Hydropower generation
- Domestic water supply
- Integrated Community Center

NIA will be responsible for execution of the entire project including pre-project planning and designing, as well as construction. For overall execution, NIA will appoint a Project Manager under the Assistant Administrator for Project Development and Implementation for the implementation of design and construction works. During the O & M period, the Project Manager will be engaged in the said work under the Assistant Administrator for Operation.

The organization for overall project execution is planned as shown in FIG. X-2. Considering the various components included in the Project, project coordination will be undertaken by the agencies concerned.

2.2 Organization for Construction Stage

The appointed Project Manager will be directly responsible for implementation of the Project and for coordinating the activities of all relevant agencies and farmers irrigators' associations. The said manager will be chief of the Project Construction Office which consists of the main office and 7 site offices. The proposed organization chart is presented in FIG. X-2.

2.3 Organization for Operation and Maintenance Stage

2.3.1 General

In the initial stage of project development, NIA will be responsible for operation and maintenance of the diversion dams and main canals up to the turnout of the lateral canals. However, operation and maintenance will be gradually turned over to the farmers' organizations, i.e. irrigators' associations accompanied by training of the farmers. Irrigators' Associations will undertake operation and maintenance on a contract basis with NIA, and the association will be responsible for collection of irrigation water charges.

The present policy of the government for operation and maintenance of irrigation projects includes strengthening of procedures to improve irrigation fee-collection and simultaneous acceleration of the transfer of responsibility for operations and maintenance to Irrigators' Associations, including that of the national system. Other measures being considered to reduce the government's high operating costs include:

a) conversion of marginal irrigation systems with incomes less than operating and maintenance costs into communal systems which will be operated by farmers' associations;

b) turning over large irrigation systems on a modular basis by sections or laterals to farmers' associations; and

c) improvement of water delivery and services to farmers.

These measures will improve efficiency of water utilization and result in larger fee collection. Tasks and obligations for NIA and Irrigators' Associations (IA) are outlined below.

NIA

The NIA is to:

a) guarantee the supply of irrigation water both for dry and wet crops in areas covered by the contract based on a pre-determined water delivery schedule;

b) provide the IA with advance information in case delivery of water is impossible due to unavoidable circumstances;

c) perform major repairs on irrigation facilities (lateral canals and appurtenant structures, turnouts and project drains);

d) remit to IA the whole amount due to the IA at least thirty (30) days after receipt of irrigation fee payment;

e) furnish the IA with the total bills of the area at least ten (10) days before harvest;

f) provide the IA with a parcellary map of the area under contract; and,

g) provide technical supervision for proper implementation of the agreement.

Irrigators' Association

The Irrigators' Associations are to:

a) clear, maintain and provide minor repairs on irrigation service canals and structures within their area, including farm ditches and drains;

b) elect a common irrigator from the IA, who should manage water distribution to individual farms, and designate a place preferably a shed for the NIA field personnel to hold consultation or to assist water distribution;

c) follow strictly the agreed irrigation water delivery schedule;

d) submit to the NIA a list of planted area fifteen (15) days after transplanting;

e) attend meetings called by the NIA on operation of canals;

f) send irrigation bills and collect corresponding irrigation fees from farmer-members;

g) remit collected irrigation fees on agreed schedule; and,

h) comply to NIA rules and regulations in order to attain the objectives of both parties of this contract.

2.3.2 Project Operation and Maintenance Office

With the progress of construction works, a part of the Project Construction Office will start functioning as an O & M Office. According to the proposed implementation schedule presented in APPENDIX XI under IMPLEMENTATION SCHEDULE AND COST ESTIMATES, a designated area will be operational under the proposed new system three years before the completion of the entire system. During these three years, therefore, the Project Construction Office will be responsible for O & M activities.

The proposed organization chart and the staff necessary for the Project O & M Office are presented in FIG. X-3 and TABLE X-1. TABLE X-2 shows required operation and maintenance facilities. The proposed plan for O & M Organization was prepared on the current practice applied to the NIA's medium scale irrigation project. The Office will consist of 5 sections; namely, Dam and Reservoir, Agricultural Development, O & M, Collection Service and Administration sections.

The proposed major roles for each section of the project O & M Office are outlined below.

