FIG.VII-19
(1 of 5)

PROPOSED IRRIGATION DIAGRAM

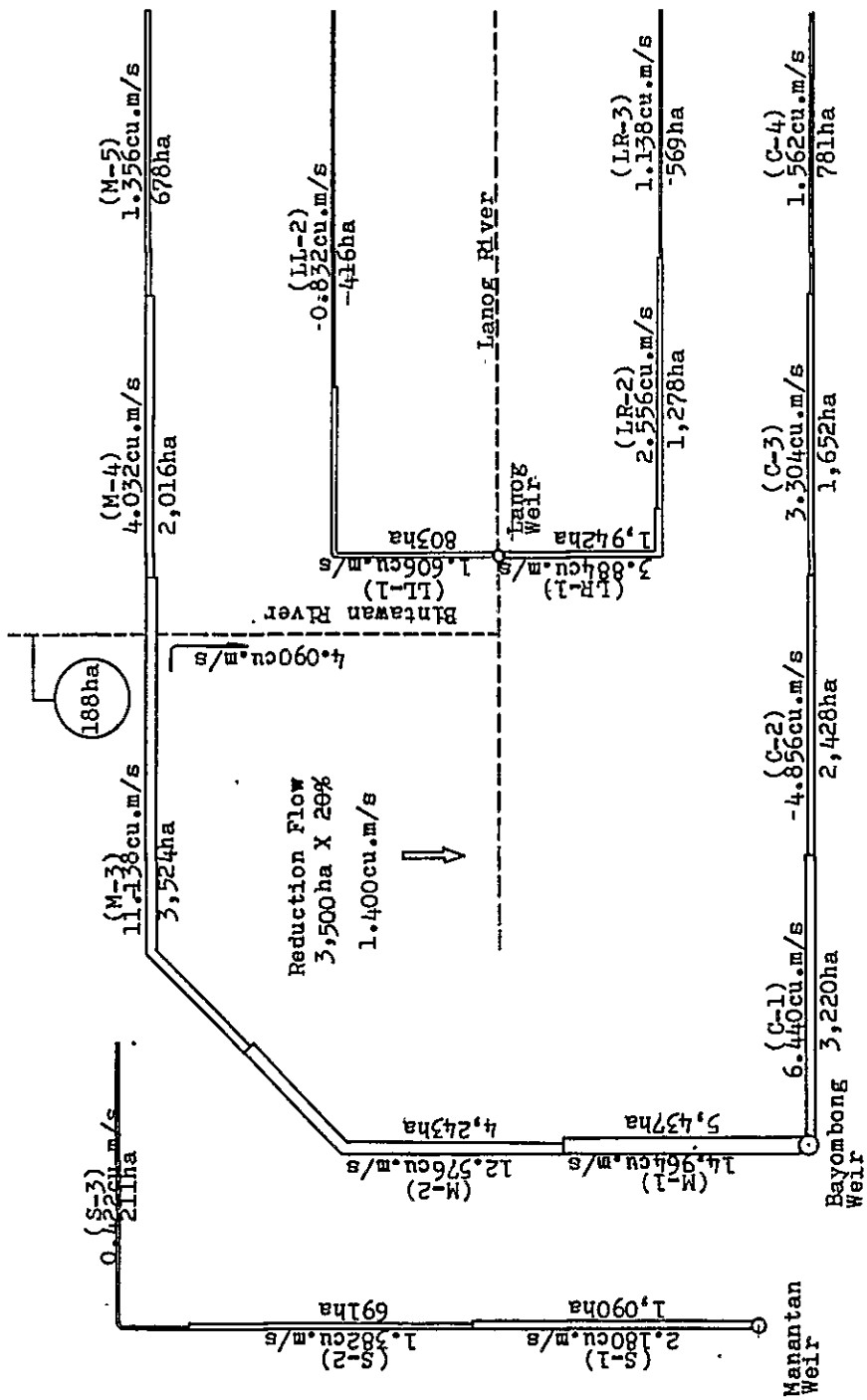


FIG.VII-19
(2 of 5)

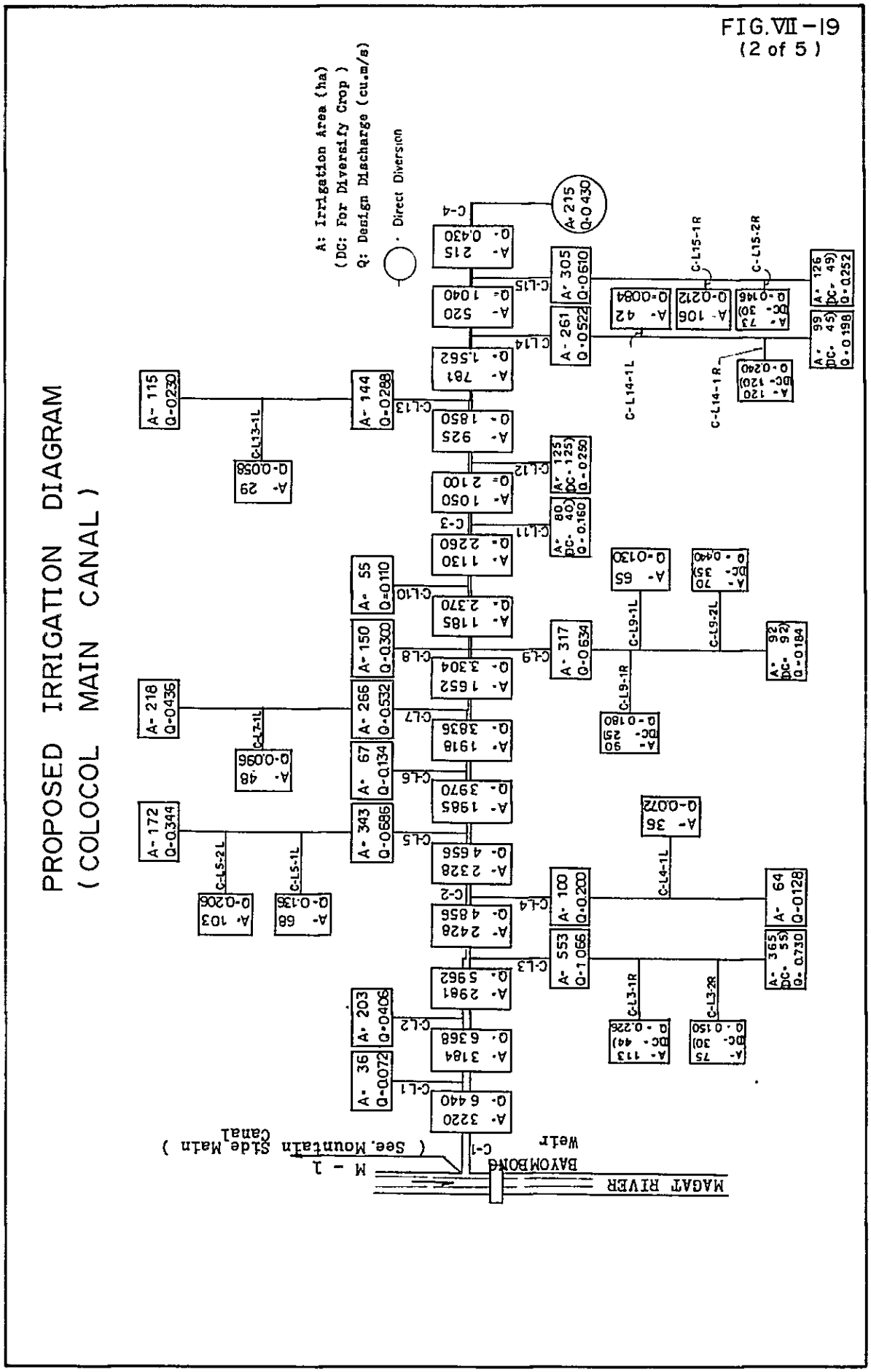


FIG.VII-19
(3 of 5)

PROPOSED IRRIGATION DIAGRAM
(MOUNTAIN SIDE MAIN CANAL)

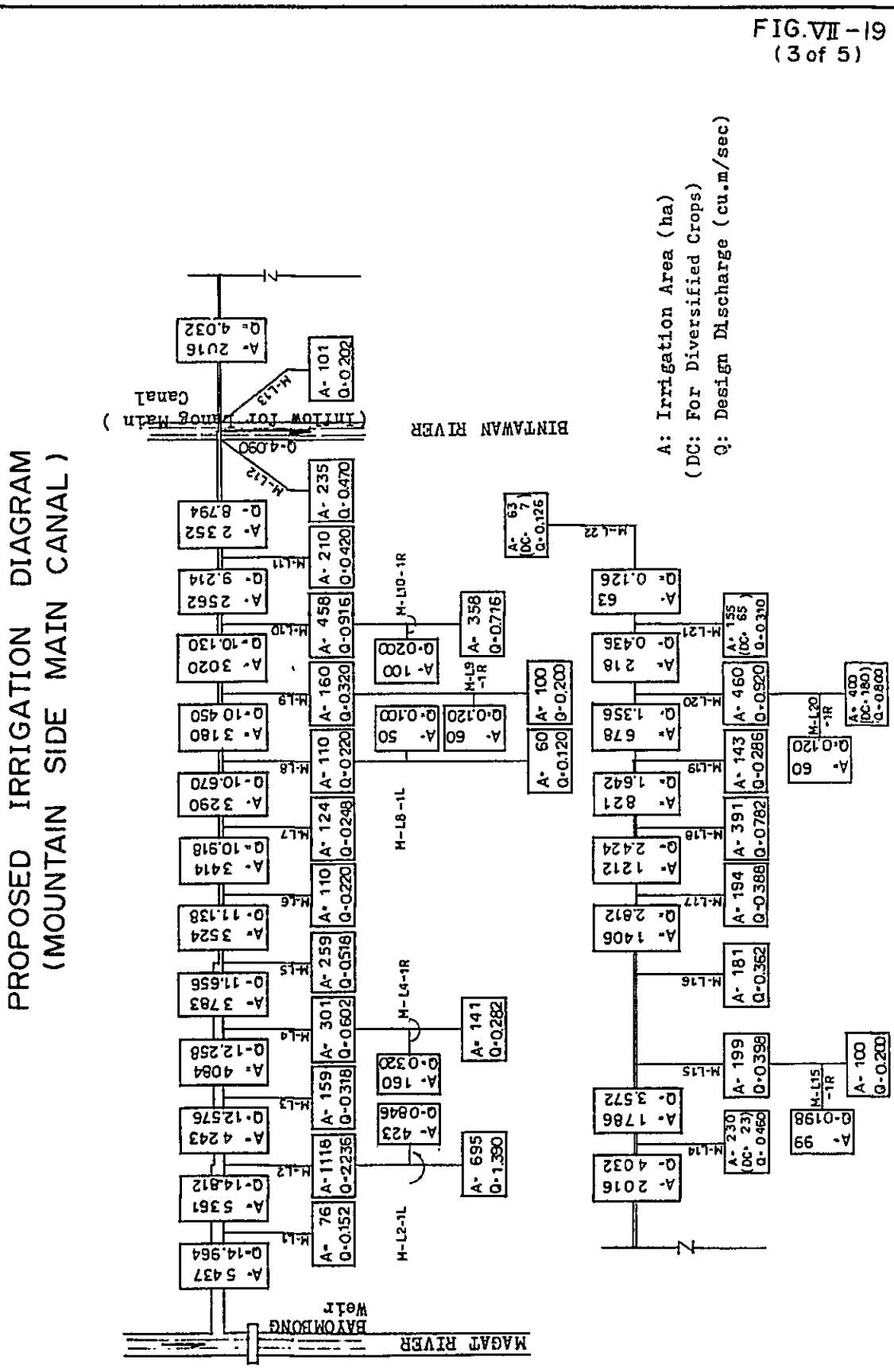
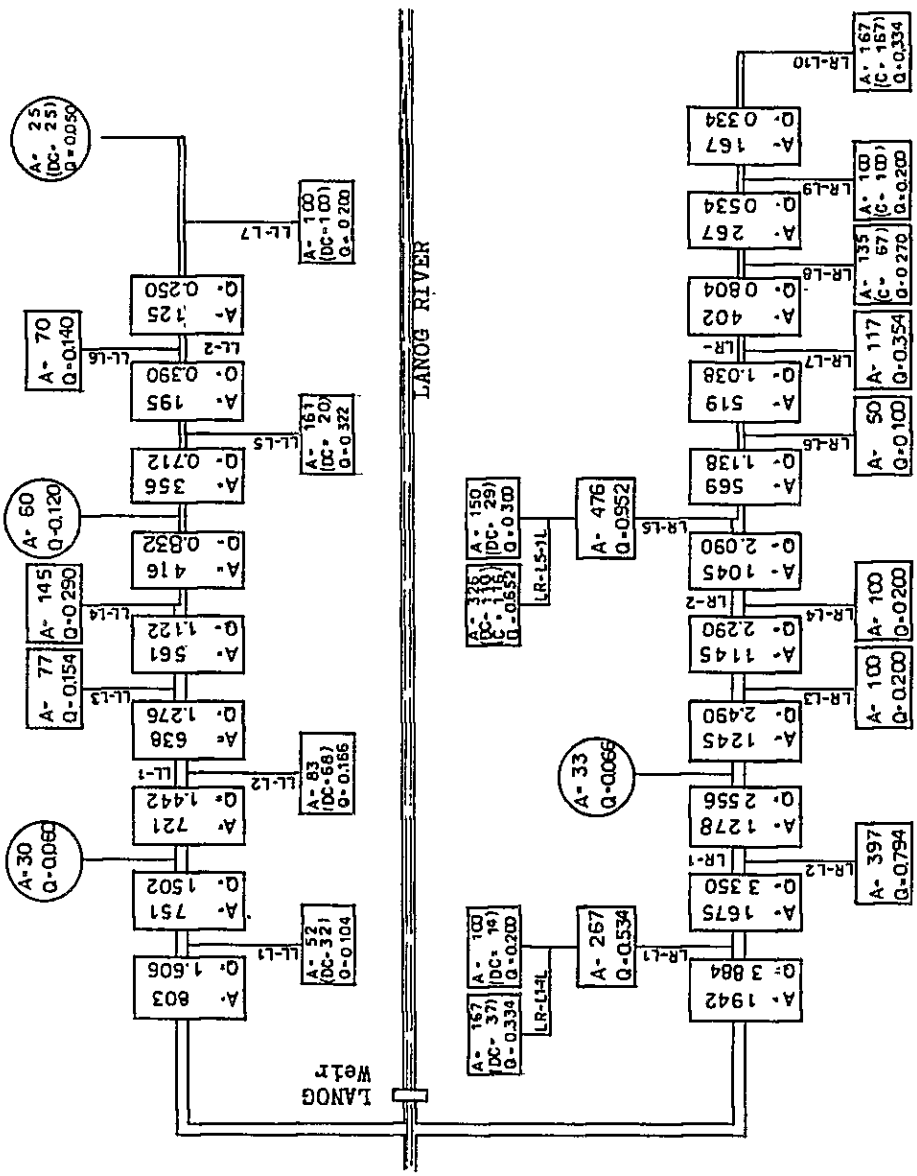


FIG. VII - 19
(4 of 5)

PROPOSED IRRIGATION DIAGRAM
(LANOG MAIN CANAL)

A: Irrigation Area (ha)
(DC: For Diversified Crops)
(C: For Corn Crop)
Q: Design Discharge (cu.m/sec)
: Direct Diversion



PROPOSED IRRIGATION DIAGRAM
(STO. DOMINGO MAIN CANAL)

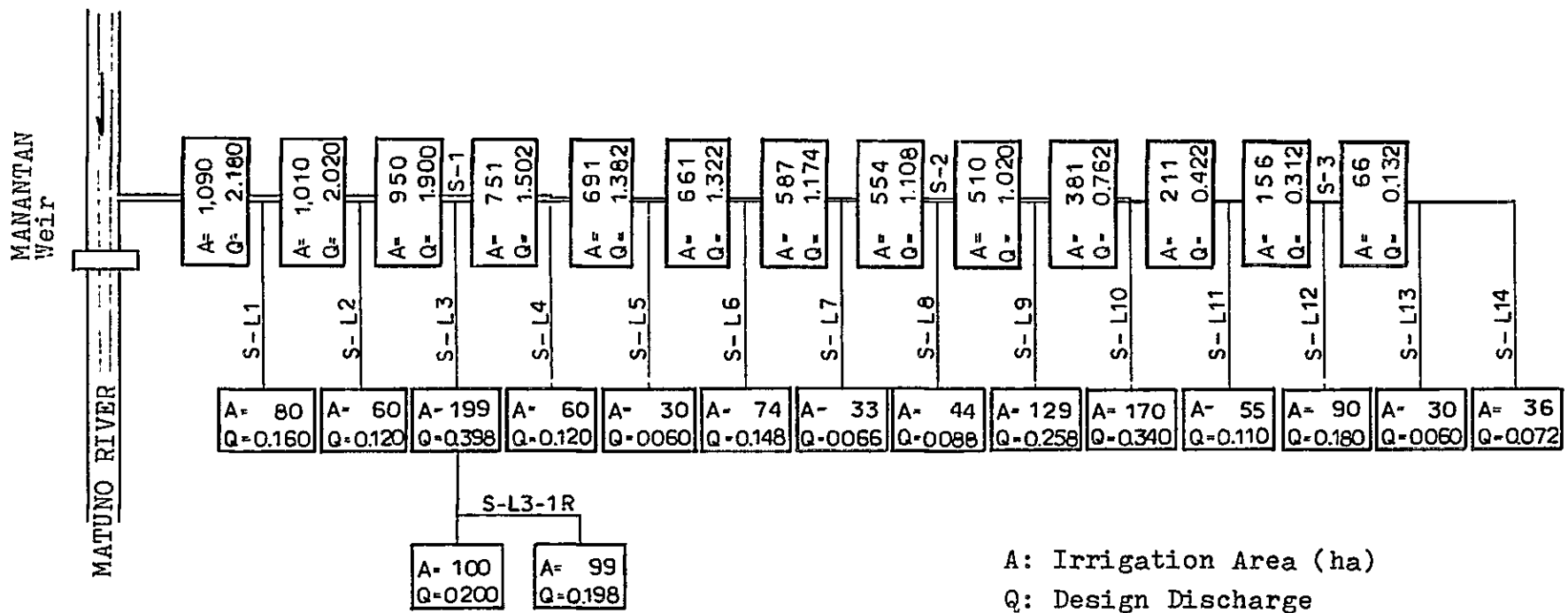


FIG. VII-19 (5 of 5)

FIG. VII-20

LOCATION OF EXISTING TURNOUT OF COLOCOL CIS

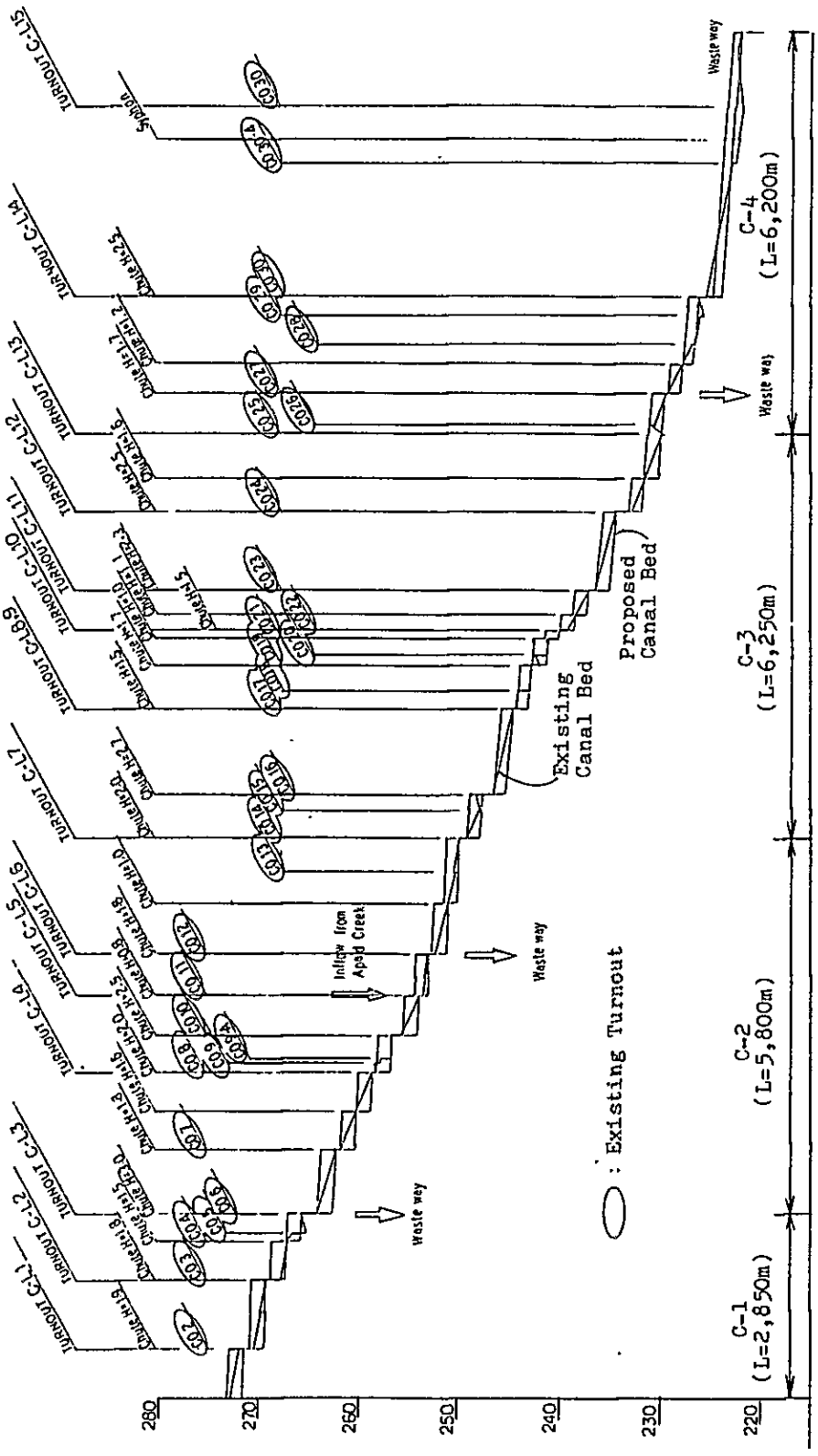


FIG. VII-21 (1 of 2)

CROSS SECTION OF COLOCOL CANAL IMPROVEMENT

SCALE 1:200

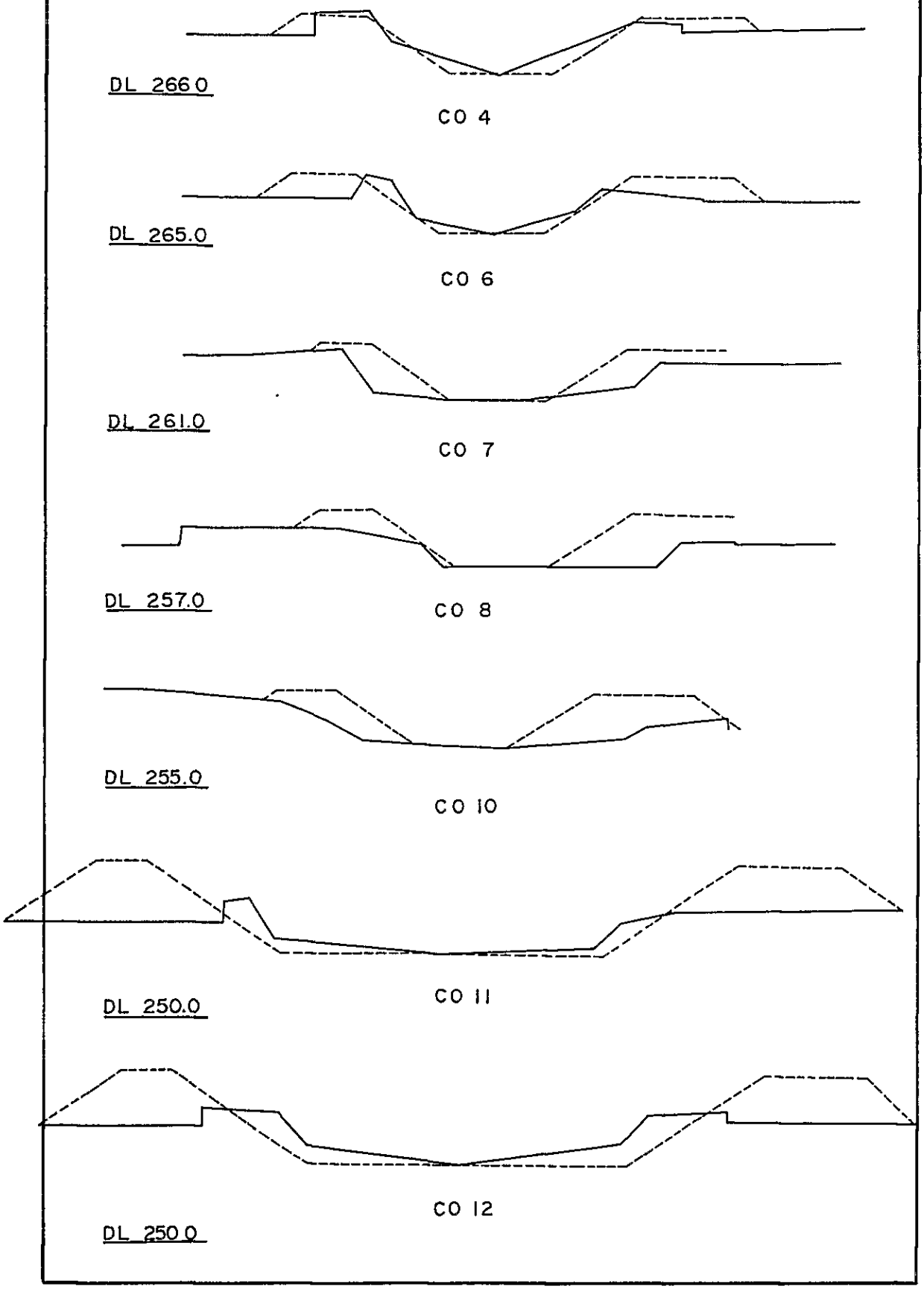


FIG. VII-21 (2 of 2)

CROSS SECTION OF COLOCOL CANAL IMPROVEMENT

SCALE 1 200

DL 2470

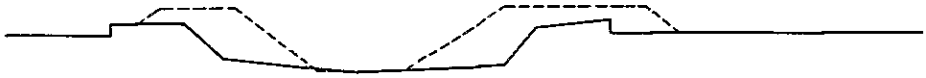
CO 14

DL 2430

CO 17

DL 238.0

CO 22



DL 2320

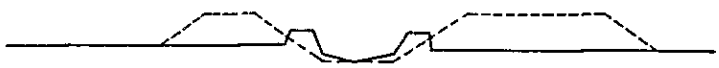
CO 24

DL 228.0

CO 27

DL 2240

CO 30



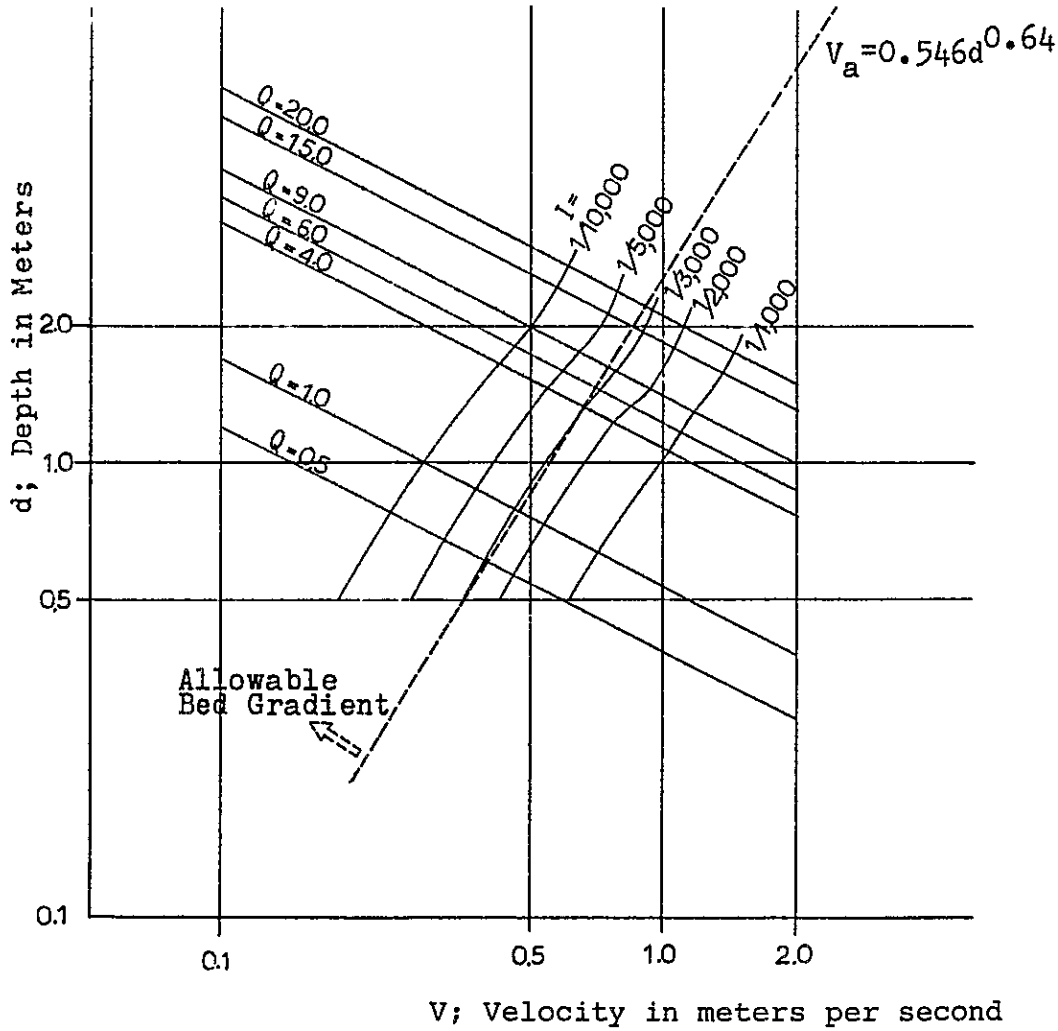
DL 2200

CO 30-4

FIG. VII-22

CANAL BED SLOPE / FLOW VELOCITY RELATION

Discharge (cu.m/s)	B/d Ratio
- 4.0	2.0
4.0 - 9.0	2.5
9.0 -	3.0



ALIGNMENT OF NEWLY PROPOSED DRAINAGE CANAL

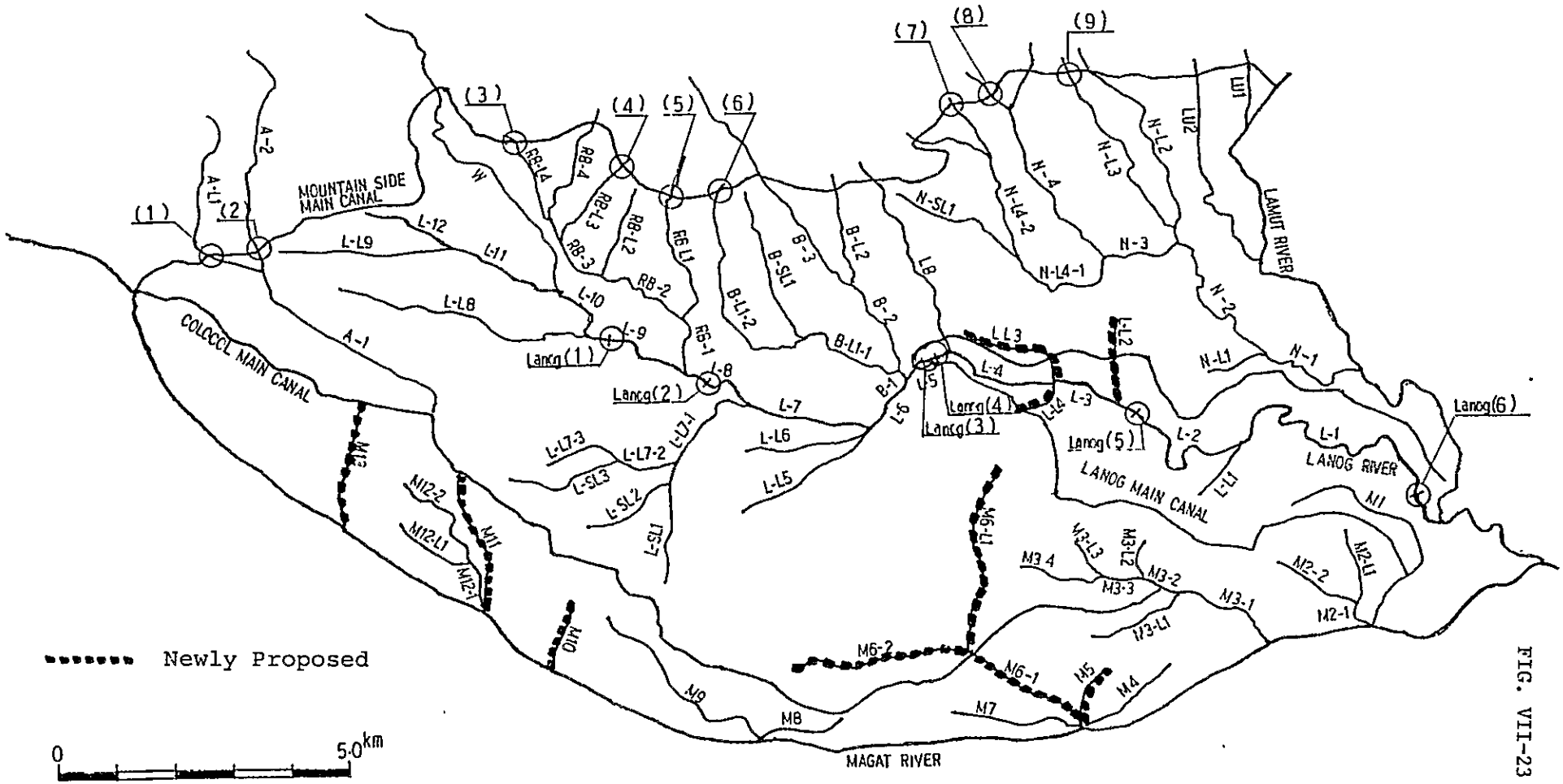
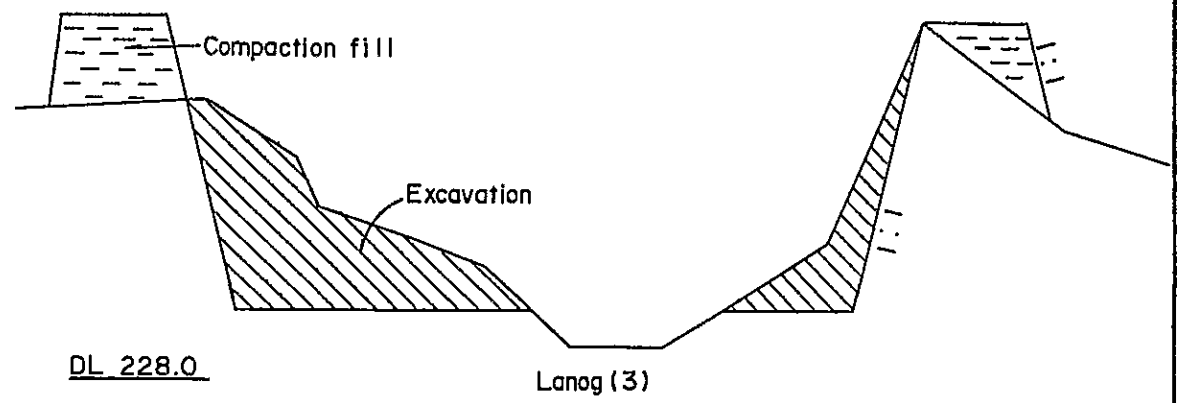


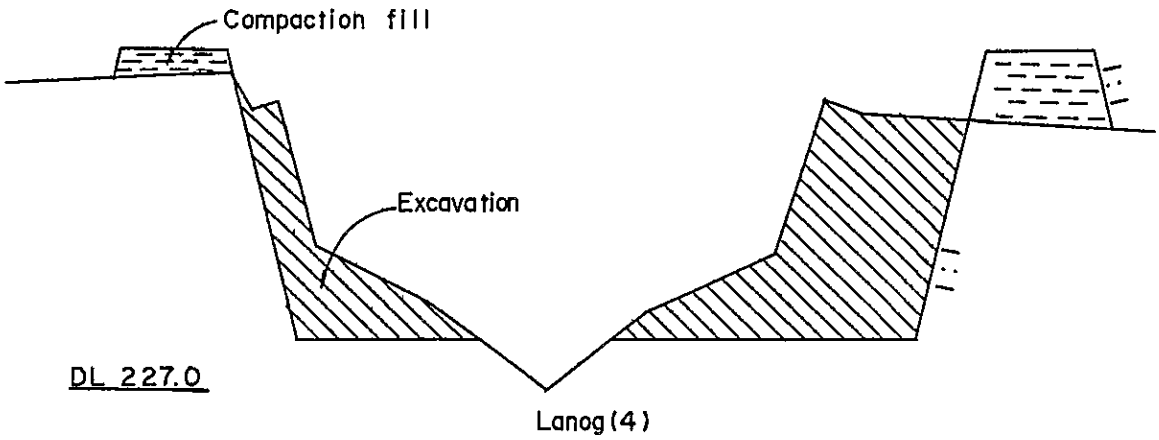
FIG. VII-23

FIG.VII-24

CROSS SECTION OF LANOG RIVER IMPROVEMENT

SCALE H 1:400
V 1:100





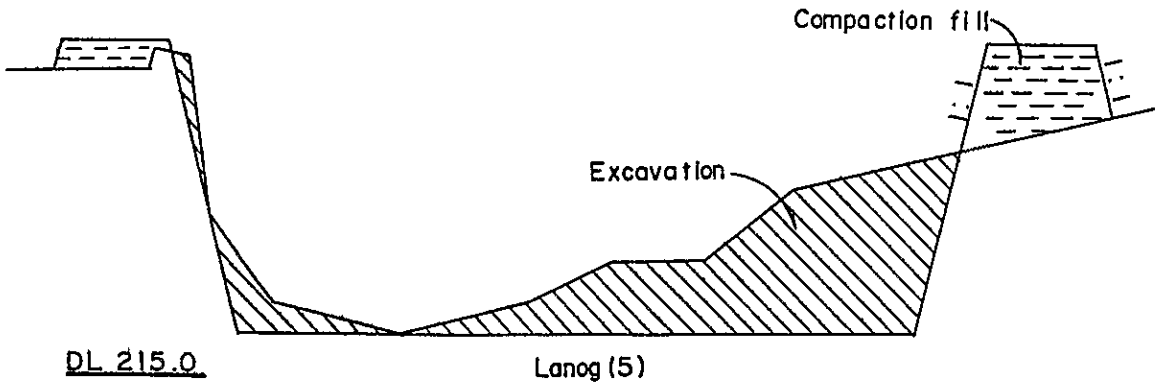


FIG.VII-25

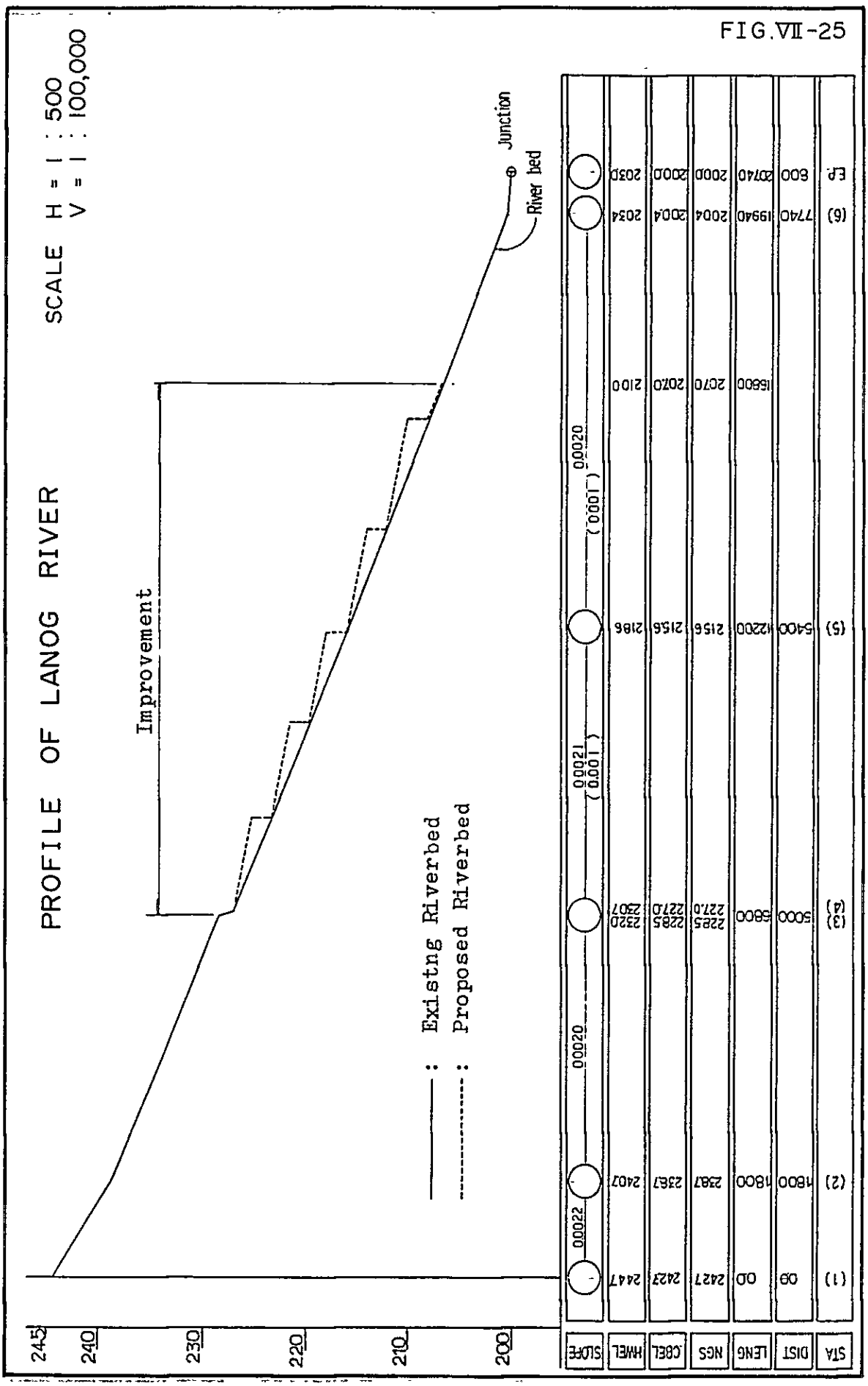

PROFILE OF LANOG RIVER
SCALE H = 1 : 500
V = 1 : 100,000
Improvement
Junction
River bed
Existng Riverbed
Proposed Riverbed
245
240
230
220
210
200
STA
DIST
LENG
NGS
CBEL
HWEL
SLOPE
E.P.
(6)
(5)
(4)
(3)
(2)
(1)
0.0020
0.0021
0.0022
(1000)
(600)

FIG.VII-26

PROPOSED DRAINAGE DIAGRAM

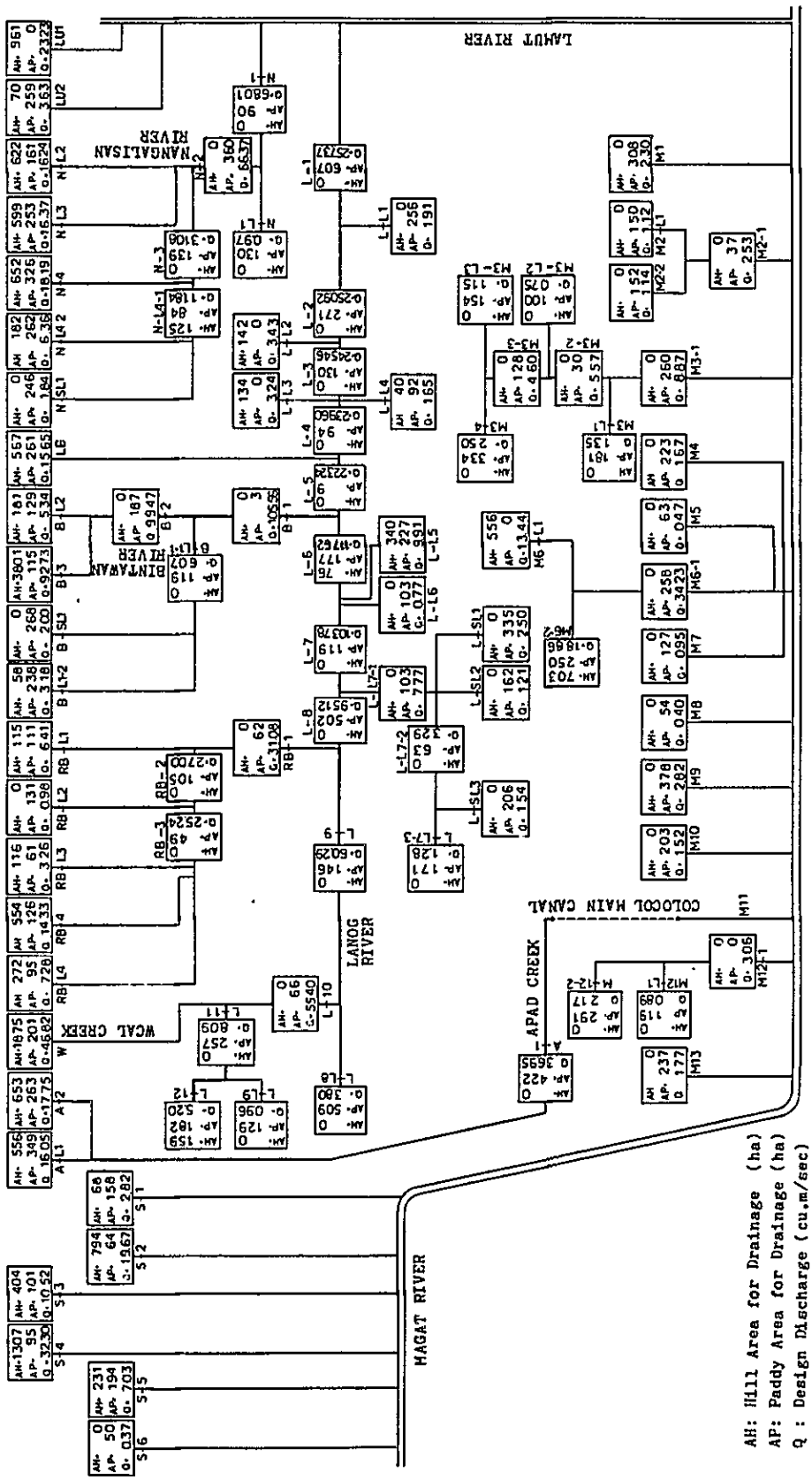


FIG. VII-27

DIMENSIONS OF DRAINAGE CANAL

Type	B (m)	H (m)	V (m/s)	I	Fb (m)
AA	8.0	3.0	1.1	0.00038	1.05
A	3.0	3.0	1.1	0.00060	1.05
B	2.1	2.5	1.0	0.00067	0.95
C	1.9	2.3	1.0	0.00075	0.90
D	1.5	1.8	1.0	0.0010	0.75
E	1.2	1.5	1.0	0.0013	0.60
F	1.1	1.3	1.0	0.0016	0.55
G	0.8	1.0	1.0	0.0023	0.40
H	0.7	0.8	1.0	0.0030	0.35