Administrative Section

The Administrative Section will be responsible for all administrative activities of the O & M Office.

O & M Section

The O & M Section will be responsible for the activities outlined on the next page.

a) estimation of the diversion water requirement and preparation of the water distribution schedule based on the cropping schedule obtained from farmers irrigators' associations (FIA) through senior water management technicians;

b) control and observation of the major irrigation facilities down to the turnout of on-farm ditches; and,

c) preparation of plans for and execution of maintenance and repair work for all major facilities such as irrigation and drainage systems, inspection roads, embankments, and all respective equipment.

Collection Service Section

The Collection Service section will be responsible for collecting irrigation fees through the federal FIA and for processing data on the said office's computor.

Agricultural Development Section

The Agricultural Development section will be responsible for assisting and advising farmers in the introduction of irrigated agricultural techniques at the farm level.

Dam and Reservoir Section

The Dam and Reservoir section will be responsible for water source management for irrigation as well as for power generation and domestic water supply.

2.3.3 Irrigators' Associations

The boundary for irrigation water management units should conform to the irrigation canal networks. Accordingly, an irrigators' association will consist of one rotational unit group (RUG) with an area of approximately 10ha. Five rotational unit groups will form an irrigators' group (IG) with a rotational area of 50ha. Irrigators' associations (IA) will be organized by lateral canal system and/or small command area of the main canal with an area of 500 to 700ha. Moreover, irrigators' associations will be organized not only on the basis of the irrigation canal system, but according to the existing Sawahay Nayon and barangay unit.

On the basis of irrigation canal networks, the service area can be divided into three areas, each to be managed by a federation of irrigators' associations which will consist of 3 to 4 irrigators' associations. The three federations will conform with the command areas

of the Asue main canal, the eastern main canal and the southern area covered by the Serruco, Gubaton and Bakabak diversion dams.

The proposed organization chart for the irrigators' association is shown in FIG. X-5. The function of the organization is not only operation and maintenance of irrigation systems but also effective extension of agricultural activities, health care and sanitation activities in rural areas to promote the diffusion of rural development. After operation and maintenance is turned over to the irrigators' associations, the latter should be responsible for water management and operation and maintenance of the irrigation systems under the supervision of water management technicians of the Operation and Maintenance Office for the Project.

TABLE X-1

PERSONNEL REQUIREMENT FOR OPERATION AND MAINTENANCE

Item	Number
Management	
Project Engineer	1
Engineer B	1
Administrative Section	
Cashier A	1
Heavy Equipment Operator	1
Accounting Clerk B	1
Property Custodian A	1
Driver B	5
Security Guard B	3
Mechanic B	1
Radio Operator B	1
Clerk B	2
Messenger	1
Janitor	1
Operation and Maintenance Section	
Engineer B	1
Irrigation Technician	1
Watermaster	9
Engineer Aide B	1
Gatekeeper	12
Ditchtender	32
Collection Service Section	1
Sr. Collection Representative	1
Collection Representative B	1
Billing Clerk	2
Agricultural Development Section	
Agronomist A	1
Farmer Organization Specialist	9
Dam and Reservoir Section	
Engineer B	1
Engineering Aide B	5
Total	96

BREAKDOWN OF OPERATION AND MAINTENANCE FACILITIES

(Unit: ₱ '000)

Work Item	Unit	Q'ty	Unit ₱	Foreign Cost	Local Cost	Total
Building and Housing						
Main Project Office	m^2	1,000	3,000	1,800	1,200	3,000
Dam Operation Office	m^2	200	3,000	360	240	600
Laboratory	m^2	75	3,000	135	90	225
Housing:						
Government Staff	m^2	500	3,000	900	600	1,500
Guests	m^2	200	3,000	360	240	600
Consultants	m^2	250	3,000	450	300	750
Equipment Shed	m^2	1,000	2,000	1,200	800	2,000
Furniture	-	L.S.	860	860	-	-
Water Supply and Sewerage Installation						
Water Supply	-	L.S.	300	200	500	-
Sewerage	-	L.S.	360	240	600	-
Electricity						
Generator	-	L.S.	600	-	600	-
Distribution Facilities	-	L.S.	450	-	450	-
Equipment						
Bulldozer (11t)	nos	1	950	950	-	950
Backhoe (0.35m^3)	nos	1	925	925	-	925
Motor Grader (blade: 2.2m)	nos	1	570	570	-	570
Dump Truck (4t)	nos	2	235	470	-	470
Jeep	nos	4	190	760	-	760
Motorcycle	nos	12	10	120	-	120
Computor	-	L.S.	-	100	-	100
Radio Set	-	L.S.	-	160	-	160
Others	-	L.S.	-	1,000	-	1,000
Spare Parts	-	L.S.	-	500	-	500
Inland Transportation	-	L.S.	-	50	-	50
Total				12,470	4,820	17,290

ORGANIZATION CHART OF NIA

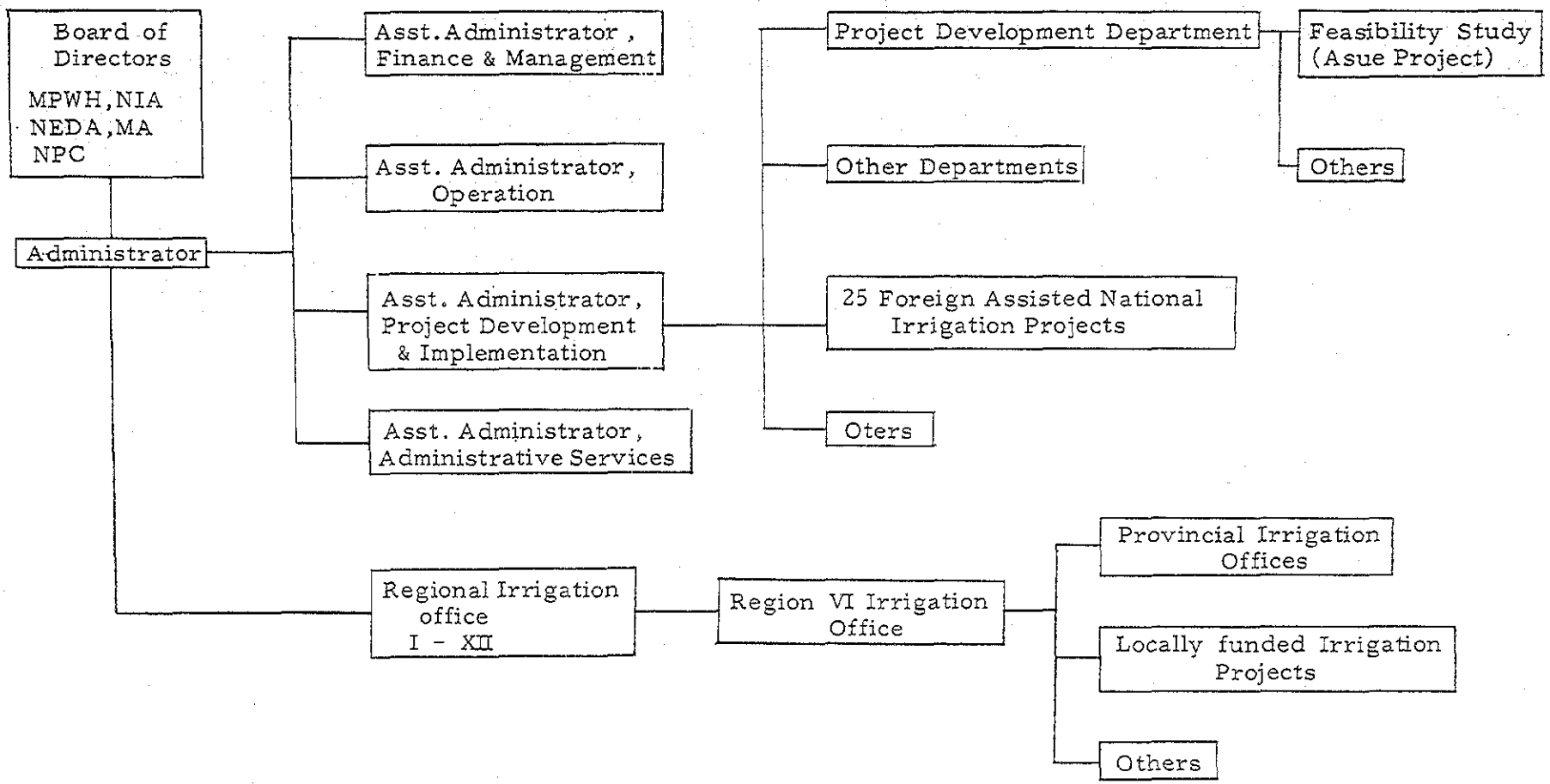


Fig. X - 1

PROPOSED ORGANIZATION CHART FOR PROJECT EXECUTION

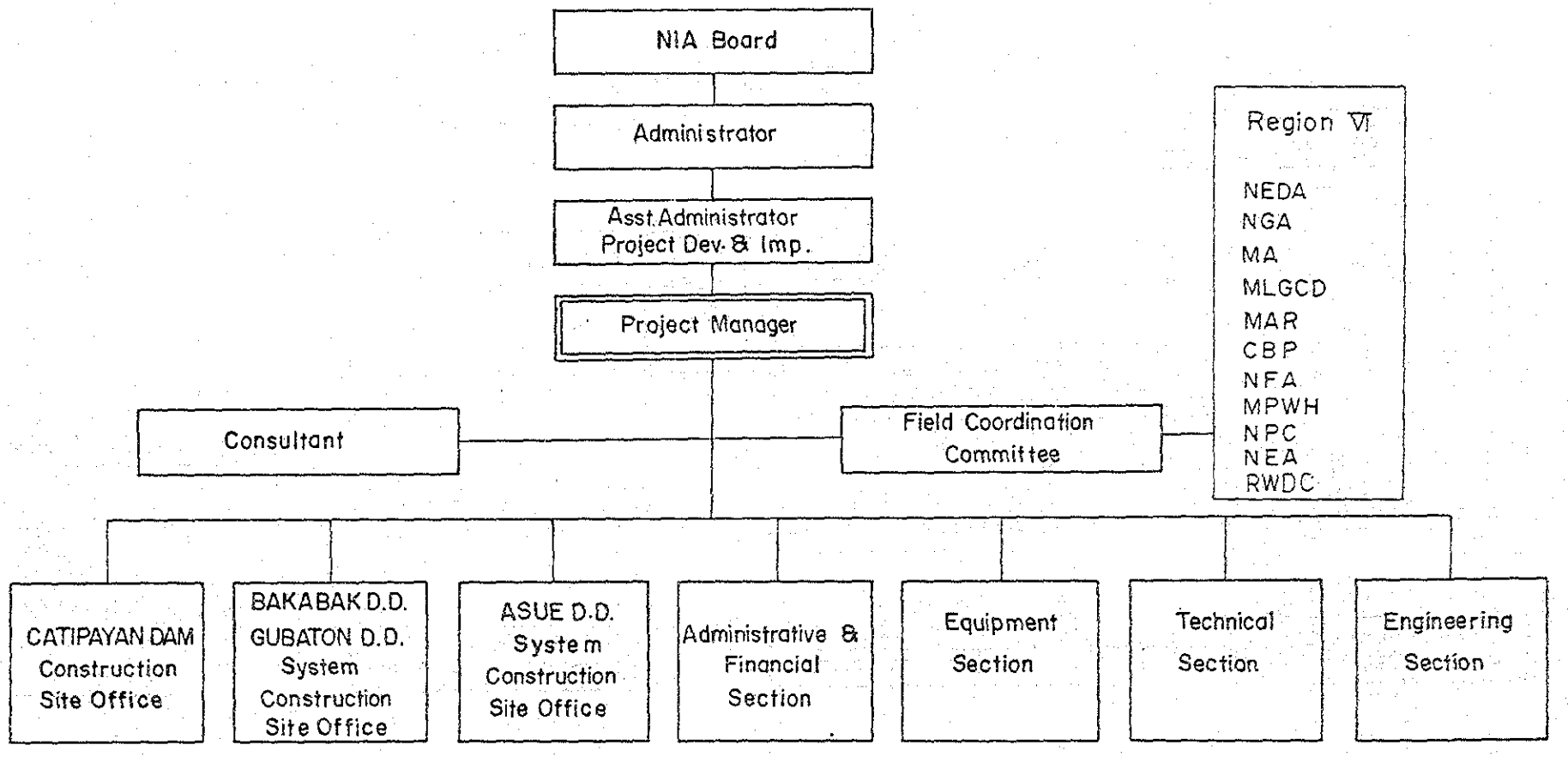


FIG. X-2

PROPOSED ORGANIZATION CHART FOR OPERATION AND MAINTENANCE