1) $n = 0.03$

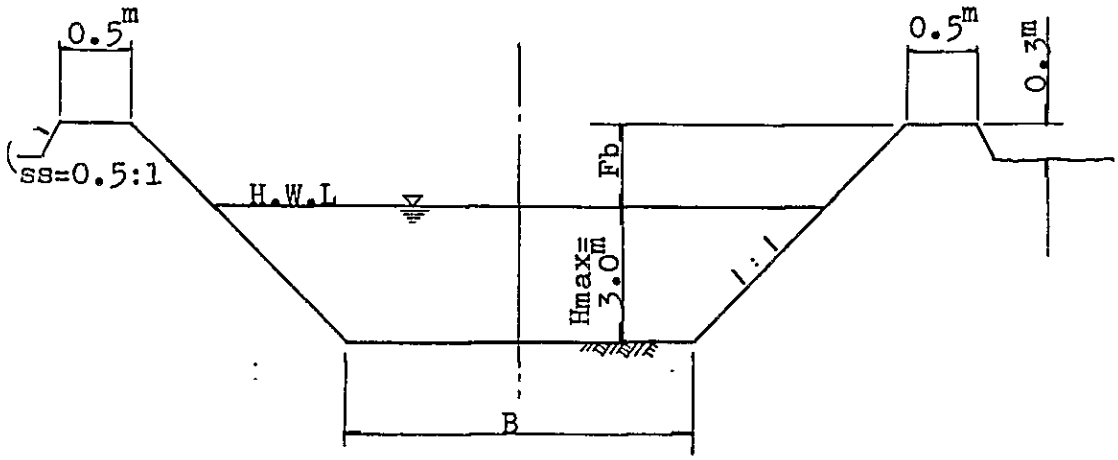
2) $B = 2H(\sqrt{1+m^2}-m)$ $m=1.0$ --> $B=0.828H$

3) Free board

$Fb = 0.25H+0.3$ $(H \geq 2.0)$

$= 0.4H$ $(H<2.0)$

4) $V = \text{Max}(0.546D^{0.64}$ or, 1.0^{m})



APPENDIX I - VIII

FLOOD CONTROL

APPENDIX I-VIII

FLOOD CONTROL

TABLE OF CONTENTS

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LIST OF FIGURES

APPENDIX I-VIII

FLOOD CONTROL

1. RIVER BASIN

The Magat River with a catchment area of 5,008km^2 is a tributary of the Cagayan River, located in the southwestern most sector of its basin. As shown in FIG. VIII-1, the Magat River basin consists of 3 lesser basins, namely, those of the Matuno, Santa Cruz and Santa Fe rivers situated upstream.

After gathering velocity from these 3 tributaries, the Magat River passes the Batu bridge, flowing along the Project area through Bayombong, Solano and Bagabag on the left bank side. At 35.2km downstream from the Batu Bridge, the Magat joins the Lamut River, flows along the narrow valley of the boundary of Ifugao and Isabela to the Magat Dam 83.7km further downstream from the Batu Bridge and finally flows into the Cagayan River. The inundated area upstream from the said Magat Dam extends to the confluence of the Lamut and Magat rivers.

The Project's service area including the above mentioned cities, is located on the level plain of the Magat's left bank in Nueva Vizcaya Province. The same is representative agricultural land with an area of about 200km^2, and a population of about 99,000.

The Uddiawan and Bintawan rivers originate from the mountains in the northwestern portion of the Project area, flowing eastward and northeastward finally joining the Lamut River near Sta. Lucia. The catchment area of the left bank of the Magat River from the confluence point of the Matuno River to the confluence point of the Lamut river is 636km^2.

The right bank of the Magat River from the confluence point of the Santa Fe and Cruz rivers to the confluence point of the Lamut River faces the mountain slopes. From the latter, small streams flow directly into the Magat River, with a total catchment area of 462km^2.

2. RIVER CONDITION

2.1 General Condition

(1) Matuno River

The Matuno River originates at Mt. Pulog with an altitude of EL. 2,800m near Encatang Guinao, first flowing northward, and then southward into the Magat River near Barangay Sto. Domingo. Total length of the river up to confluence with the Magat River is 81km with a catchment area of 593km^2.

The basin is well-forested, and is thus assumed to have superior water holding capacity. The river forms a valley and, as shown in FIG. VIII-2, after passing through the mountains has a bed slope of about 1/40 near the proposed dam site.

As mentioned in APPENDIX I-I, METEOROLOGY AND HYDROLOGY, the average daily discharge at Bante gauging station from 1957-76 was 37.85m^3/s, while the observed peak discharge on the daily basis was 861.0m^3/s in November 1967. Accordingly, actual peak discharge is assumed to be larger than the above value.

(2) Santa Cruz River

The Santa Cruz River has a semicircular catchment area of 282km^2 stretching between the basins of the Matuno and Santa Fe rivers. The river gathers water from the eastern slope of the mountain range which extends from Tabungan to Santa Fe, and the total stream length to confluence with the Santa Fe River is about 50km.

The basin is devastated, and from its semicircular shape, the river is assumed to carry relatively coarse bed material. In the downstream portion near the confluence with the Santa Fe River, there is roughly 200ha of cultivated area with an average width of about 500m.

(3) Santa Fe River

The Santa Fe River basin has a watershed in the vicinity of Dulton Pass. The main stream and three other principal

tributaries catch water from the basin of 626km^2 at the confluence with the Santa Cruz River. The river with a total stream length of 57.5km, after steep rapids before the municipal Santa Fe, flows consistently with a bed slope of 1/110-1/450 to the confluence with the Santa Cruz River.

The basin is devastated with little vegatation, and sediment from the upstream area is presumably deposited in mid and lower stream. Along the mid and lower stream, 600-1200m width of land is cultivated.

(4) Magat River

The Magat River has a riverbed gradient of 1/370 on the average for a 40km section from Batu Bridge to Bagabag. The Magat River flows down mainly in the form of a primitive river; mountains are close to the river in many of the sections along the right bank whereas the left bank is low and level, and the increased discharge caused by typhooons often brings about floods in the Project area.

The river has an average width of about 600m along the Project area from Bambang to Bagabag except for a few narrow parts. In the short run, changes in the river route resulting from floods are limited within the floodway. In the long run, however, the floodway itself has changed the shape owing to erosion and deposits at many points as shown in FIG. VIII-3.

(5) Lamut River

The Lamut River flows through the mountainous district to the east of the Matuno River basin. It originates near Ubuol and has a total length of 44km to the confluence with the Magat River with a catchment area of 303km^2 excluding the Bintawan and Lanog river basins.

After leaving the mountainous district around Panupnupan, the right bank side of the river around Villanverde forms the northern end of the Project area, with an elevation of 240-205m above sea level, while the left bank side is covered by gently rolling hills.

(6) Other Tributaries

From the western slope of the Project area, about 20 streams and creeks flow directly into irrigated land. Many of these streams dry up during the dry season, although in the wet season heavy rainfall brought by typhoons causes minor overflows in downstream areas.

2.2 River Channel of Magat River

The Magat River forms the alluvial flood plain area on the left bank extending from the Batu Bridge to the confluence with the Lamut River. It forms a primitive flow channel through the area, while frequently changing its route after floods with an average meandering range width of 600m.

The Magat River along the area along the area has no cross-sectional control point and has never been subjected to a systematic cross-sectional leveling. The Team therefore carried out a cross-sectional leveling, assisted by NIA, at the points shown in FIG. VIII-4 to collect fundamental data necessary for analysis. The results for the main sections are illustrated in FIG. VIII-5.

No river training program has ever been developed, and as shown in FIG. VIII-4, the distinction between minor and major bed is not known. Levees and revetments are limited to parts along trunk roads and around urban areas. Bank protection works are now under construction and planning at main points along the river by MPWH. Bank revetments already executed and in planning along the Magat River within the Project area are illustrated in FIG. VIII-4.

Typhoons often cause overflow of the Magat River. One of the causes for the increased scale of these overflows is the rise in the riverbed elevation, which is attributable to the deposits of sand and gravel carried from the devastated upstream areas, which in turn result in decreased flow capacity through the actual river channel cross-section. Although not quantitatively expressed, this rise in the riverbed of the Magat River along the Project area is reported in the "Report on Floods in Cagayan River Basin" by MPWH, N.V., 1980.

3. FLOOD DAMAGE

3.1 Flood Condition

The sub-basin of the Magat River from near the Batu Bridge to the confluence of the Lamut River is the agricultural development area under the present Project, and has a gradient of about 1/300 in general from upstream to downstream.

National Highway No. 5 from Manila to Cagayan Valley runs along the Magat river at about 300-2,000m distance from the same. Most urban districts within the Project area have developed along this highway. Out of these Bayonbong and Solano have about 30,000 and 37,000 residents respectively.

For the inhabitants of the Project area, the Magat River is a major source of supply of water for irrigation and living purposes, and at the same time, parts of this area yearly suffer from floods. Most recently, these parts were seriously damaged by typhoon Aring in November 1980: the discharge at that time is estimated at Batu Bridge to be about 3,600m^3/s, as is analyzed in APPENDIX I-I, METEOROLOGY AND HYDROLOGY. The flooded area is conjectured to have covered the range shown in FIG. VIII-4, judging from the results of a flood mark survey carried out by the Team.

According to observation at the site, floods in the Project area demonstrate a storage type pattern in which overflow from non-levee portions of the Magat River, inflow through existing CIS inlets, and defective drainage of water coming from the mountainous area to the northwest of the area cause floods.

Through the investigation on damages and the flood mark survey conducted through hearings at the site regarding floods, a particularly strong demand for flood control was found in Santo Domingo downstream basin, Bonfal Proper and Quirino along the Magat River.

Although the Project area has constantly been subjected to flooding and people are hoping for successful flood control, there are almost no available records on flood water level, discharge, depth and period of flooding and no systematic data regarding actual damages. The

estimated amount of damages is calculated using the results of the flood damage survey carried out by the Team, data collected from the authorities concerned, and the results of hydrological analysis.

3.2 Estimation of Flood Damages

The estimated damage is calculated by discharge as follows:

(1) Project Control Point

Point at the Batu Bridge across the Magat River

(2) Damageless Discharge

2,000m^3/s as the maximum non-overflow discharge based on non-uniform flow calculation

(3) Objected Discharges

3,000, 5,000 and 7,000m^3/s

(4) Ground Height

Derived from a 1/4,000 topographic map and the results of a cross-sectional leveling of the river

(5) Flooding Area

The flood ranges for the various objected discharges are estimated by non-uniform flow calculations

(6) Property Survey

The breakdown of rural and urban household properties derived from the results of Barangay survey is shown in TABLE VIII-I.

(7) Estimated Amount of Damages:

TABLE VIII-2 gives estimated flood damage to household properties, TABLE VIII-3 shows that to agricultural products, and TABLE VIII-4 shows that to public facilities, for each of the

objected discharges. The amount of damages to public facilities given in the Tables were estimated from the data on damages caused by typhoon Aring, made available to the Team through hearings with MPWH, N.V. and N.V. Provincial Governments. Indirect damages equal to 10% of the above mentioned damages are estimated to cover such losses as interruption of traffic along Highway No. 5 and of business activities.

Judging from the results of these calculations, estimated damages for individual discharges with the Batu Bridge as the control point are as shown in TABLE VIII-5 and FIG. VIII-6.

4. FLOOD CONTROL PLAN

4.1 Consideration for Flood Control Planning

The Team has studied flood control by the reservoir on the Matuno River and flood protection by embankments on the left bank of the Magat River. If drafting a plan only for flood control in the Project area, it would be ideal to select the most effective plan from among combinations of dams on the Matuno, St. Cruz and St. Fe rivers with river training plans. However, since the present survey's object is to select an effective and feasible multi-purpose plan for agriculture, power generation and flood control, and the survey schedule was also limited, a flood control plan along the Matuno and the Magat rivers was conceived.

4.2 Flood Control by Reservoir

The following paragraphs discuss flood regulation capacity in the reservoir of the proposed Matuno Dam.

4.2.1 Standard Flood

With reference to the MPWH flood control scheme, the standard flood is assumed to have a 100-year return period and flood control should correspond to probable years of occurrence up to the standard flood. The 100-year return period flood is shown in FIG. I-15 and 16.

Hourly discharge for the individual probable years of occurrence at Bante and Batu points are shown in TABLE VIII-6.

4.2.2 Average Annual Damage Reduction

Results of calculations for flood control capacities of 10, 20, 30 and 40 MCM imparted to the proposed Matuno dam, with discharge rule at a constant rate and a constant flow volume, as tabulated in the Data Book, are summarized in FIG. VIII-7. The annual damage reduction was estimated by scale of flood control capacity in the reservoir and by discharge obtained on the basis of the above figures, (i.e., the difference between damage caused by natural discharge and that caused by controlled discharge, as shown in TABLE VIII-7 and 8), and the results are summarized below.

Surcharge Capacity (MCM)	Average Annual Damage Reduction ($\times 10^6$ Pesos)
10	4.1
20	6.9
30	8.9
40	9.3

The relationship between the storage capacity and the average annual damage reduction, as derived from these calculations, is shown in FIG. VIII-8.

4.2.3 Evaluation

The average annual damage reduction thus calculated forms the annual benefit, which in the case of flood control by the Matuno Dam is rather small when compared to the scale of the reservoir. The reason is that the extent of the flood controlling effect of the proposed Matuno Dam is as short as 35km along the Magat River from the confluence of the Matuno and Magat rivers to the confluence of the Lamut River. The basin downstream of the confluence of the Lamut River is the inundated area of the Magat Dam reservoir, while the right bank of this 35km range is closest to the mountains leaving only a very limited benefit area.

When the proposed Matuno Dam project is viewed from a standpoint of effective use of funds and the national economy, on the other hand, it is necessary to compare the economic merits with those of hydropower in a concurrent relationship of the storage capacity of the dam. More particularly, when Matuno Dam capacity is selected, the possible annual benefits between flood control and power generating should be compared.

The reduction of capacity, changes in average annual energy production, and benefits resulting from a change in the high water level of the power generating capacity of Matuno Dam are as shown in the following table. These figures are plotted over FIG. VIII-8 representing the scale of capacity and the average annual damage reduction curve of floods.

NHWL (EL.m)	Effective Volume (MCM)	Annual Average Energy (GWh)
520.0	97.6	550
510.0	64.0	524.5
500.0	36.0	500

As shown in FIG. VIII-8, for any scale of flood controlling capacity, the reduction of benefits for power generation is always larger than the benefit of resultant flood reduction. It is therefore decided not to provide flood control capacity in Matuno Dam. It is however possible to control floods to some extent by operating the gates with the use of vacant sections of the power generating capacity. This will be described later in VOLUME 3, APPENDIX II.

4.3 River Embankment Plan

4.3.1 Basic Plan

As has been concluded from the study described so far, flood control via the reservoir will not be adopted in the present Project, then river embankment has been considered. The plan covers embankment

alone excluding river channel training. Study was made for embankments to be applied in Stage I development of the Project where the effect would ensure successful agricultural development.

The Team examined the most effective alignment considering the existing and under planning levees by MPWH.

4.3.2 Embankment Plan

(1) Design Flood

With regard to design flood, a 50-year return period discharge is assumed, with reference to the existing plan of MPWH and the cross-sections of the existing banks. As analized in APPENDIX I-I, METEOROLOGY AND HYDROLOGY, a flood discharge of Q = 5,860m^3/s at Batu Bridge corresponds to a 50-year return period.

(2) Design Criteria

i) Heights and cross-sections of the existing banks are based on a 1km interval cross-sectional survey carried out by NIA.

ii) Longitudinal sections are based on the above-mentioned cross-section and 1/4,000 topographical maps prepared by NIA.

iii) Hydrographic calculations follow the varied flow method with Manning's roughness coefficient "n" at 0.028.

iv) The bank top width is 6.0m.

v) The bank slope is 1:2.0 for both sides of the river.

vi) The riverside slope is protected by gabion to the level of design flood.

vii) The freeboard is 1.5m.

viii) Backwater of the Magat Diverison Dam has been considered.

The standard cross-section, designed by taking into account the above criteria, is shown in DRAWINGS.

(3) Alignment

To study investment efficiency, it was decided to prepare a construction plan of banks of the following two points on the left bank of the Magat River, as shown in FIG. VIII-4.

i) a total of 6,100m from 700m downstream from Batu Bridge to the proposed Bayombong Diversion Dam; and,

ii) 7,400m from 1,070m downstream from the proposed Bayombong Diversion Dam to a point near Curipang (nearly 23km cross-section point).

A longitudinal section of the plan is presented in the DRAWINGS.

4.3.3 Construction Cost

Project works and construction costs are shown in APPENDIX I-XII, IMPLEMENTATION SCHEDULE AND COST ESTIMATE. Principal Project works are as follows:

- Length	13.5km
- Embankment	468 x $10^3 m^3$
- Gabion	31.6 x $10^3 m^3$
- Drainage Culvert	20 units

The total Project cost including civil works, land acquisition, contingency, engineering and administration would amount to 50 million Pesos.

4.3.4 Project Benefits

In Barangay, the beneficiaries of the present embankment project would include Sto. Domingo, Vista Hills, Busilack, Bayombong, Bonfal East, Bonfal Proper, Quirino, Roxas and Curifan. From among the damages calculated under 3. FLOOD DAMAGES above, those to household properties and agricultural production are calculated from the ratio of the total benefitted area to the total area damaged in the barangay. For public facilities, flood protection measures are not included in the benefits brought about by embankment. It is therefore excluded from the amount of damages. The damages for individual discharges resulting from embankment are as shown in TABLE VIII-9 and FIG. VIII-9.

Estimated annual average damage reduction, calculated in TABLE VIII-10 by multiplying the estimated damage for each discharge smaller than the design flood discharge of Q = 5,860m^3/s by the probability of occurence, is ₱7.52 x 10^6.

4.3.5 Stepwise Plan

(1) Plan Formulation

Although the flood embankment plan with a 50-year return period flood is proposed as a basic plan, the Team has also studied the possibility of introducing a stepwise implementation plan to create immediate benefit and to develop the most practicable approach. In due consideration of the proposed embankment's scale, two steps for construction are considered. At the second step as the final target the proposed basic plan would be implemented, while for the first step the Team studied three alternative plans according to scale of design flood as shown below.

Plan	Design Flood Return Period	Annual Benefit (x 10^6 Pesos)	Construction Cost (x 10^6 Pesos)	Discounted Cost (x 10^6 Pesos)	B/C
1	30-year	7.28	47.5	4.79	1.52
2	10-year	6.22	38.8	3.91	1.59
3	5-year	4.88	35.8	3.61	1.35

The results show that the plan for the design flood with a 10-year return period would be economically most advantageous. The plan with 10-year design flood of 4,700m^3/s is therefore proposed as the first step of the proposed Project.

(2) First Step Plan

The outline of the first step is as follows:

- Design Flood	10-year return period discharge 4,700m^3/s
- Freeboard	1.2m
- Alignment	same as basic plan (total 13.5)
- Longitudinal Section	as shown in the DRAWINGS
- Embankment	315 x 10^3m^3
- Direct Construction Cost	US$ 2.83 x 10^6 (breakdown in TABLE XII-9)
- Annual Benefit	₱0.622 x 10^6

TABLE VIII-1

HOUSEHOLD PROPERTY

I T E M	A M O U N T (Pesos/Household) Rural	Urban
Residential/commercial		
Building structure	₱ 8,233.00	₱ 8,794.00
Contents in building	5,904.00	8,603.00
Vehicle	1,213.00	2,892.00
Water supply related facilities	234.00	160.00
Agro-related facilities	6,230.00	3,743.00
Livestock	1,289.00	1,008.00
T O T A L	23,103.00	25,200.00

FLOOD DAMAGE TO HOUSEHOLD PROPERTY

Barangay	No. of Households	Q = 7000(m^3/s) Inundated Depth (cm)	Q = 7000(m^3/s) Damage ($x10^3$ ₱)	Q = 5000(m^3/s) Inundated Depth (cm)	Q = 5000(m^3/s) Damage ($x10^3$ ₱)	Q = 3000(m^3/s) Inundated Depth (cm)	Q = 3000(m^3/s) Damage ($x10^3$ ₱)
1. Sto. Domingo	332	-	-	-	-	-	-
2. Vista Hills	205	100	142.1	67	142.1	26	142.1
3. Busilak	195	-	-	-	-	-	-
4. Magsaysay	-	-	-	-	-	-	-
5. Bayombong	2977	66	2,250.1	40	2,250.1	13	2,250.1
6. Magapuy	83	73	57.2	46	57.2	15	57.2
7. Paitan	292	34	202.4	9	-	-	-
8. Bonfal East	267	58	185.0	25	185.0		-
9. Bonfal Proper	527	69	365.2	45	365.2	-	-
10. Quirino	1033	122	715.9	92	715.9	52	715.9
11. Roxas	780	85	540.5	65	540.5	36	540.5
12. Curifang	344	84	238.4	51	238.4	7	-
13. Dadap	153	2	-	-	-	-	-
14. Bangar	105	41	72.8	2	-	-	-
15. Pogosin	-	-	-	-	-	-	-
16. Tuao	464	21	321.6	-	-	-	-
17. Baretbet	363	74	251.6	31	251.6	-	-
T O T A L			5,342.8		4,746.0		3,705.8

TABLE VIII-3

FLOOD DAMAGE TO AGRICULTURAL PRODUCTION

Barangay	Cultivated Area (ha)	Q = 7000(m^3/s) Inundated Depth (cm)	Q = 7000(m^3/s) Damage ($x10^3$₱)	Q = 5000(m^3/s) Inundated Depth (cm)	Q = 5000(m^3/s) Damage ($x10^3$₱)	Q = 3000(m^3/s) Inundated Depth (cm)	Q = 3000(m^3/s) Damage ($x10^3$₱)
1. Sto. Domingo	P:300	-	-	-	-	-	-
	c: 7	-	-	-	-	-	-
2. Vista Hills	P:150	100	387.2	67	251.1	26	-
	c: 20	100	44.1	67	30.2	26	-
3. Busilak	P: 70	-	-	-	-	-	-
4. Magsaysay	P:220	-	-	-	-	-	-
5. Bayombong	P:200	66	313.9	40	274.7	13	-
6. Magapuy	P:100	73	157.0	46	137.3	15	-
7. Paitan	P:350	34	480.7	9	-	-	-
	c: 50	34	58.3	9	-	-	-
8. Bonfal East	P: 70	58	109.9	25	-	-	-
9. Bonfal Proper	P:500	69	392.4	45	343.4	-	-
10. Quirino	P:250	122	605.0	92	392.4	52	392.4
11. Roxas	P: 75	95	117.7	65	117.7	36	103.0
12. Curifang	P:250	84	392.4	51	392.4	7	-
	c: 10	10	22.0	51	15.1	7	-
13. Dapdap	P:200	2	-	-	-	-	-
14. Bangar	P:150	41	206.0	2	-	-	-
15. Pogonsin	P:200	-	-	-	-	-	-
16. Tuao	P:430	21	-	-	-	-	-
17. Baretbet	P:200	74	313.9	31	274.7	-	-
18. San Pedro	P: 92	-	-	-	-	-	-
	c: 60	1.6	132.2	1.6	132.2	0.56	40.7
19. Villa Colloma	P:360	-	-	-	-	-	-
	c:100	1.6	220.3	1.16	220.3	0.56	151.2
20. Sta Lucia	P:300	-	-	-	-	-	-
	c:400	1.6	881.3	1.16	881.3	0.56	604.8
T O T A L			4,834.3		3,462.8		1,342.1

TABLE VIII-4
TABLE VIII-5

FLOOD DAMAGE TO PUBLIC FACILITIES

	Q=7000** (m^3 s)	Q=5,000** (m^3/s)	Q=3,600* (m^3/s)	Q=3.000** (m^3/s)
Provincial Roads and Bridges	3,800	2,280	1,220	760
Highway	22,080	13,250	7,068	4,410
School Buildings and Hospitals	47	28	15	9
National Buildings	280	170	90	56
Flood Protection Measures	4,060	2,430	1,300	810
T O T A L	30,267	18,158	9,693	6,045

Note * : Data for Typhoon ARING
** : Estimated Value

TOTAL FLOOD DAMAGES

Unit: 1,000 Peso

	Q=7,000 (m^3/s)	Q=5,000 (m^3/s)	Q=3,000 (m^3/s)
Household Property	5,343	4,746	3,706
Agricultural Production	4,834	3,463	1,342
Public Facilities	30,267	18,158	6,045
sub-total	40,444	26,367	11,093
Indirect Damage	4,044	2,637	1,109
Total	44,488	29,004	12,200

Matuno River at Bante — unit: m^3/s

Hrs.	Return Period					
	1/100	1/75	1/50	1/30	1/10	1/2
0	50.0	50.0	50.0	50.0	50.0	50.0
2	74.3	73.4	71.1	68.9	64.6	57.5
4	169.7	165.2	155.7	145.6	124.4	88.9
6	380.5	368.6	347.2	321.2	265.1	166.7
8	829.0	802.6	759.5	703.5	581.9	351.9
10	1,994.9	1,929.4	1,835.0	1,703.5	1,423.1	867.0
12	2,646.3	2,569.7	2,462.3	2,305.7	1,973.5	1,282.1
14	1,790.8	1,751.9	1,694.9	1,607.5	1,424.0	1,014.4
16	1,109.2	1,090.0	1,059.1	1,009.9	912.6	686.6
18	758.9	746.3	726.7	694.6	632.0	488.5
20	558.4	547.3	535.5	512.4	468.4	368.5
22	418.0	409.0	399.8	397.6	358.4	279.4
24	290.6	285.4	278.8	287.9	258.7	205.2
26	200.2	197.6	194.4	198.9	184.3	155.8
28	152.9	151.5	149.6	152.2	143.8	126.8
30	125.0	124.1	123.0	124.6	119.4	108.3
32	107.2	106.6	105.8	106.9	103.4	95.8
34	95.0	94.6	94.1	94.8	92.3	86.9
36	86.4	86.1	85.7	86.2	84.4	80.4
38	80.0	79.8	79.5	79.9	78.6	75.5
40	75.2	75.0	74.8	75.1	74.1	71.7
42	71.4	71.3	71.1	71.4	70.6	68.7
44	68.5	68.3	68.2	68.4	67.8	66.3

Magat River at Batu — unit: m^3/s

Hrs.	Return Period					
	1/100	1/75	1/50	1/30	1/10	1/2
0	168.1	167.4	165.7	164.0	160.8	155.5
2	272.5	267.6	257.1	246.2	223.9	187.6
4	582.7	565.7	533.2	496.1	418.0	288.1
6	1,348.0	1,302.0	1,223.8	1,126.4	919.7	556.9
8	3,441.1	3,316.8	3,128.4	2,876.5	2,344.5	1,355.3
10	6,203.9	5,995.0	5,695.7	5,273.7	4,382.8	2,628.3
12	6,281.3	6,106.4	5,855.9	5,486.4	4,703.7	3,052.1
14	4,377.5	4,284.1	4,143.1	3,925.9	3,472.6	2,445.1
16	2,980.1	2,926.8	2,843.5	2,710.6	2,441.3	1,810.5
18	2,168.5	2,129.5	2,077.1	1,986.9	1,806.9	1,384.1
20	1,639.6	1,607.9	1,572.2	1,528.8	1,390.6	1,081.0
22	1,219.9	1,197.5	1,171.1	1,172.8	1,062.7	836.0
24	884.4	871.4	854.6	866.0	794.2	648.0
26	666.9	659.3	649.5	655.5	613.3	522.6
28	536.1	531.3	525.0	528.5	501.3	440.5
30	450.4	447.1	442.8	445.1	426.3	383.4
32	390.8	388.4	385.3	386.9	373.4	341.8
34	347.5	345.8	343.5	344.6	334.5	310.6
36	315.1	313.8	312.0	312.9	305.1	286.5
38	290.1	289.0	287.7	288.3	282.3	267.5
40	270.4	269.6	268.5	269.0	264.2	252.3
42	254.6	254.0	253.1	253.5	249.5	239.8
44	241.8	241.2	240.5	240.8	237.6	229.5

ESTIMATED DAMAGE REDUCTION BY RESERVOIR

Magat River Original Discharge (m^3/s)	Flood Damage for Original Discharge (10^6Peso)	Flood Control Capacity											
		10 MCM			20 MCM			30 MCM			40 MCM		
		(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
6,281	39.0	5,690	34.4	4.6	5,320	31.5	7.5	5,050	29.4	9.6	4,820	27.5	11.5
6,106	37.5	5,480	32.7	4.8	5,120	29.8	7.7	4,840	27.6	9.9	4,620	25.9	11.6
5,856	35.7	5,210	30.5	5.2	4,850	27.6	8.1	4,570	25.5	10.2	4,340	23.7	12.0
5,486	32.8	4,820	27.5	5.3	4,430	24.4	8.4	4,190	22.5	10.3	3,980	20.8	12.0
4,703	26.5	4,060	21.4	5.1	3,650	18.0	8.5	3,380	15.7	10.8	3,240	14.4	12.1
3,052	12.7	2,470	6.9	5.8	2,160	2.8	9.9	1,970	-	(12.7)	1,900	-	(12.7)

Note: (1):Controlled Discharge(m^3/s), (2):Damage for (1) Discharge(10^6Peso), (3):Damage Reduction(10^6Peso)

ESTIMATED AVERAGE ANNUAL DAMAGE REDUCTION BY RESERVOIR

Magat River Discharge (m^3/s) (1)	Probability of Exceedance and Occurrence (2)	(3)	Flood Control Capacity											
			10 MCM			20 MCM			30 MCM			40 MCM		
			(4)	(5)	(3)×(5)	(4)	(5)	(3)×(5)	(4)	(5)	(3)×(5)	(4)	(5)	(3)×(5)
2,000	.93		0	-	-	0	-	-	0	-	-	0	-	-
3,000	.565	.365	5.8	2.9	1.06	9.9	4.95	1.81	12.8	6.4	2.34	12.8	6.4	2.34
4,000	.21	.355	5.4	5.6	1.99	9.1	9.5	3.37	11.6	12.2	4.33	12.4	12.6	4.47
5,000	.067	.149	5.2	5.3	0.97	8.5	8.8	1.31	10.6	11.1	1.65	12.1	12.3	1.83
6,000	.017	.044	5.0	5.1	0.22	7.9	8.2	0.36	10.0	10.3	0.45	11.8	12.0	0.53
7,000	.0042	.0128	3.8	4.4	0.06	6.7	7.3	0.09	8.5	9.3	0.12	11.1	11.5	0.15
Estimated Reduction					4.12			6.94			8.89			9.32

Note: (4):Damage Reduction(10^6Peso), (5):Average Damage Reduction(10^6Peso)

TABLE VIII-7
TABLE VIII-8

TABLE VIII-9
TABLE VIII-10

ESTIMATED DAMAGE REDUCTION BY EMBANKMENT

Unit: 1,000Peso

	Magat River Discharge at Batu (m /s)		
	Q=7,000	Q=5,000	Q=3,000
Household Property	4,437	4,437	3,649
Agricultural Production	2,363	1,802	495
Public Facilities	15,666	9,402	3,130
Total	22,466	15,641	7,274

ESTIMATED AVERAGE ANNUAL DAMAGE REDUCTION BY EMBANKMENT

Magat River Discharge (m^3/s) (1)	Probability of Exceedance (2)	Probability of Occurrence (3)	Damage Reduction (10^6Peso) (4)	Average Damage Reduction (10^6Peso) (5)	(10^6Peso) (3)×(5)
2,000	0.93	-	0	-	-
3,000	0.565	0.365	7.3	3.65	1.33
4,000	0.210	0.355	12.0	9.65	3.43
(4,700)	(0.100) 1/10	(0.110)	(14.5)	(13.25)	(1.46)
5,000	0.061	0.149	15.6	13.80	2.06
5,860	0.020 1/50	0.041	18.6	17.10	0.70
Estimated Average Annual Damage Reduction				(50-year)	7.52
		-do-		(10-year)	6.22

FIG. VIII - 1

CATCHMENT AREA OF MAGAT RIVER AND ITS TRIBUTARIES

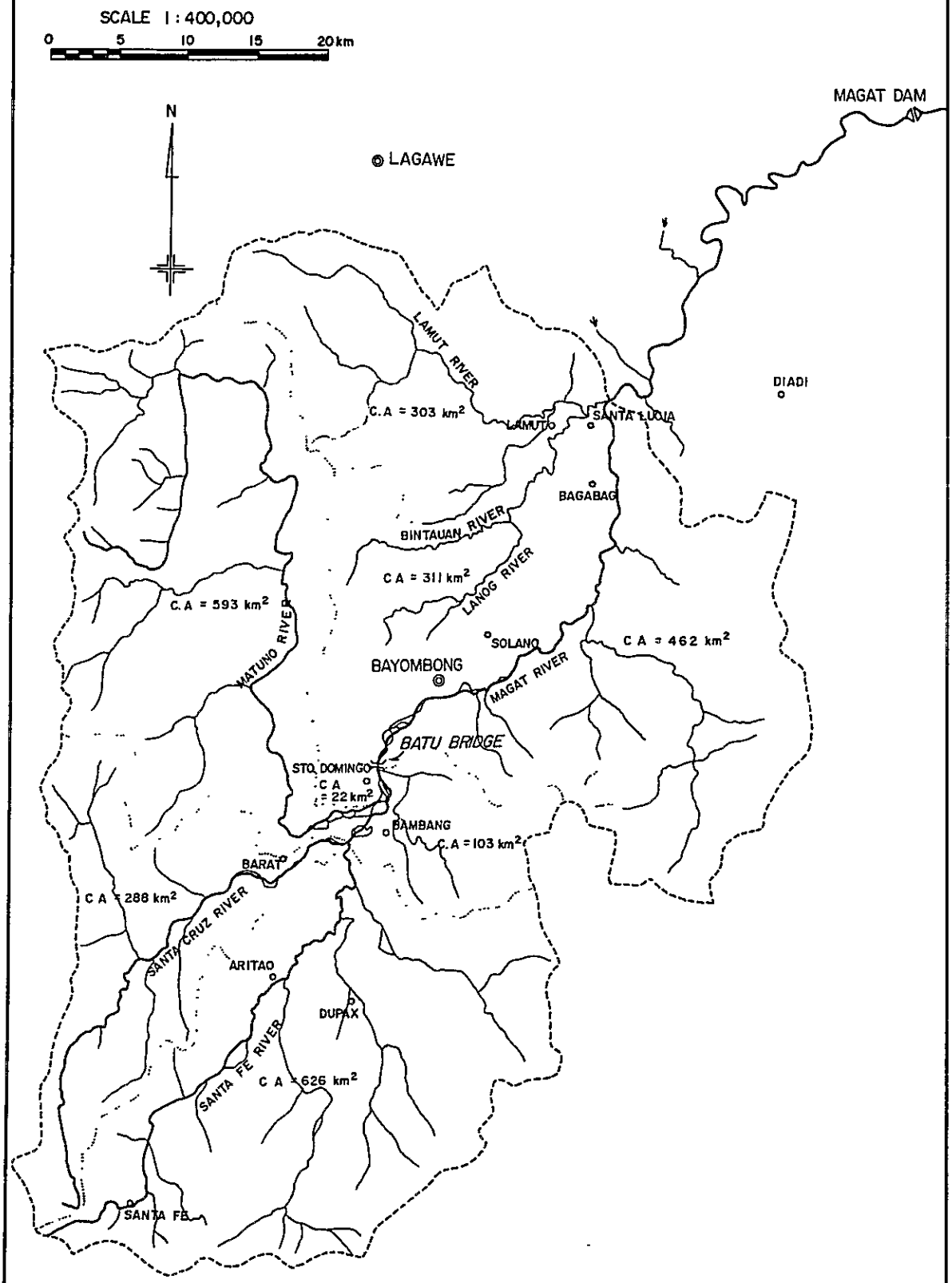
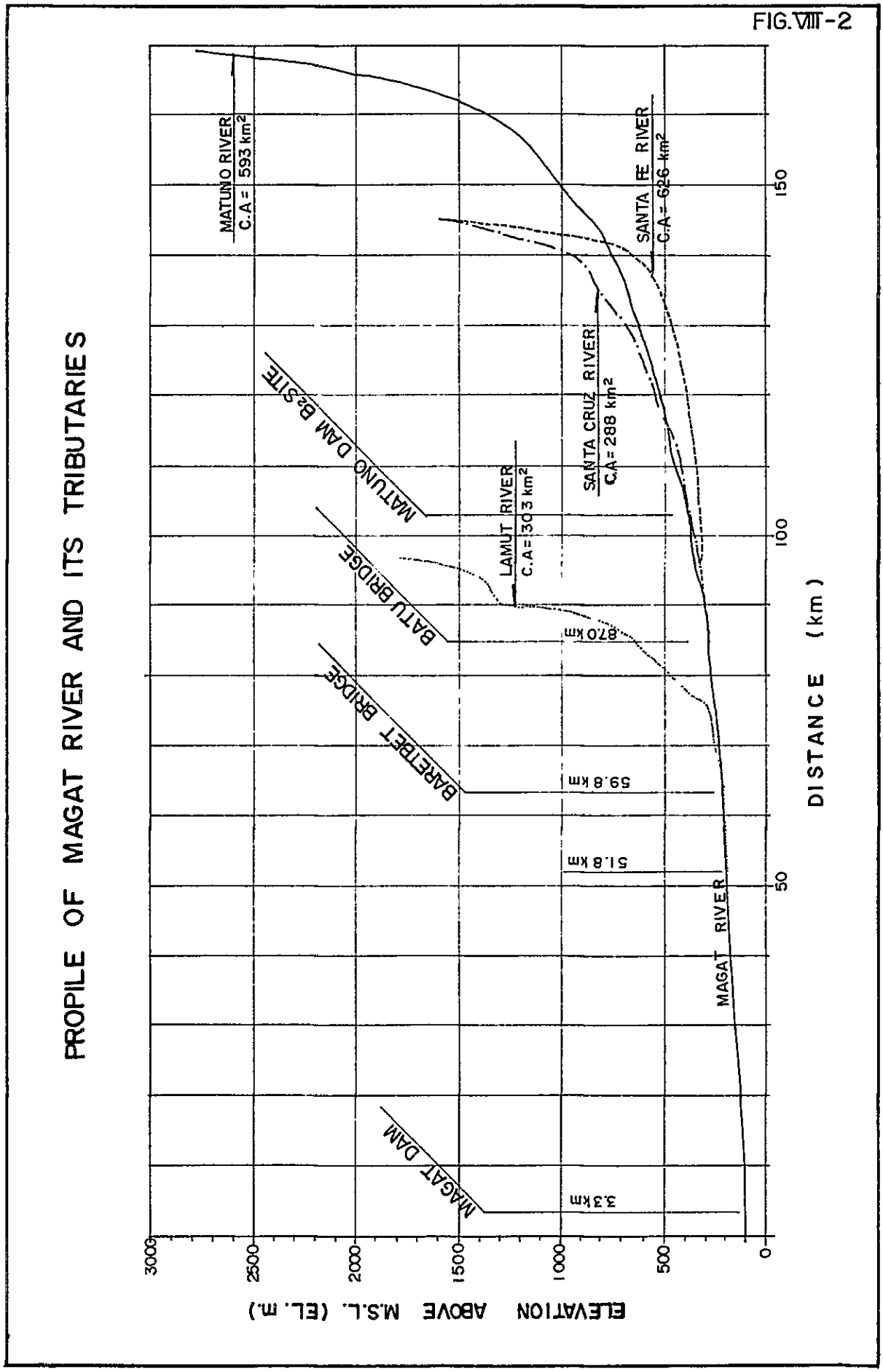


FIG. VIII-2


PROPILE OF MAGAT RIVER AND ITS TRIBUTARIES
ELEVATION ABOVE M.S.L. (EL. m.)
DISTANCE (km)
3000
2500
2000
1500
1000
500
0
50
100
150
MATUNO RIVER
C.A = 593 km²
SANTA FE RIVER
C.A = 626 km²
SANTA CRUZ RIVER
C.A = 288 km²
LAMUT RIVER
C.A = 303 km²
MATUNO DAM Bs SITE
BATU BRIDGE
BARETBET BRIDGE
MAGAT DAM
87.0 km
59.8 km
51.8 km
3.3 km
MAGAT RIVER

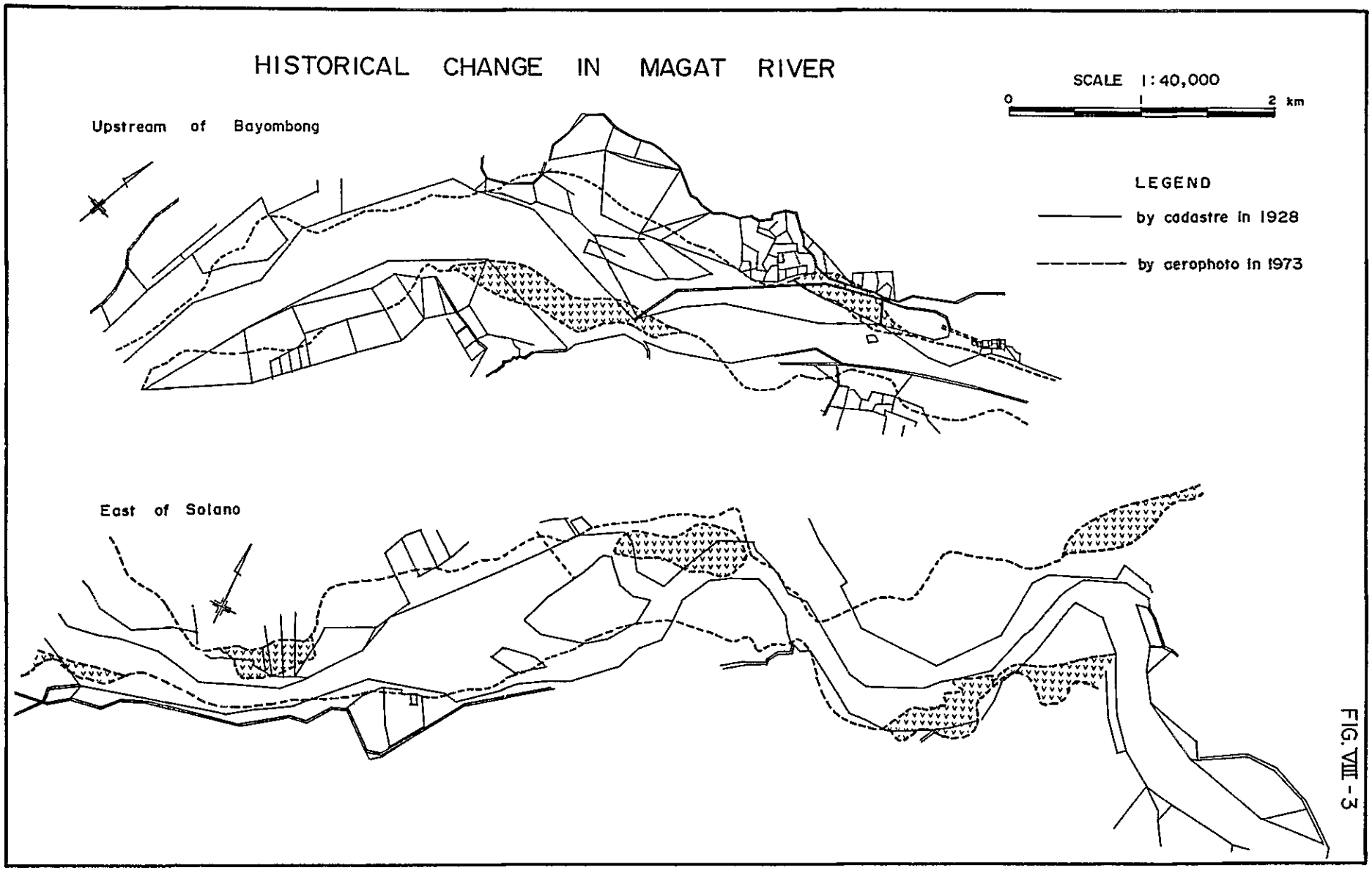
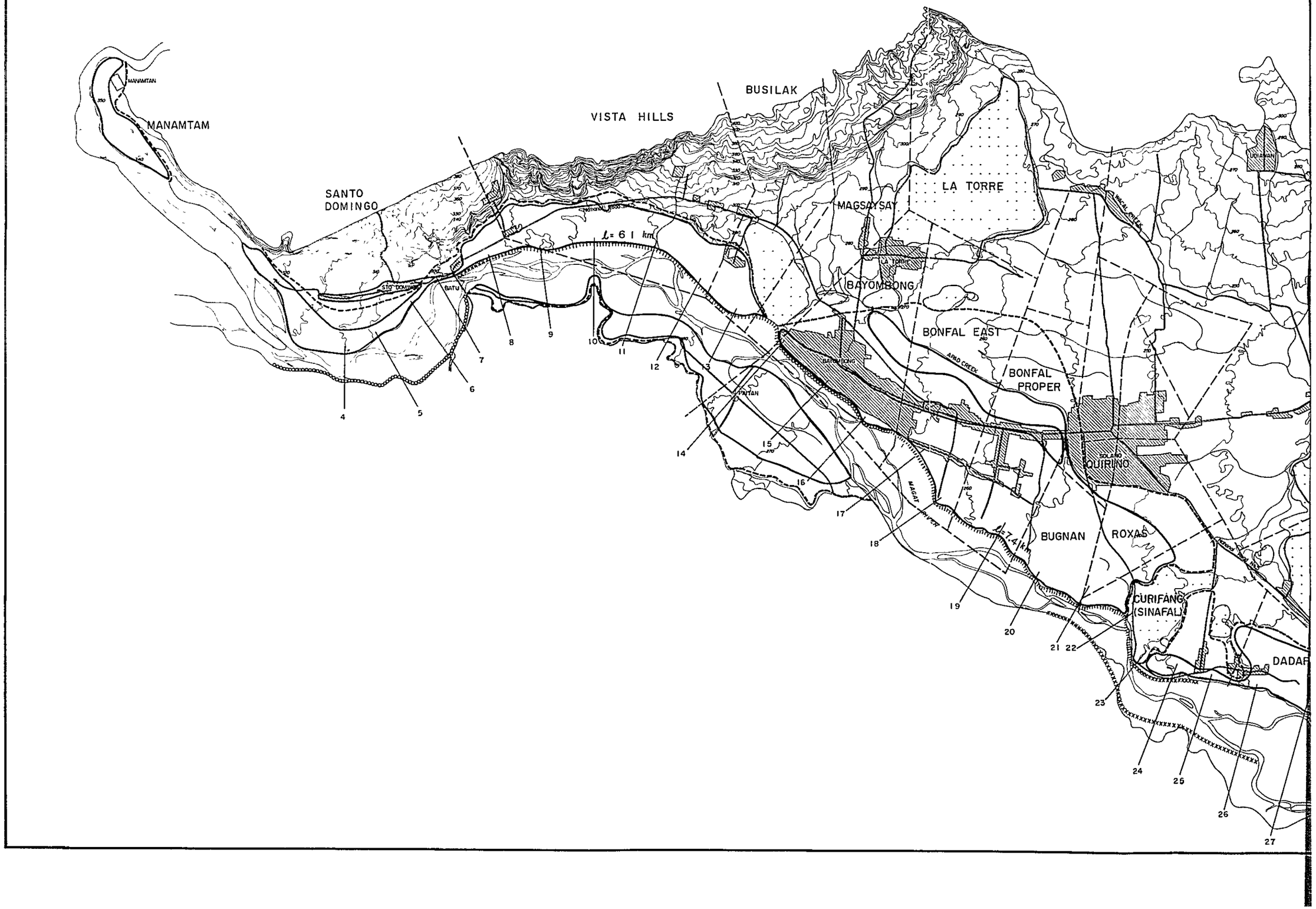