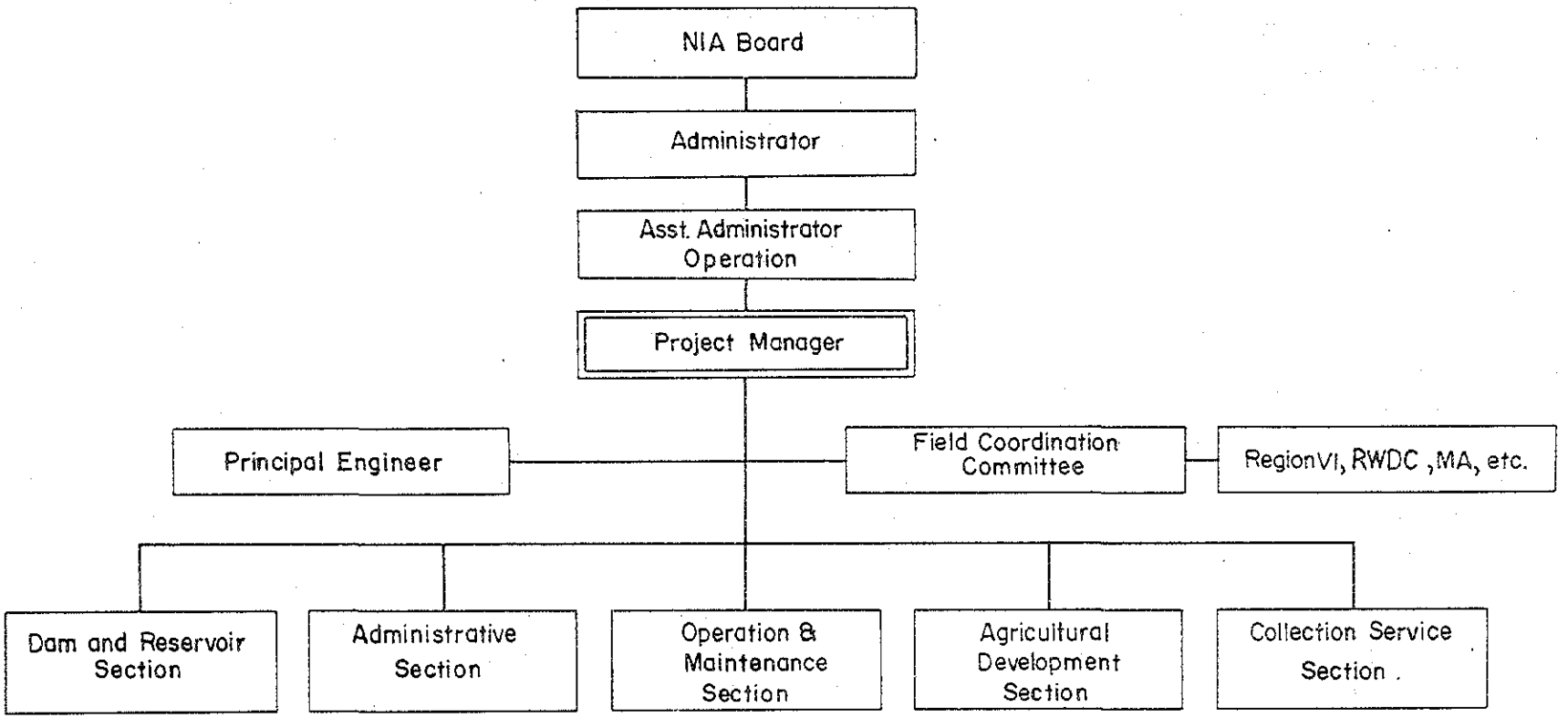
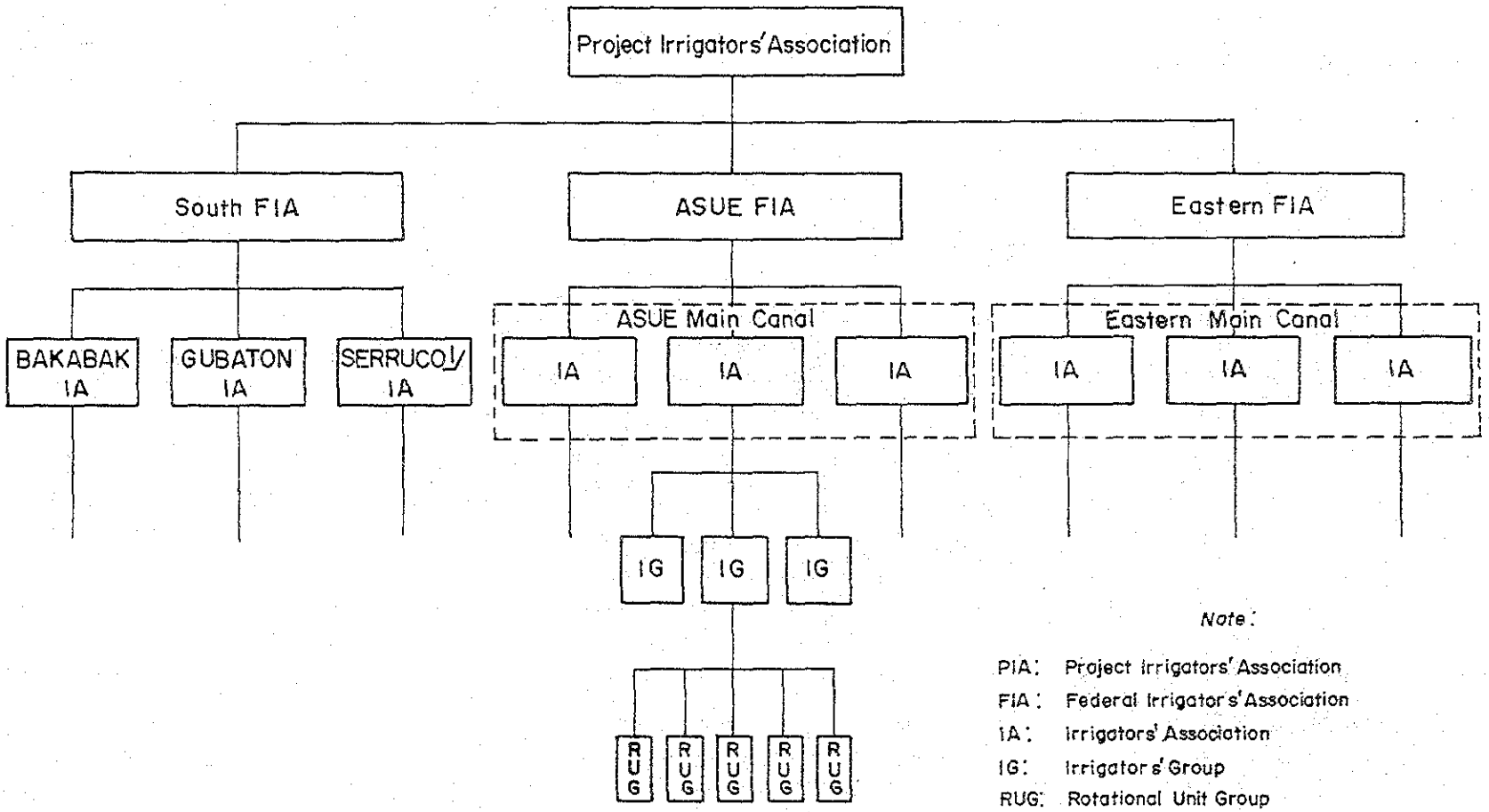


FIG. X-3

PROPOSED FARMERS. IRRIGATORS' ASSOCIATION



1/: to be integrated into the new system.

FIG. X-4

APPENDIX XI

IMPLEMENTATION SCHEDULE

AND COST ESTIMATES

APPENDIX XI

IMPLEMENTATION SCHEDULE AND COST ESTIMATES

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APPENDIX XI

IMPLEMENTATION SCHEDULE AND COST ESTIMATES

1. MAIN FEATURES OF THE PROJECT

The main features of the proposed development plan for all components, including agriculture, hydropower, road network, Integrated Community Center and domestic water supply, are presented in TABLE XI-1.