HISTORICAL CHANGE IN MAGAT RIVER
SCALE 1:40,000
0
1
2 km
LEGEND
by cadastre in 1928
by aerophoto in 1973
Upstream of Bayombong
East of Solano

FIG. VIII - 3


MANAMTAM
MANAMTAM
VISTA HILLS
BUSILAK
SANTO DOMINGO
LA TORRE
MAGSAYSAY
BAYOMBONG
BONFAL EAST
BONFAL PROPER
SOLANO
QUIRINO
BUGNAN
ROXAS
CURIFANG (SINAFAL)
DADAP
l = 6.1 km
l = 7.4 km
1
2
3
4
5
6
7
8
9
10
11
12
13
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18
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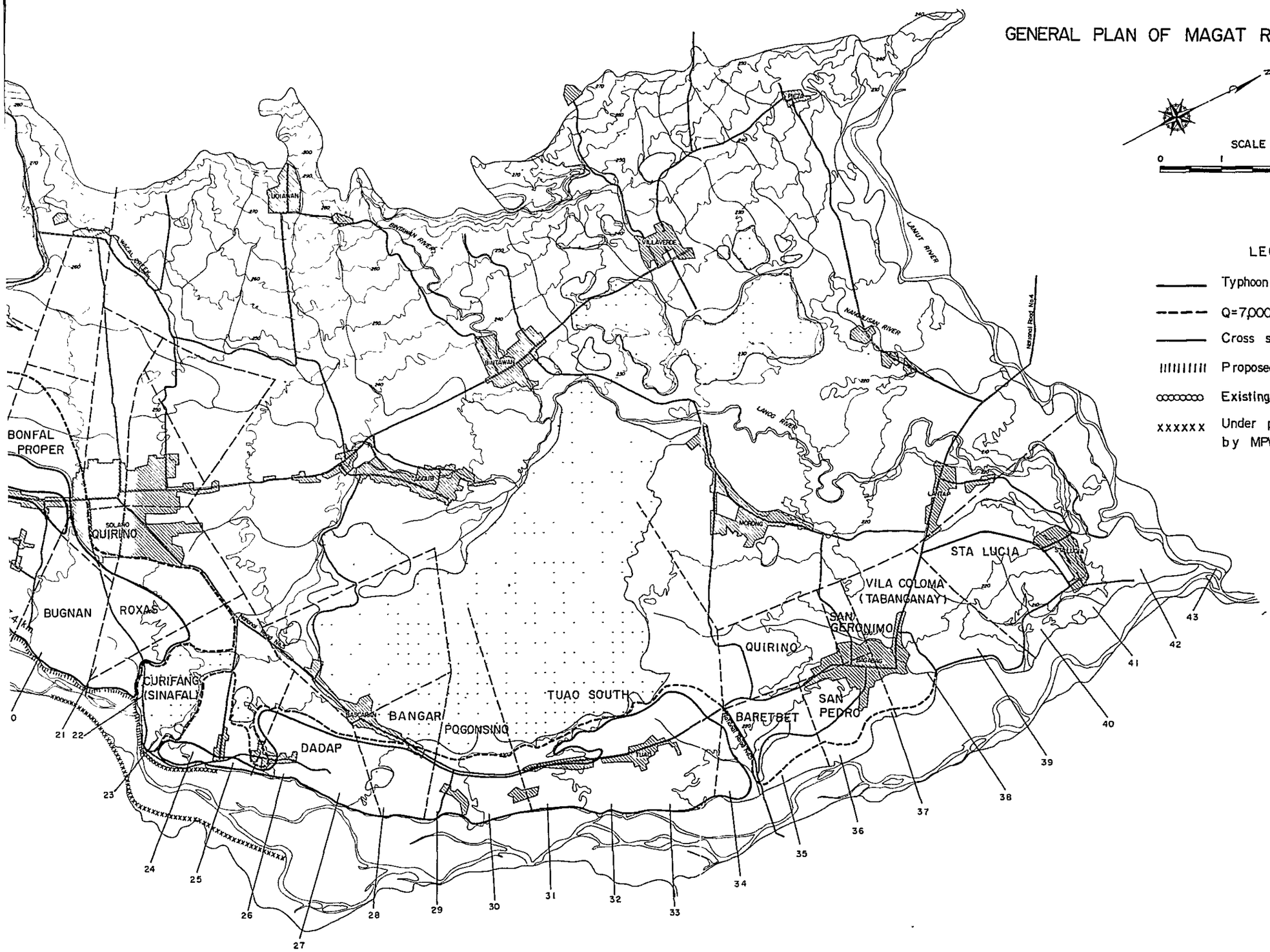
FIG. VIII-4

GENERAL PLAN OF MAGAT RIVER



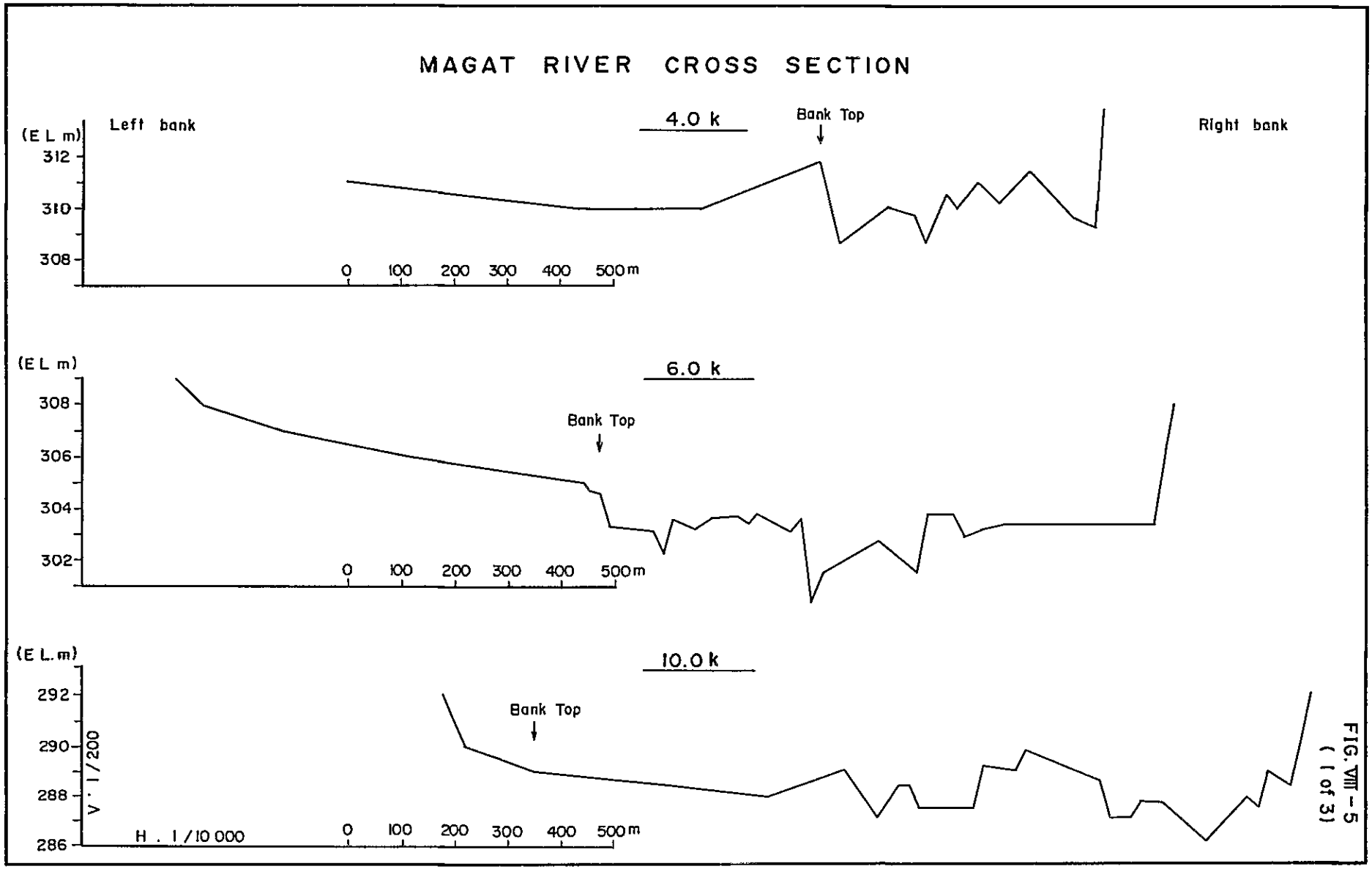


FIG. VIII - 5
(1 of 31)

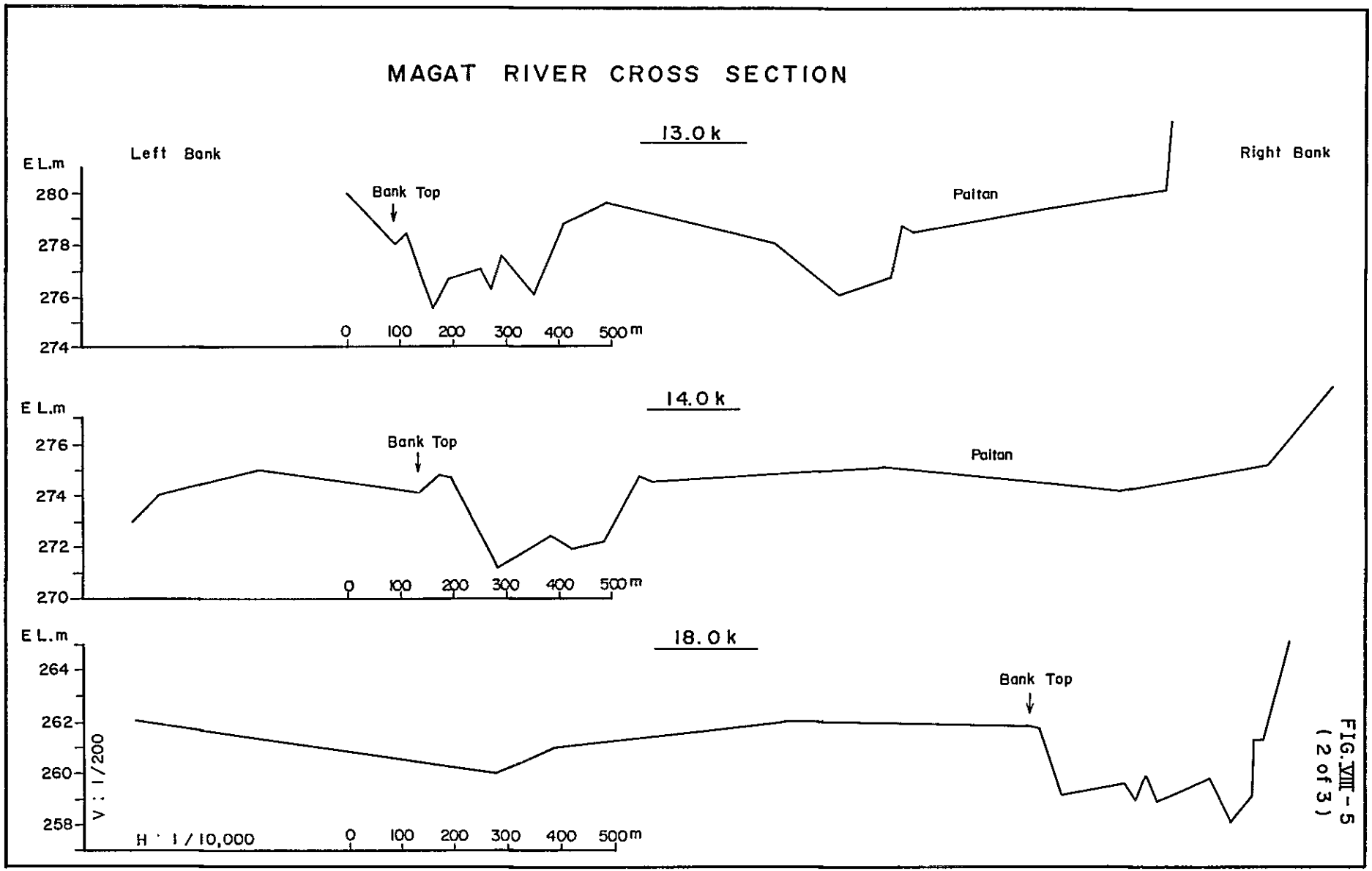


FIG. VIII - 5 (2 of 3)

MAGAT RIVER CROSS SECTION

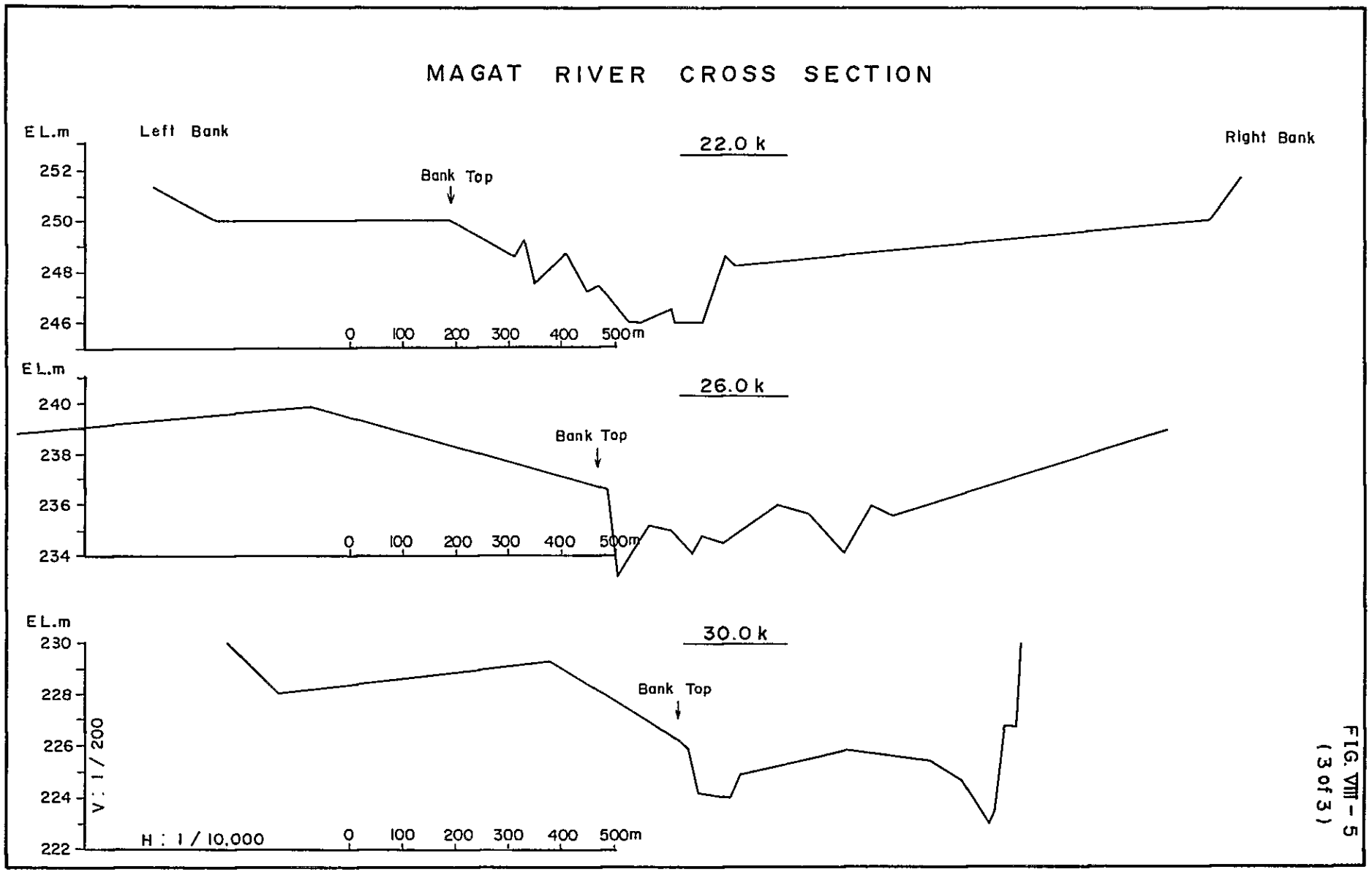
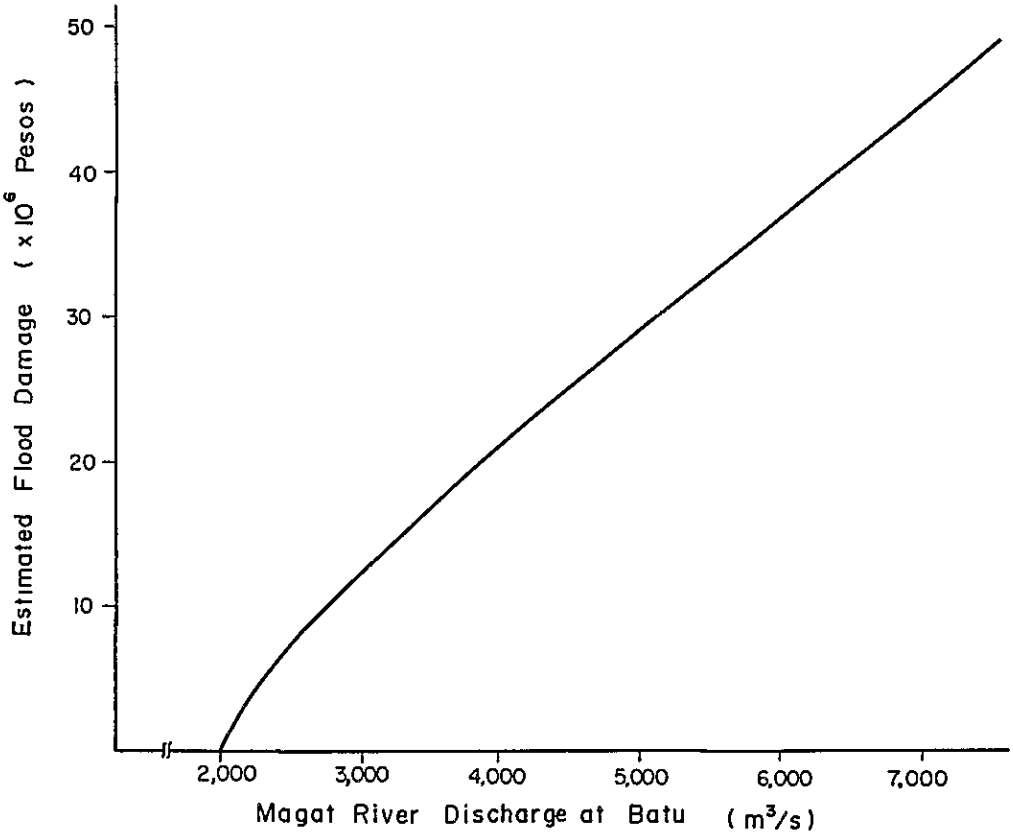


FIG. VIII - 5
(3 of 3)

FIG. VIII - 6
FIG. VIII - 7

MAGAT RIVER DISCHARGE - ESTIMATED FLOOD DAMAGE



MATUNO DAM STORAGE CAPACITY- CONTROLLED DISCHARGE

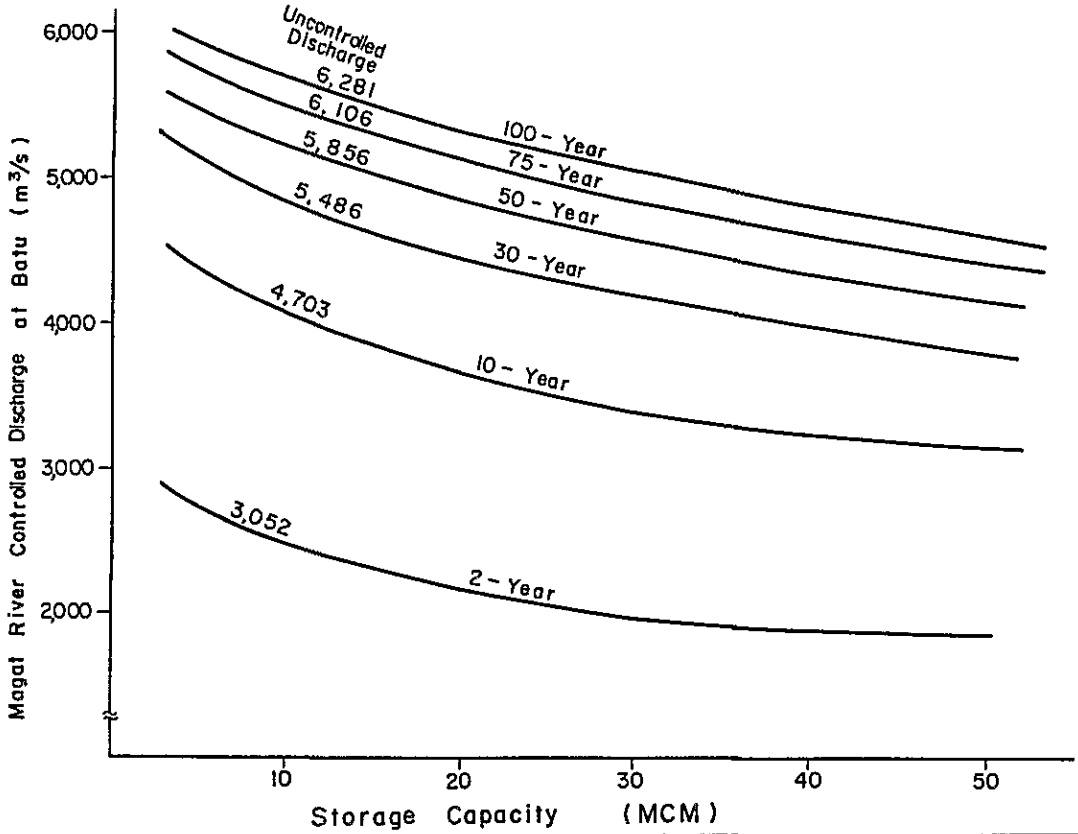
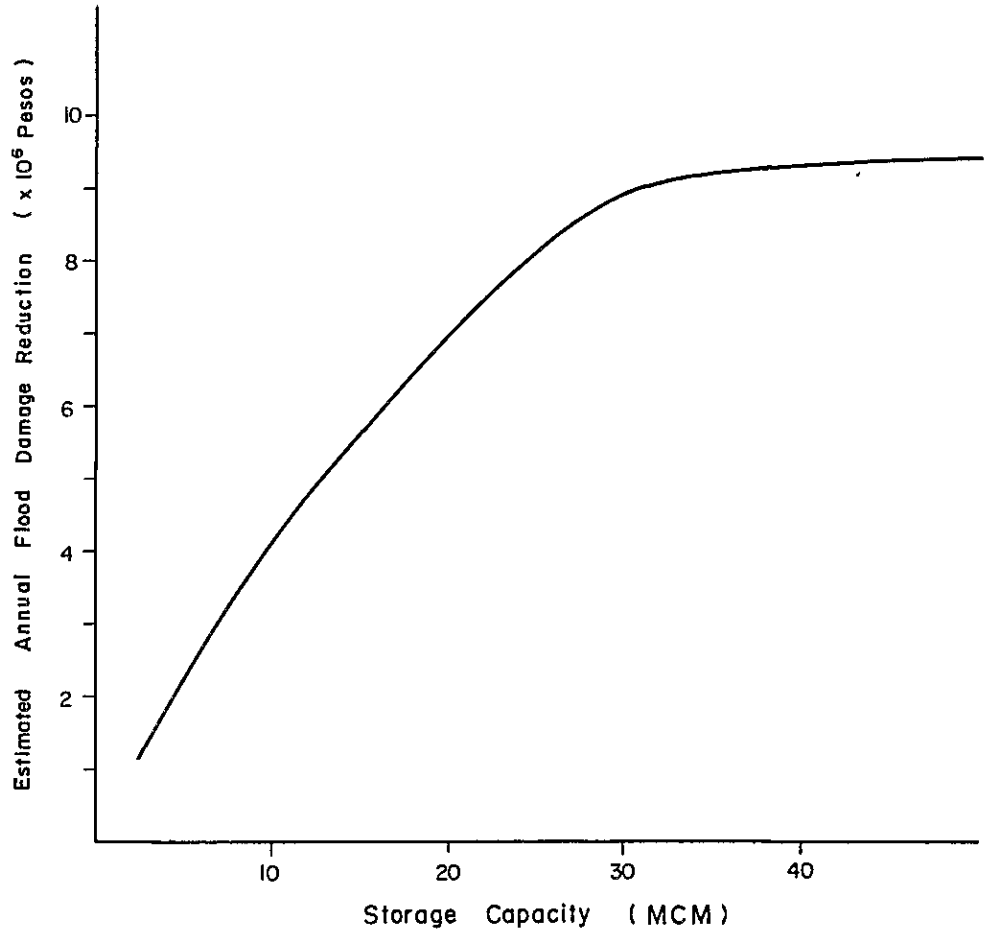
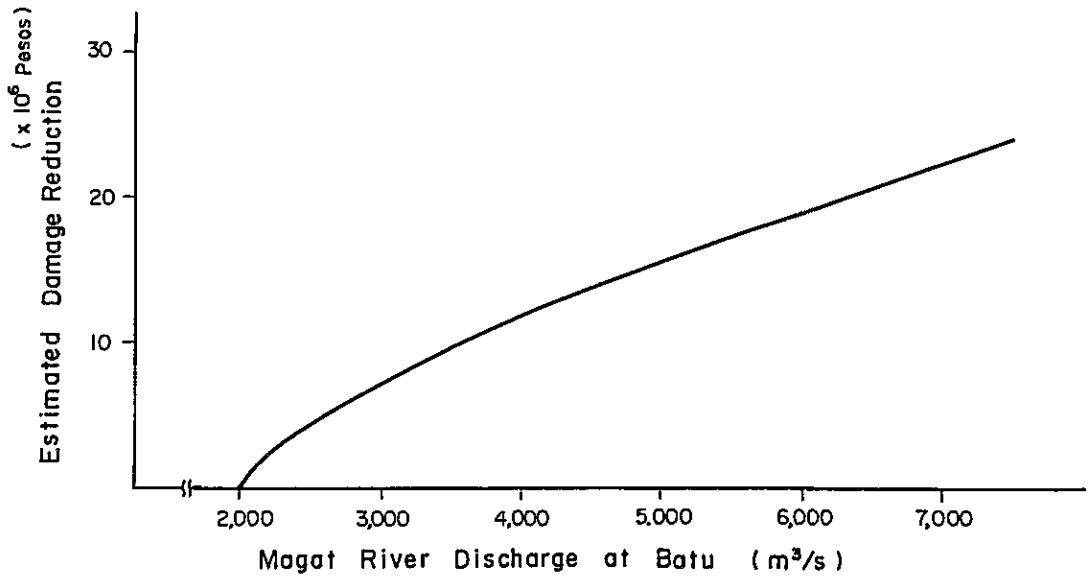


FIG. VIII - 8
FIG. VIII - 9

MATUNO DAM STORAGE CAPACITY -
ESTIMATED ANNUAL FLOOD DAMAGE REDUCTION



MAGAT RIVER DISCHARGE - ESTIMATED DAMAGE REDUCTION



APPENDIX I - IX

DAM AND RESERVOIR

ANNEX I-IX

DAM AND RESERVOIR

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX I-IX

DAM AND RESERVOIR

1. DAM ENGINEERING

1.1 Dam Site

Three dam sites on the Matuno River were initially reconnoitered by NIA. These three potential dam sites have been expediently named as site A, B and C. Downstream of the river, site C is located at the end of the canyon as the Matuno River traverses the plain, site B is located about 8km upstream of site C, and site A is immediately downstream of the confluence point with the tributary Nansiacan River as shown in FIG. IX-1.

At the preliminary survey stage (January-March 1982) placing primary emphasis on irrigation and flood control components of the proposed Project, the irrigation team centered its main attention on candidate sites B_2 and C whereas the hydropower team primarily conducted field survey on a dam scheme for hydropower development at candidate sites A and B_1. The location of these candidate sites are illustrated in FIG. IX-1.

As the result of the irrigation team's survey and investigations on site B_2 and C, the team concluded that candidate site B_2 is the most appropiate dam site for irrigation development, while on the contrary, controversial site C with a limestone bedrock is judged unfavorable.

1.1.1 Site B2

At the preliminary survey stage, Site B_2 had already been designated as one of the more promising candidate dam sites. The site is characterized by a protruding ridge on the left bank. In the event that design reservoir capacity is 100 x $10^6 m^3$ or less, the above topographical feature can be utilized as a spillway site thereby presenting economical advantages for dam construction. The site is not appropriate, however, for a dam requiring a reservoir capacity of more than 100 x $10^6 m^3$.

The spillway for dam at Site B_2 would be of the overflow type, utilizing natural hill terrain at the site. Said protruding ridge would accordingly dictate a dam height of 116m (106m above the riverbed). A dam of either lesser or greater height would incur additional unit construction cost.

The gorge at the site has a slope of 50° at both abutments, with about a 50m riverbed width. The ridge protruding from the left bank has a top elevation of 510-530m, whose thickness at elevation 500m averages about 70m.

Geology at the site is predominantly conglomerate; the riverbed provides outcrops of bedrock. The area on the left bank side above elevation 450m has a thick weathered zone, while, on the other hand, the right bank side weathered zone is comparatively thin. Thus, the site is blessed with favorable topographic and geologic conditions for constructing a fill type dam.

1.1.2 Site C

Topograghy at Site C consists of a steep walled canyon approximately 1km in length. River width is 40-50m, and both banks form cliffs 300m in height. A natural pocket exists upstream of the canyon which is favorable for reservoir formation. At the time of the preliminary survey, it was estimated that a concrete dam, 100m in height with a reservoir capacity of 100 x $10^6 m^3$ would be possible at the site. However, an outcrop of limestone at the site indicated the possibility of seepage. Geological survey was accordingly carried out during the concerned study to determine the extent of foundation improvement works which would be necessary to ensure proper dam stability and permeability.

Finally, as discussed in detail in APPENDIX I-II, GEOLOGY AND CONSTRUCTION MATERIALS, it has been concluded that site C should be eliminated from consideration as a dam site in due consideration of the following points:

i) The site is situated in an area of limestone distribution, evidenced by geological sampling and lack of surface water rivulets. Accordingly, an extensive groundwater system is assumed to be in existence at the site with seepage most likely occuring to a great depth.

ii) Erosion has possibly progressed to a considerable depth because the groundwater table is low.

iii) Open cracking is present in all outcroppings. On the basis of boring results, cracking is judged to be present to a great depth at elevations above the riverbed.

iv) The Lugeon value extracted from Boring No. BC-2 indicates high permeability at 30-50 Lugeon over the entire interval.

v) Open cracking and caves at the site suggest potential danger of seepage, sinking in bedrock, deterioration of shearing strength, etc.

The above therefore indicate that in comparison with B_2 dam, C dam has several major construction restraints which effect both the security of the structure as well as cost effective approach to project development.

1.2 Selection of Dam Type and Optimum Scale

1.2.1 Selection of Dam Type

For the purpose of selecting dam type, rockfill and concrete gravity were compared based on topography, geology, construction materials, etc. As a result of these comparisons it is concluded that the rockfill dam is more suitable and economical for site B_2 for the following reasons.

i) The site presents an advantageous topography for planning the spillway of the rockfill dam.

ii) Shear force of bedrock is assumed to be about $150t/m^2$; this value is not sufficient for a concrete dam with a height of 100m. Generally, for this height of concrete dam $250t/m^2$ or more of shear force of bedrock is preferable. The thick weathered zone of the left bank ridge is also a disadvantage for concrete dam construction.

iii) Embankment materials for a rockfill dam are available in the vicinity of the site.

iv) Roughly estimated construction cost for a 100m high rockfill dam is US$220 million, while a concrete dam is estimated at US$345 million.

On the basis of the above, it was therefore concluded that the rockfill dam is more economical than the concrete dam.

1.2.2 Optimum Scale

Optimum scale of the dam was determined based on an economic comparative study for different heights.

The topographic and geologic conditions of site B_2 dictate a maximum height of 116m. Accordingly, a comparative study for the height of B_2 dam was made for 3 alternative heights, namely, 116, 106 and 96m. Basic criteria for the comparative study were as follows:

i) The benefits from the irrigation sector upon project completion by different dam heights do not fluctuate, so the comparative study was made upon the basis of assumed benefits from the hydropower sector.

ii) The low water level of the reservoir is assumed at EL. 475.0m.

iii) Considering operation and maintenance, electro-mechanical equipment is assumed at 2 units.

iv) A coal-fired thermal plant is considered as an alternative energy, source, details of which are discussed in APPENDIX II, HYDROPOWER COMPONENT.

v) Economic evaluation is made upon benefit-cost ratio (B/C).

Main features and economic index for the alternative heights are tabulated on the following page.

Item	Unit	Alternative 1	2	3
Dam Height	m	116	106	96
High Water Level	m	500	490	480
Normal Water Level	Elm	491.7	485.0	478.3
Tail Water Level	m	300	300	300
Effective Depth	m	183.3	180.0	176.7
Maximum Discharge	m^3/s	30	30	30
Installed Capacity	MW	140	140	140
Construction Cost	10^6US$	252.3	245.0	238.2
Present Value	10^6US$	309.8	300.8	292.5
Annual Energy Output	GWh	394.42	369.40	343.09
Annual Benefit	10^6US$	39.29	37.89	36.43
Present Value	10^6US$	389.55	375.67	361.20
Benefit/Cost		1.257	1.249	1.235

The above results indicate that a height of 116m for B_2 dam is economically most advantageous. Accordingly, 116m was selected and a subsequent preliminary design was made for this height.

1.3 Foundation and Construction Materials

1.3.1 Foundation

As discussed above, shearing strength of the bedrock is assumed at about $150t/m^2$. This value is sufficient for the 116m rockfill dam, although previous to embankment work, stripping and excavation should be carried out over the entire embankment site to completely eliminate organic materials, fluvial deposits and highly weathered rocks.

The characteristics of the bedrock are generally good. Details of the same are in APPENDIX I-II, GEOLOGY AND CONSTRUCTION MATERIALS.

Grouting works are needed in light of seepage and bearing capacity as mentioned later.

1.3.2 Construction Materials

As noted in APPENDIX I-II, GEOLOGY AND CONSTRUCTION MATERIALS, all materials are available in the vicinity of the dam site. A proposed impervious core material borrow area is situated 2.9km downstream from B_2 dam site on the right bank near Bante. It encompasses deposits of weathered conglomerate and terrace secondary deposits of conglomerate.

Semipervious material borrow area is located 10.5km to the east of site B_2 and encompasses the river deposits distributed on the riverbed upstream from Batu bridge. Although this site is at a considerable distance from the dam site requiring construction of an access road, deposits are widely distributed and excavation depth is minimal.

A rock material quarry site is located 2.7km downstream of site B_2 on the right bank and encompasses a limestone formation. The site location is advantageous for access road construction.

1.4 Preliminary Design

1.4.1 Embankment

(1) Design Seismic Coefficient

Design seismic coefficient for dam design has been determined on the basis of earthquake records in the vicinity of the proposed Matuno dam as shown in TABLE IX-1 and FIG. IX-2. The design seismic coefficient(k) is determined at 0.20, after allowing for a margin to the calculated value of 0.14 for a 100-year return period.

(2) Slope

Upstream and downstream slope of the dam was determined based on the above determined design seismic coefficient: k=0.2 and the laboratory test results of rock material using the formula presented on the following page.

- Without water

$$Fs = \frac{1 - m \cdot k}{m + k} \cdot \tan\phi$$

- With water

$$Fs = \frac{\gamma sub - m \cdot k \ \gamma sat}{m \cdot \gamma sub + k \ \gamma sat} \cdot \tan\phi$$

where,

	Fs :	safety factor
m = 1/tan	:	slope (= 1/tan α)
γ sat	:	saturated unit weight (t/m^3)
γ sub	:	submerged unit weight (t/m^3)
ϕ	:	angle of shearing strength
k	:	design seismic coefficient

Assuming a safety factor: F=1.2, angle of shearing strength: =42°, specific gravity of rock: Gr=2.65, effective void ratio: e=0.35, slopes with and without water are calculated at 1:3.29 and 1:2.09 respectively. Accordingly, considering allowance, the upstream slope is determined at 1:3.30 and the downstream slope 1:2.10.

(3) Zoning

An important point for planning a fill type dam is to effectively dispose of embankment materials with materials of similar characteristics. Accordingly, attention is paid to grasp the characteristics and available volume of materials and to effectively dispose of materials considering the interrelation of each. Detailed information of available volume, characteristics, etc. of materials for impervious, semi-pervious and rock zones are described in APPENDIX I-II.

Basic considerations for zoning of the dam are discussed on the following page.

(a)Impervious zone

Since site B_2 presents the steep slope at both banks, the center core type dam, which is advantageous to transformation of the dam itself, was adopted. Minimum width of the impervious zone was determined based on permeability, resistance to piping and factors which cause differential settlement.

The following is the basic conception for width of impervious zone.

i) Impervious zone width of 30-50% of water depth is generally appropriate under standard construction practice.

ii) If constructed with the utmost care especially for the impervious zone, the width of 15-20% of water depth is generally sufficient.

iii) Impervious zone width of less than 10% of water depth is applicable only on the condition that seepage through the zone does not cause collapse of the dam itself.

For the Matuno dam, 1:0.2 for both the upstream and downstream slope is determined based on the above condition and existing dams in the Philippines. Accordingly, an impervious zone width of 45% to any water depth is obtainable.

(b) Semi-perivious zone

The proposed borrow area of semi-pervious material is located on the Magat River 2km upstream of Batu bridge, and the material is river deposits.

The semi-pervious zone theoretically requires only a thin width if the material is effectively well-graded. However, the minimum width has to be determined in consideration of the multiformity due to construction conditions. For Matuno B_2 dam, a slope of 1:0.4 was determined for both upstream and downstream considering material test results and construction conditions.

(c) Rock zone

Since the rock zone determines the stability of the dam, material with sufficient shearing strength must be embanked with necessary width. Excavated muck is frequently applied to the rock zone, though in the case of B_2 dam, less excavated muck at dam foundation and spillway is required because the rock is easily crushable. For the purpose of obtaining stability against slope sliding and ensuring proper drainage, larger size rock is needed for embankment on the outer side and smaller size rock on the inner side of the dam.

Limestone excavated from a quarry site will be embanked on the outer side of B_2 dam, while a conglomerate of excavated muck at the spillway and appurtenant structures will be used for the inner surface. Shearing strength of the rock zone, if of the same material, is proportionate to density, and rolled compaction is therefore needed for rock zone. For slope protection, larger rock will be embanked to the depth of 1m on the surface of the dam.

(3) Crest Width

Crest width of the dam was determined in due consideration of construction condition and utilization after completion of works. Moreover, considering the 6-15m crest width of existing dams in the Philippines, a 10m width for B_2 dam was decided.

(4) Freeboard

Considering that B_2 dam is fill type with installed spillway gates, crest elevation of the dam was determined as below. Within the 3 elevations shown on the following page the maximum value of the same was adopted for dam crest elevation.

- $Hf + hw + he + 1.5$
  (if $hw + he < 1.5$ then $hw + he = 1.5$)

- $Hs + hw + \frac{he}{2} + 1.5$
  (if $hw + \frac{he}{2} < 1.5$ then $hw + \frac{he}{2} = 1.5$)

- $Hh + hw + 1.5$
  (if $hw < 0.5$ then $hw = 0.5$)

where,

Hf : Normal high water level

Hs : Surcharge water level

Hh : Design flood stage

hw : Wind wave height from reservoir water level

he : Earthquake wave height from reservoir water level

(a) Wind wave height

Wind wave height is determined based on the SMB method and Saville method assuming opposite shore distance (F) at 1,500m, wind velocity (V) at 30m/s, and slope at 1:3.30. Wind wave height is thus calculated as 0.55m.

(b) Earthquake wave height

Applying Sato's formula

$$he = \frac{k \cdot \tau}{2\pi} \cdot \sqrt{gHo}$$

where,

k : Design Seismic Coefficient (0.20)

τ : Earthquake cycle (1 sec)

Ho : Reservoir water depth at normal high water level

(112.0m)

g : Gravity acceleration ($9.8 m/s^2$)

1.06m of earthquake wave height is obtained by the above.

(c) Freeboard

Utilizing the first formula above the highest elevation of the 3 formulas is EL 503.00m. Freeboard must be sufficient to prevent overtopping of the embankment due to occasional abnormal and severe flooding and wave action. Accordingly, with a 1m allowance for extraordinary situations, the freeboard of the dam was determined as 4m.

1.4.2 Foundation Treatment

Blanket grouting works will be made for strengthening the bearing capacity of the foundation and for securing water tightness of all portions of foundation core material to the depth of 10m with an interval of 2m zigzag.

On the other hand, curtain grouting works will be made to prevent seepage through the foundation. Depth and alignment of grouting was determined based on reservoir water depth, foundation rock condition and Lugeon maps. Generally, curtain grouting depth for fill dams has a Lugeon value of 2-5. For site B_2, the depth was determined at 70% of the maximum storage water depth with the minimum depth of 30m, and the interval of grouting hole was determined at 1.5m.

Rim grouting for the left bank ridge will be carried out to a depth of 40m. For that depth, the Lugeon value will be about 5. The alignment of the grouting holes will be 40m interval zigzag.

1.4.3 Appurtenant Structures

(1) Service Spillway

(a) Design flood discharge

Design flood discharge was determined at 10,300m^3/s which is equivalent to a 10,000-year return period. For the determination of this value, details are discussed in APPENDIX II, HYDROPOWER COMPONENT.

(b) Type

The spillway is vitally influenced by the condition of the site. The reservoir elevation is limited by the

topographic condition of site B_2, hence, an overflow shute type with 5 gates (W x H : 19.00 x 14.00) is proposed for B_2 dam. The ski jump-type will be adopted as an energy dissipator. Design flood discharge of 10,300m^3/s, results in 126m distance from the drop point to the end point of the spillway.

Some portion of the elevation of the left bank ridge is proposed at 1m lower than the crest elevation as an emergency spillway to supplement the service spillway to drain off excess flood water in the reservoir during an extraordinary flood.

(c) Spillway dimension

The dimension of the service was is determined by the following formula:

$$Q = C \cdot B \cdot H^{3/2}$$

where,

Q : Design flood discharge (10,300m^3/s)
C : Coefficient of overflow (2.08)
B : Crest length (m)
H : Overflow depth (m)

In light of the allowable maximum water surface elevation, overflow depth and width was determined as 14.00m and 95.00m respectively. Given these calculations, it is proposed to install 5 gates each with a width and height of 19.00m and 14.00m.

(2) Diversion Works

The diversion works during construction will be composed of a cofferdam and diversion tunnel. Site B_2 presents a narrow riverbed of 40m and steep slopes on both banks. Subsequently, overall closure works with a tunnel to divert all discharge is proposed.

Design discharges for diversion tunnel works in the Philippines adopt a 10-50 year return period flood. For B_2 dam, considering the scale of the dam, a 3,200m^3/s (20-year return period of flood) is proposed and the details are discussed in APPENDIX II, HYDROPOWER COMPONENT.

(a) Route plan and dimensions

The proposed route for the diversion tunnel is to short-cut the left bank ridge in due consideration of topography advantagous to site B_2. Two tunnels are proposed to be constructed considering the fact that discharge is relatively high. After completion, the tunnels are to be diverted to the outlet works, with additional construction of a blockade plug.