2. CONSTRUCTION PLAN

2.1 Mode of Construction

Various kinds of civil works in the Project will be executed by force account and on a contract basis. The contract basis will be adopted for all main works and for procurement of major equipment. International or local contractors will execute construction works with machinery rented from NIA, and materials imported by the Government.

Force account will be applied only to specialized works such as part of a survey or investigation. Construction works for on-farm facilities which may be conducted by local farmers under the direction of NIA, will also be executed by force account.

2.2 Catipayan Dam Construction Plan

2.2.1 Workable Days

On the basis of the number of rainy days as tabulated in TABLE II-10 under APPENDIX II METEOROLOGY AND HYDROLOGY, workable days for dam embankment were calculated for each zone as discussed below.

(1) Impervious Zone

From the same table, the average number of days per year with rainfall equal to or less than 1.0mm is 237.2 days when estimated for a 20-year period. Based on this value, design workable days for impervious zone embankment were calculated as follows:

- 365 - 237.2 = 127.8
- 127.8 x (1.15 to 1.20) = 147.0 to 153.4
- 365 - (147.0 to 153.4) = 218.0 to 211.6

Therefore, design workable days are (218.0 to 211.6) x 0.8 = 174.4 to 169.3 : average 172 days.

(2) Pervious Zone

For pervious zone embankment, excluding holidays, 25 days a month are workable, and annual workable days amount to 300.

2.2.2 Embankment Material Borrow Plan

Based on the results of the embankment material survey, material for each zone of the dam will be obtained from the sites tabulated below.

Zone	Material	Site
Impervious	Weathered rock	Borrow area, spillway river deposit
Rock	Fine rock	Quarry area, spillway excavation
Transition	Weathered rock & rock	Quarry area, spillway excavation
Filter	Crushed weathered rock & rock	Quarry area, river deposit
Riprap	Gravel	Quarry area, spillway, river deposit

2.2.3 Dam Construction Procedure

In excavation of the dam foundation, a by-pass tunnel will be constructed to protect dam construction from flood. As both abutments have steep slopes, excavation of dam foundation will commence from the same. Rock material for the cofferdam will be obtained from the upper section of the dam crest excavation of the spillway. Excavation of the riverbed will be conducted after excavation of the abutments. In order to facilitate early commencement of dam embankment works, foundation treatment should be made from the riverbed. At the lower section of the dam crest, the spillway will be excavated parallel to the dam embankment. Useable excavated materials will be hauled directly to the dam embankment.

2.2.4 Construction Method

(1) By-pass

All sections will be excavated by blasting and crushing with a jumbo drill, and excavated materials will be gathered by Rocker shovel and hauled by dump truck. After one cycle of excavation, an H-beam support with sheet piles should be set up around the excavated face. Concrete lining will be applied after completion of excavation.

(2) Excavation of Dam Foundation

Stripping and common soil excavation will mainly be performed by bulldozer and back-hoe shovel, while weathered rocks will be excavated by ripper-dozer. Rock materials will be broken by blasting and gathered by bulldozer. After excavation, these materials will be loaded by tractor shovel or back-hoe shovel and hauled by dump truck to the stockyard or the spoil-bank.

(3) Foundation Treatment

After excavation of the dam core trench, curtain grouting will be applied. After completion of grout holes drilled by drilling machines, cement mixed by concrete mixer will be pumped into the holes under controlled pressure by a grouting pump. To check the grouting condition, a test hole will be drilled and the grout checked by observation of lifted core. If grouting is inadequate, supplementary grouting around the same should be performed.

(4) Embankment

According to the material borrow plan, embankment materials to be transported from proposed sites will be spread by bulldozer at the specified thickness and compacted by suitable compacting machines. Impervious zone materials are strictly controlled by D-value ($=\gamma/\gamma$ wopt), and other materials by void ratio. The water content will be checked throughout the construction period and in case of a low water content ratio, some amount of water will be added to the materials by tank lorry so as to approximate the optimum water content (wopt).