The cross section of the tunnel is a standard horseshoe-shape (2R type). The flow at discharge 3,200m^3/s is under pressure flow conditions, due to the upstream water surface elevation of 429.00m and cofferdam height of EL. 430.00m.

(b) Diversion tunnel capacity

Based on the above condition, the discharge capacity for the tunnel was checked, using the following formula:

$$Q = A \left(\frac{2gH}{1+\Sigma f}\right)^{1/2}$$

where,

Q : Discharge (m^3/s)
A : Area (m^2)
g : Gravity acceleration (9.8m/s^2)
H : Head (m)
Σf : Total loss (m)

The discharge is thereby calculated at 1,690m^3/s for a tunnel with a diameter of 10.6m, and the value is sufficient for 1,600m^3/s (= 3,200/2) of design discharge.

(c) Blockade plug

The required length of blockade plug was determined based on studies for shearing strength of the wall and for resistance against slippage. The length required for these two factors are 10.6m and 40.6m respectively. Including allowance, the length was determined at 50m which is almost the same width of the core zone.

(3) Emergency Outlet Works

It is preferable to install emergency outlet works for the fill type dam in order to discharge stored water when inspection and repairment of the dam body is required. The discharge capacity for the outlet was determined based on reservoir scale and catchment area characteristics. The capacity of B_2 dam was assumed to enable discharge of stored water at normal high water level to the lowest water level within 7-10 days. Since the volume of the reserve is 61MCM, average required discharge was assumed at $110m^3/s$. Herein it is proposed that the outlet facilities be made up of an intake tower at an elevation of EL. 465.00m, a 5.0m diameter shaft, diversion tunnel, a 2.4m diameter discharge pipe installed at the concrete plug and a 2.4m diameter hollow jet valve.

The capacity was calculated by the following formula:

$$Q = C \cdot ao \cdot \left(\frac{2gH}{\Sigma f}\right)^{1/2}$$

where,

Q : Discharge (m^3/s)
ao : Discharge pipe area (m^2)
C : Discharge coefficient of valve (0.85)
H : Head (m)
Σf : Total loss (m)

Based on the above mentioned conditions, discharge is calculated at $124m^3/s$.

1.5 Main Features

Based on the above studies, the main features of B_2 dam are tabulated in TABLE IX-2. Reservoir features are presented in the following section.

1.6 Work Quantity

On the basis of the above preliminary design, were prepared as shown in FIG. IX - 3 to 6. Work quantity is summarized in TABLE IX - 3 based on working drawings.

2. RESERVOIR PLAN

2.1 Physical Characteristics

The reservoir created by the B_2 dam has the following physical characteristics:

(1) Elevation-Capacity and Elevation-Area

The relation between pond elevation and storage capacity, and between pond elevation and inundated area were developed based on topographic maps of 1/4,000 scale. Curves for the same are presented in FIG. IX - 7.

(2) Distribution of Storage Capacity

Normal high water elevation was determined as EL. 500.0m. With this elevation, 94.6MCM of gross storage capacity is available.

The dead storage volume comprises 40 MCM of sediment volume as discussed in APPENDIX II, HYDROPOWER COMPONENT and 3.6MCM of dead water volume below the Low Water Level. The useful storage capacity was thus estimated at 51.0MCM by deducting the dead storage volume from the gross storage capacity.

Distribution of storage capacity is illustrated in FIG. II-8.

2.2 Reservoir Operation

A detailed reservoir operation study was carried out and the results are shown in APPENDIX II, HYDROPOWER COMPONENT.

PROBABLE EARTHQUAKE ACCELERATION

Date	Epicenter Latitude	Epicenter Longitude	Magnitude	Distance	Acceleration gal	Acceleration max	Ranking	Occurence
Apr 13-27	16.0	120.5	6.75	78.4	99.0			
Apr 13-27	16.0	120.5	6.25	78.4	59.2	99.00	1	0.020
Apr 19-27	16.0	120.0	6.75	126.8	46.2			
Mar 19-31	18.0	120.5	6.90	134.4	23.7	23.7	12	0.240
Oct 28-31	17.5	121.5	6.25	128.3	21.7			
Aug 24-32	16.5	120.5	6.25	61.8	82.6	82.6	2	0.240
Feb 14-34	17.5	119.0	7.65	257.1	23.6	23.6	13	0.260
Mar 16-37	18.0	121.0	6.50	174.0	14.2	31.8	8	0.160
Aug 20-37	14.5	121.5	7.50	221.4	31.8			
May 23-38	18.0	119.5	7.00	245.0	11.7	11.7	18	0.160
Dec 29-49	17.5	121.5	7.20	128.3	73.4	73.4	3	0.060
	18.0	121.0	7.20	174.0	40.7			
Jan 3-50	18.0	121.5	6.50	180.9	12.6	12.6	17	0.340
Feb 14-56	17.0	120.0	6.20	132.7	18.2	18.2	14	0.280
Jun 11-57	18.0	121.5	6.70	180.9	18.1	18.1	15	0.300
Jul 18-59	15.5	120.5	6.60	121.1	41.8	66.7	4	0.080
	15.5	120.5	7.00	121.1	66.7			
Feb 26-61	16.1	121.6	6.10	71.7	57.0	57.0	5	0.080
	15.5	121.0	6.10	104.5	28.0			
Jun 23-62	17.1	121.4	6.30	83.3	56.9	56.9	6	0.120
Mar 15-63	16.75	121.0	4.75	35.2	30.9	30.9	9	0.180
Oct 25-65	17.19	121.4	4.90	84.3	5.8	5.8	21	0.420
17-67	17.27	121.83	5.50	126.8	5.2	5.2	22	0.440
Aug 1-68	16.3	122.1	5.90	117.7	14.9	14.9	16	0.320
Aug 3-68	16.45	122.31	6.10	140.1	13.0			
Apr 7-70	15.78	121.71	6.50	103.6	49.8	49.8	7	0.140
Oct 27-71	17.30	120.40	5.50	120.3	6.3	6.3	20	0.400
Mar 16-72	16.2	121.6	5.40	66.5	25.6			
May 22-72	16.6	122.3	6.50	140.1	26.0	26.0	10	0.200
	16.6	122.19	5.90	128.0	11.6			
Jan 17-74	16.7	120.2	5.50	99.2	11.5	11.5	19	0.380
Feb 7-74	16.5	121.6	4.70	61.5	9.8			
Dec 8-74	17.0	121.28	4.70	67.6	7.6			
Apr 3-75	16.9	120.5	5.50	80.1	20.0			
Sep 15-75	16.87	121.57	4.50	75.1	3.7	24.7	11	0.220
Oct 31-75	17.0	121.0	5.30	62.8	24.7			
Jun 23-76	17.03	121.52	4.70	84.1	3.9	3.9	23	0.460

Okamoto's Formula;

$$\log 10 \frac{Ac\ max}{640} = \frac{D + 40}{100} (-7.604 + 1.7244M - 0.1036M^2)$$

where, Ac : Acceleration at the damsite
D : Distance between damsite and epicenter
M : Magnitude at epicenter

Seismic Force
K : Ac/980

MAIN FEATURES

Reservoir

Catchment Area	553.0	Km^2
Surface Area at Full Supply Level	2.71	Km^2
Gross Storage Capacity	94.6	MCM
Usable Storage Capacity	51.0	MCM
Sediment Volume (100 years)	40.0	MCM
Normal High Water Level	500.0	EL m
Minimum Water Level	475.0	EL m
Sediment Level	473.0	EL m

Dam

Type	Center Core Rockfill Dam	
Crest Elevation	504.0	m
River Bed Elevation	406.0	m
Dam Height	116.0	m
Crest Length	430.0	m
Crest Width	10.0	m
Slope of Dam		
Upstream	1:3.3	
Downstream	1:2.1	
Dam Volume	5.3	MCM
Bedrock	Conglomerate	

Spillway

Type	Chute and Ski Jump	
Design Flood (1/10,000 years)	10,300	CMS
Width	70.0	m
Crest Level	480.0	m

Diversion Tunnel

Quantity	2	nos
Average Length	440	m
Diameter	10.6	m
Discharge Capacity (1/20 years)	3,200	CMS

Power Station

Installed Capacity	46	MW
Tail Water Level	300.0	EL m
Maximum Discharge	30.0	CMS
Maximum Net Head	185.0	m
Minimum Net Head	160.0	m
Annual Average Energy	405	GWh

TABLE IX - 3

WORK QUANTITY

Item	Unit	Quantity	Remarks
Diversion			
Excavation	m^3	11,000	
Tunnel Excavation	m^3	94,000	
Concrete	m^3	2,000	
Reinforcing Bar	t	710	
Tunnel Lining Concrete	m^3	16,000	
Plug Concrete	m^3	9,300	
Cofferdam (embankment)	m^3	240,000	
Gate	t	510	
Dam			
Stripping	m^2	256,000	
Excavation	m^3	9,000	
Core Trench Excavation	m^3	600,000	
Embankment Core	m^3	611,000	
" Filter	m^3	566,000	
" Rockfill	m^3	3,964,000	
" Rip-rap	m^3	95,000	
Grouting (blanket)	m	52,000	
" (curtain)	m	45,600	
Spillway			
Excavation	m^3	1,600,000	
Concrete	m^3	115,000	
Reinforcing Bar	t	2,300	
Grouting Curtain	m	1,800	
Gate	t	1,450	
Outlet			
Excavation (open cut)	m^3	15,000	
" (shaft)	m^3	9,000	
Concrete (open)	m^3	2,400	
" (shaft)	m^3	3,000	
Reinforcing Bar	t	200	
Gate	t	150	
Hollow-jet Valve			

FIG. IX - I

LOCATION MAP OF CANDIDATE DAM SITES

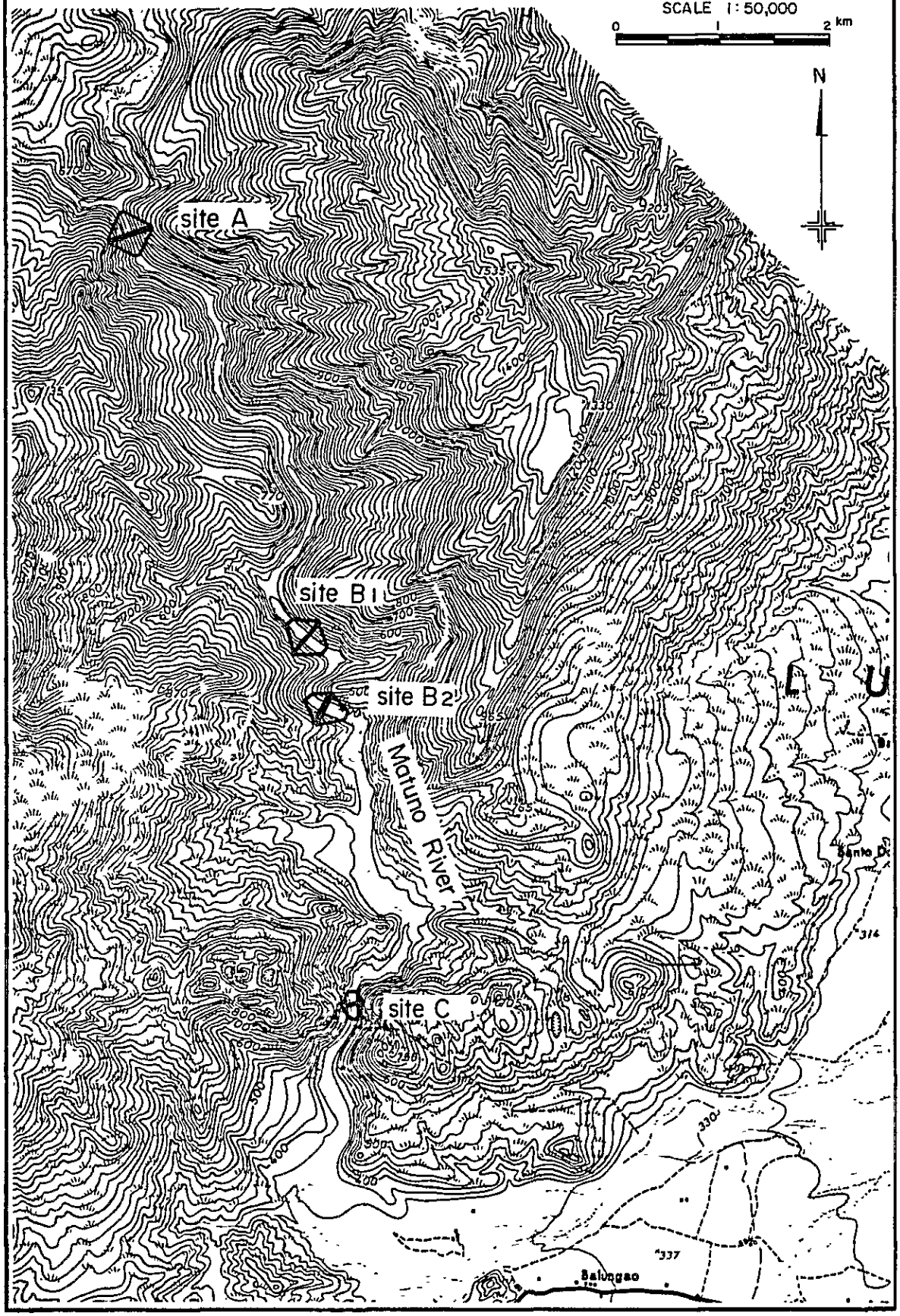
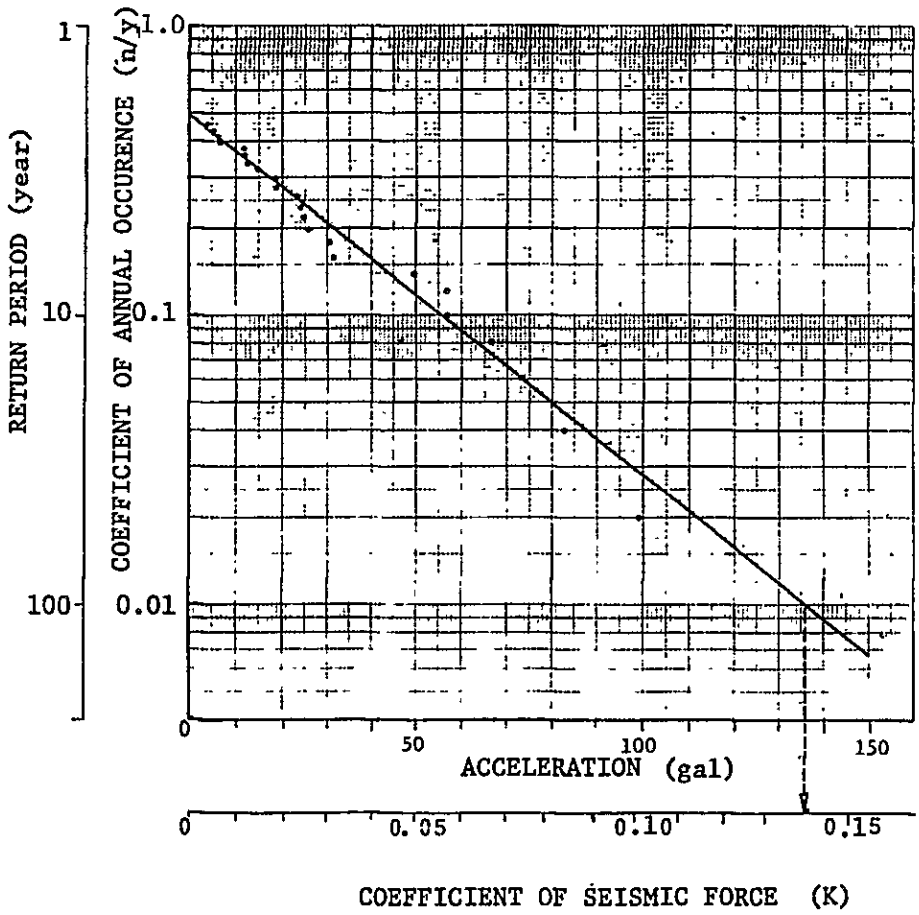


FIG. IX - 2

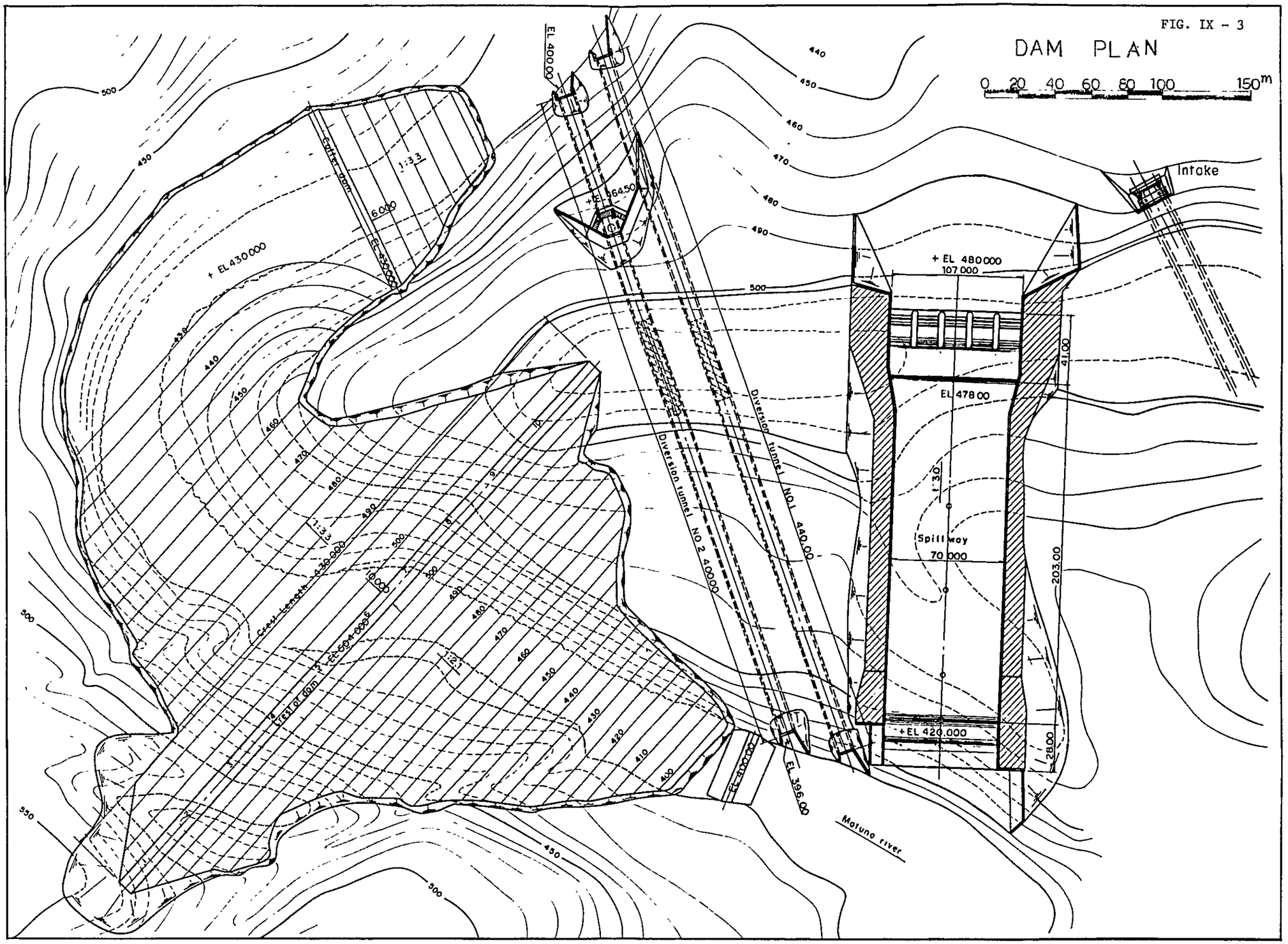
PROBABLE EARTHQUAKE ACCELERATION CURVE



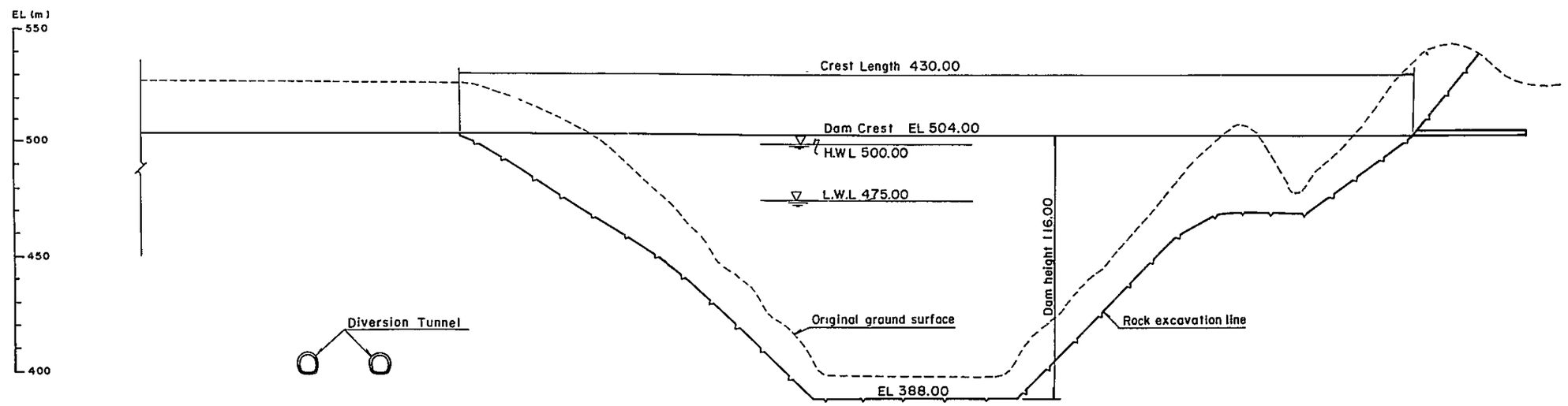
Note: n: Chronogical order according to acceleration.