Details of spreading and compaction for each zone are tabulated below.

Zone	Spreading (cm)	Compaction (passes)	Compacting Machine
Impervious	20	8	Tamping Roller
Rock	80	6	Vibration Roller
Transition	40	4	Vibration Roller
Filter	30	4	Compactor
Riprap	30	4	Compactor

(5) Construction of Appurtenant Structures

Appurtenant structures of the dam include the spillway, tunnels and others. Suitable materials excavated at the spillway will be used as embankment for the cofferdam and main dam. Remaining or unusable materials will be hauled to the spoil-bank. Concrete for these structures will be mixed at the batching plant and the crushing, washing, screening plant installed at the Project site.

2.3 Diversion Dam Construction Plan

The proposed Asue, Bakabak and Gubaton diversion dams are planned to be constructed in a single year. The construction works will mainly be conducted during the dry season to avoid flood damage. The construction method for each diversion dam is outlined below.

(1) Asue Diversion Dam

The Asue Diversion Dam is planned as a 1-span on a flat area beside the Asue River which will be excavated to the designed elevation. After completion of the dam, a new waterway will be excavated to connect the river and the dam.

(2) Bakabak Diversion Dam

The Bakabak Diversion Dam is planned as a 2-span rubber dam. A temporary cofferdam will be made with riverbed materials to enclose half of the diversion dam site. After completion of the first half of the dam enclosed by the cofferdam, river flow will be diverted to the opposite side of the river and the latter half of the dam will be constructed.

(3) Gubaton Diversion Dam

The Gubaton Diversion Dam is planned as a 5m high 1-span rubber dam. The dam will be constructed on river land near the present river course. After completion of the dam, a new waterway will be excavated and the water diverted from the existing course to flow through the dam.

An 11t bulldozer and 0.6m^3 back-hoe shovel will be utilized in excavation of each diversion dam. Concrete will be mixed at concrete plants installed in the vicinity of the proposed diversion dam sites, transported by a 1.0m^3 bucket and placed in the forms by a 10t truck crane.

2.4 Irrigation Facilities Construction Plan

Proposed canals will generally be excavated by construction equipment such as a D-7 bulldozer, with a hydro-ripper attachment. A 90HP dozer and vibrating roller will be utilized in soil compaction. Concrete works such as related facilities and especially construction of farm ditches for on-farm development, will be executed manually using a portable concrete mixer.

2.5 Drainage Works Construction Plan

Construction of new drainage canals and excavation of existing creeks will mainly be executed by a 0.6m^3 back-hoe shovel. Materials left-over from drainage canals will be utilized for the construction of irrigation canals and roads located near the site.

A jack hammer will be utilized to crush existing wiers to facilitate removal.

3. IMPLEMENTATION SCHEDULE

3.1 Pre-Project Stage

In the first year of the pre-project stage, detailed design, investigations and additional surveys will be conducted. Preparatory works such as construction of an access road, temporary works, land acquisition, etc. will commence in the second year.

During the pre-project stage, completion of a cadastral map for the design of on-farm facilities and promotion of land reform are recommended.

3.2 Construction Stage

The construction schedule is proposed in consideration of smooth implementation, effectiveness and prompt realization of the project benefit. The proposed schedule is presented hereinafter.

The dam and related facilities for water resources development of the Catipayan River will be constructed from the first year of the construction stage. The works for irrigation and drainage such as irrigation facilities, drainage facilities, roads and on-farm facilities will be scheduled from the first year to the last year of this stage.

Bakabak area and Gubaton area where irrigation water is sufficiently available without trans-diverted water from the Catipayan River will be initially developed. Along with the construction of the trans-diversion system, the central and eastern portion of the Project area will be developed step by step.

The implementation schedule for on-farm development which is connected with the schedule of construction for main facilities, is presented in FIG. XI-1. The implementation schedule for overall construction is shown in FIG. XI-2 and the realization of agricultural benefits is illustrated in FIG XI-3.

4. COST ESTIMATES

All construction costs are estimated according to current prices as of October 1984. Physical contingency was estimated at 15% of the total cost, composed of direct construction, land acquisition, equipment and engineering administration costs. Considering future cost escalation, price contingency was estimated as in the following table.