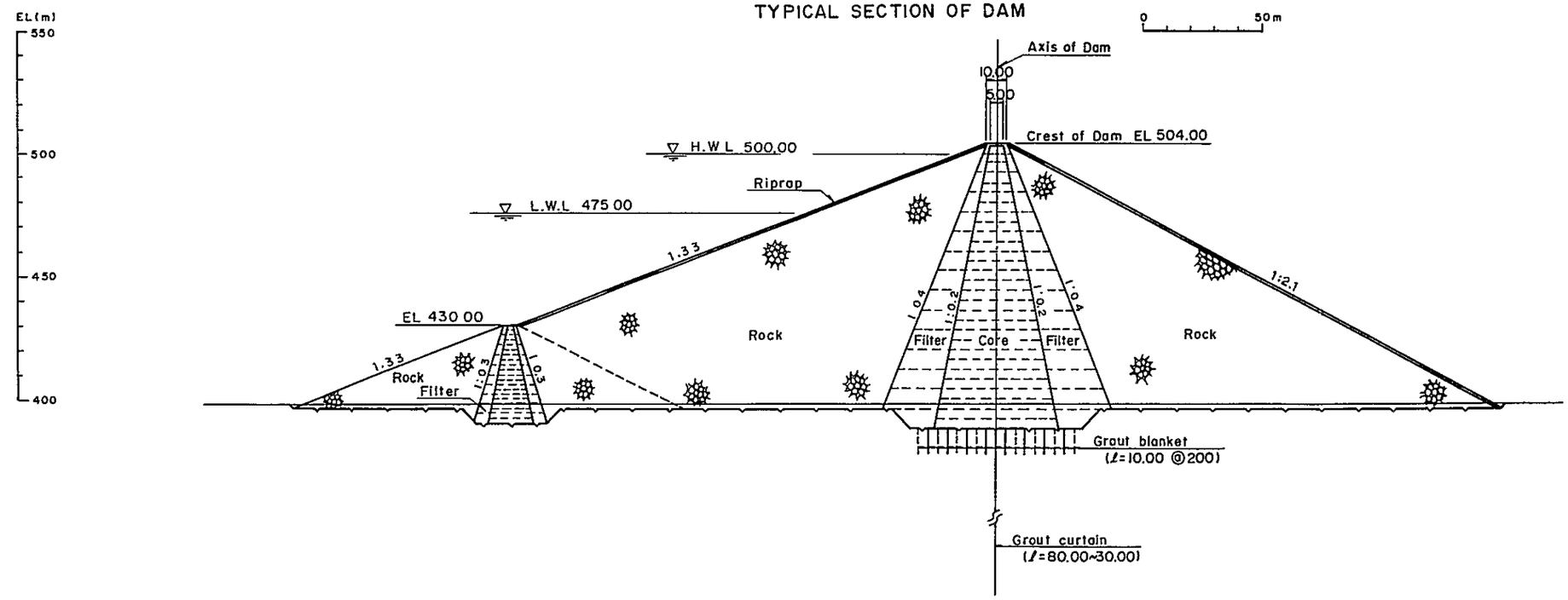
y: Number of recorded year.

FIG. IX - 3


DAM PLAN
0 20 40 60 80 100 150m
Intake
+ EL 480000
107 000
EL 478 00
41.00
Spillway
70 000
203.00
28.00
+EL 420.000
EL 396.00
EL 400.00
+ EL 430 000
Earth dam
6.000
1:3.3
Crest length 430.000
Crest of dam
Diversion tunnel NO 1
Diversion tunnel NO 2 40000
440.00
Matuna river

DAM PROFILE AND TYPICAL SECTION





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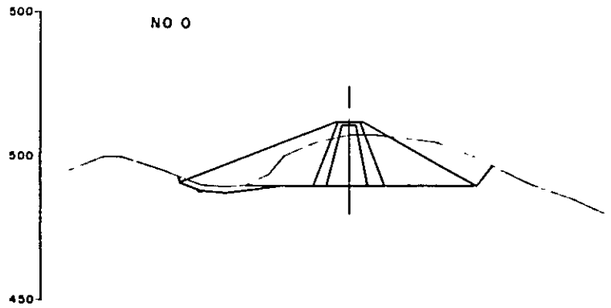

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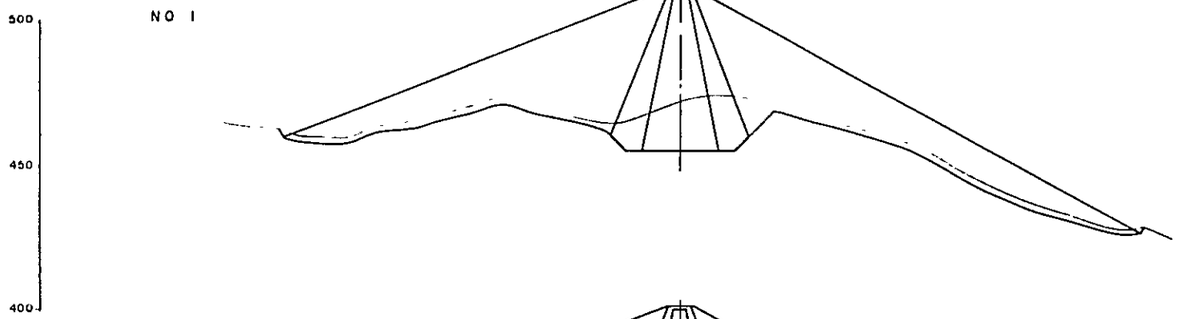
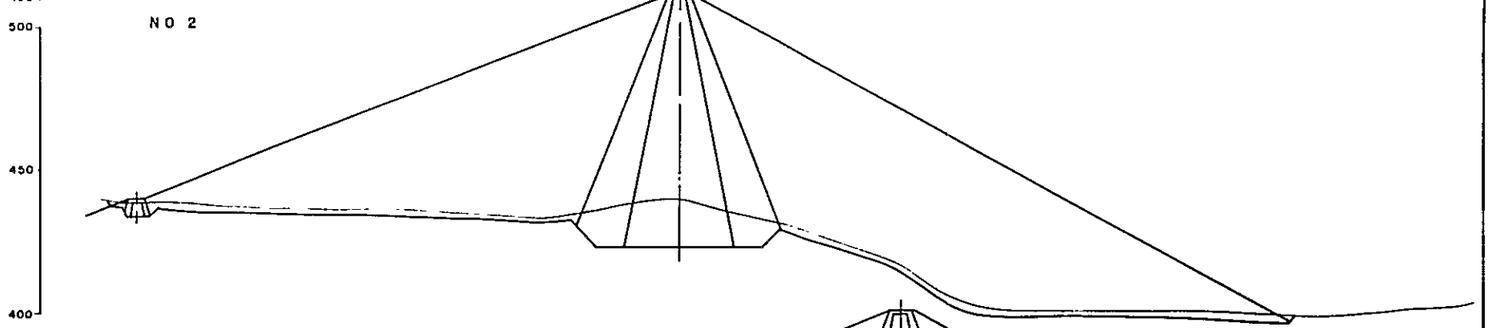


NO 2



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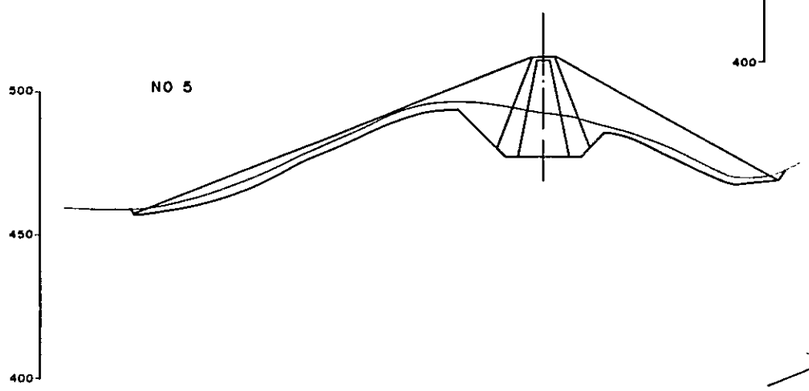

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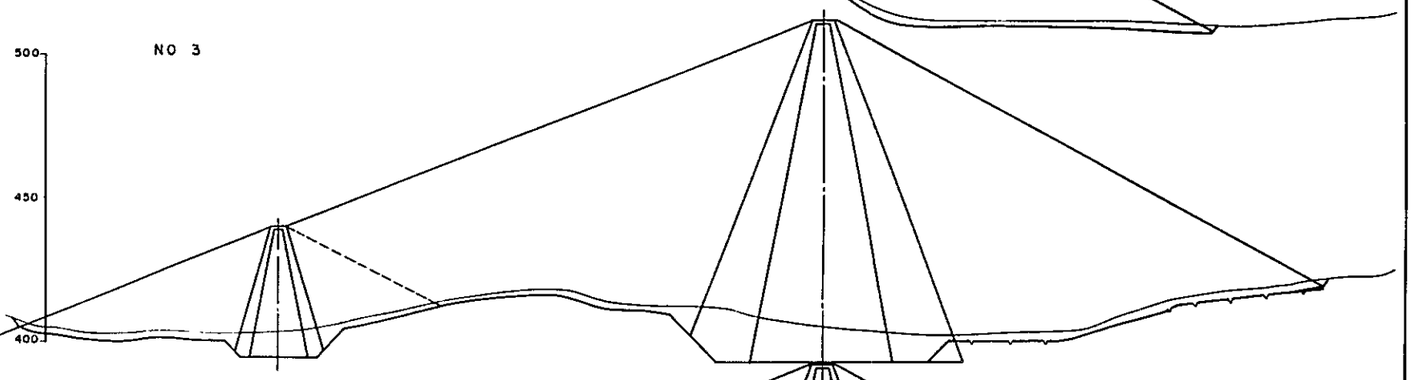

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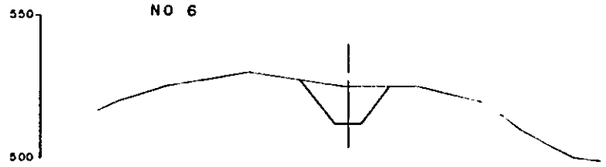

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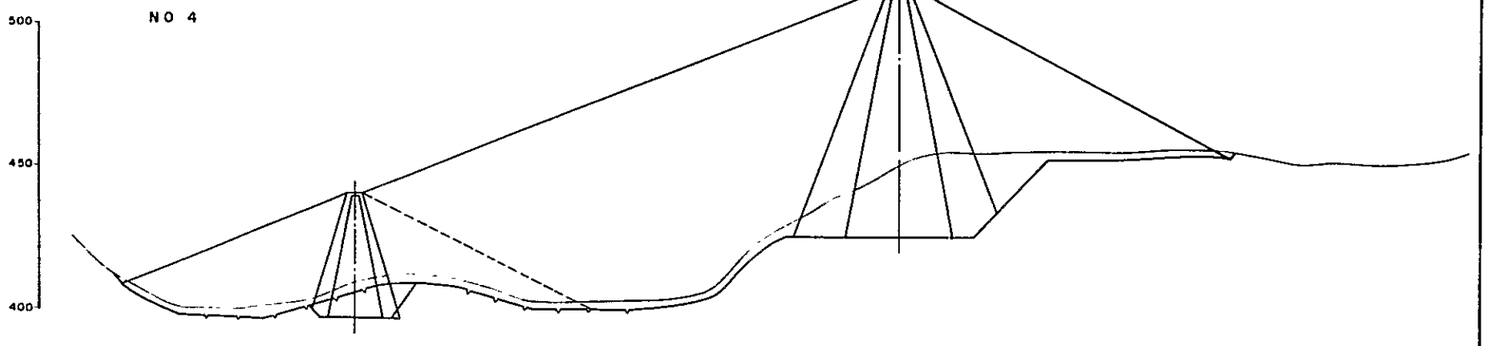


EMBANKMENT CROSS - SECTION

SCALE

0 10 20 30 40 50m

(1 1,000)

CROSS SECTION OF POWER STATION

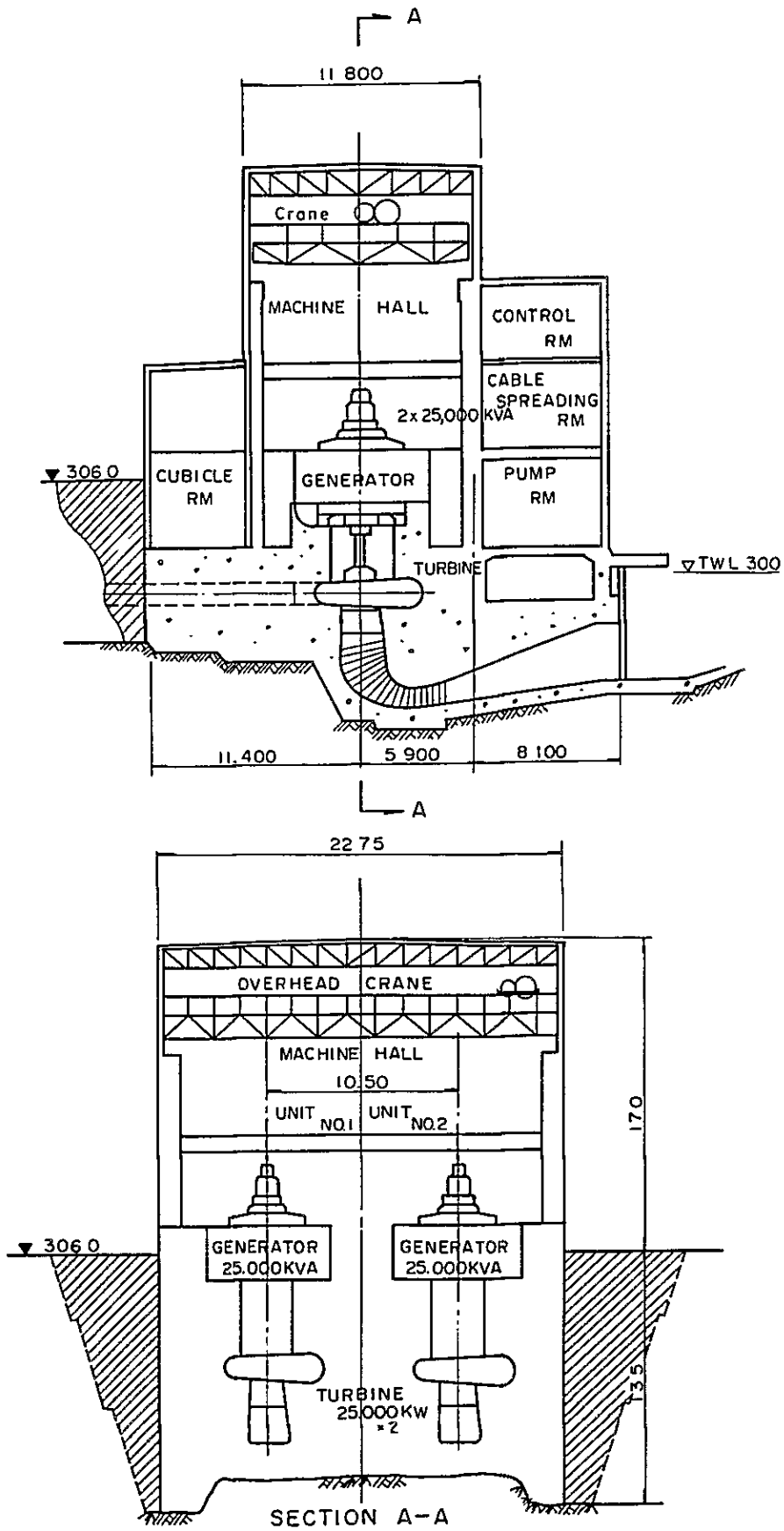
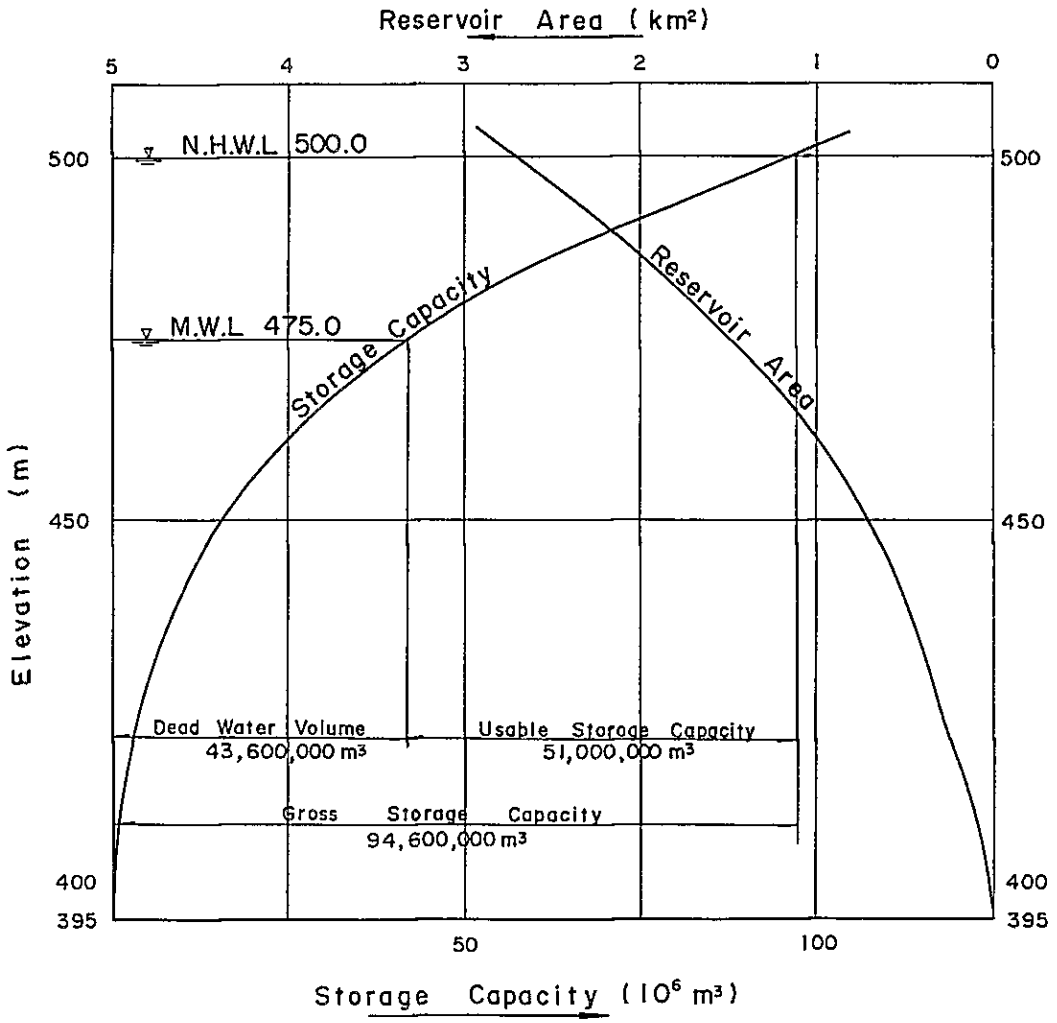
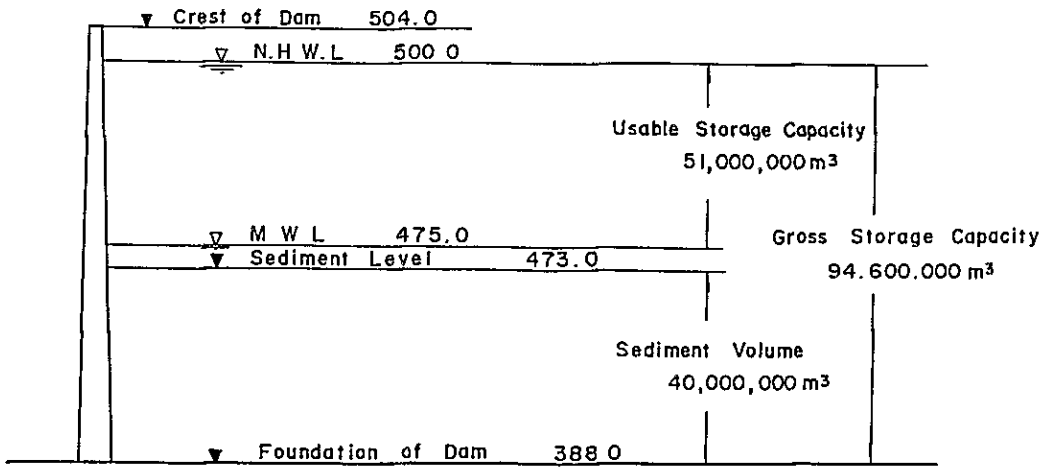


FIG. IX-7
FIG. IX-8

STORAGE CAPACITY AND RESERVOIR AREA



DISTRIBUTION OF RESERVOIR CAPACITY



APPENDIX I - X

INTEGRATED AGRICULTURE DEVELOPMENT APPROACH

APPENDIX I-X

INTEGRATED AGRICULTURE DEVELOPMENT APPROACH

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INTEGRATED AGRICULTURE DEVELOPMENT APPROACH

1. BACKGROUND

(1) Location

The western hillside area is located in the southern part of the Project lowland. This lower foothill area of the Cordillera Mountains faces the Magat River and runs south to north.

(2) Area

The Team has demarcated about 1,300ha of land on the 1:4,000 topo-map with an altitude range of 300-420m from sea level.

(3) Topograghy and Land Use

From the viewpoint of topograghy and land use, the area could be classified as a 6th Block with 4 major sub-blocks as follows:

Different charactristics by sub-block in the western hillside area are as follows:

Sub-Block	Location	Topograghy	Present Land Use
6-1	Sto. Domingo -Vista Hill	Southern part (upper Sto. Domingo) is gentle sloping, while the northern part (Vista Hill) has a conparatively steep gradient and many creeks.	The southern portion is mostly used as natural pasture and partly cultivated. The northern part is also used as pasture but in some locations farmerscultivate paddy. Firewood is collected at various sites.
6-2	Magsaysay	Area is on both sides of National Road No. 5 with a gentle gradient.	Land is mostly used as orchard for cultivation of mango, banana, coconut and citrus fruit trees, or is cultivated with rainfed palay or corn.

Sub-Block	Location	Topograghy	Present Land Use
6-3	Magsaysay-La Torre	Undulations and gradient are gentle, with rock outcroppings in evidence.	Mostly land is used as natural pasture. Small orchards, paddy and dry fields are also present at scattered locations.
6-4	La Torre -Masoc	This area is located at the northern most part of the subject hill area, featuring much undulation and numerous rock outcroppings.	Cultivated land is limited with most of the area utilized as natural pasture. Recently, small-scale plantations of coffee, banana and mango have been established.

Present land use of the area is tabulated as follows:

	Land Use	Area (ha)	Percentage (%)
1.	Cultivated Area		
	a. Irrigated Paddy	30	2.3
	b. Rainfed Paddy	40	3.1
	c. Corn, Veg. & Root Crops	110	8.5
	d. Orchard	115	8.8
	Sub-Total	295	22.7
2.	Natural Pasture	845	65.0
3.	Non-arable Land		
	a. Class 6	140	10.8
	b. Residential Area	20	1.5
	Sub-Total	160	12.3
	Total	1,300	100.0

(4) Soil and Vegetation

Areas of different soil types in the area are tabulated below.

Soil Type	Area (ha)	Percentage (%)
1. Guimbalaon Clay Loam	650	50
2. Guimbalaon Gravelly Clay Loam	630	48
3. Others	20	2
Total	1,300	100

About 65% of the subject area consists of natural pasture where forest vegetation has been altered through slash and burn and other processes to pasture of gramineous grasses. This area is mainly utilized for cattle grazing. However, some farmers are attempting to change to cultivation of fruit trees and coffee. The conversion from natural pasture to cultivated land was observed in limited areas of upper Sto. Domingo and La Torre with planting of Ipil-Ipil (Leucaena leucocephala). In this area, some mountainous ethnic people who engage in charcoal production, also reside. Accordingly, the importance of reforestation will steadily increase.

The distribution of primary and secondary forest in the hillside is only about 11% of the total demarcated area and is scattered on the ravine and sharp gradient portions.

2. RELATED DEVELOPMENT PLAN

Related on-going development plans and plans under study for the area are tabulated below.

Policy/Development Plan	Institution	Progress Stage
1. Fruit Tree Development Plan	Ministry of Agriculture Ministry of Human Settlement (KKK)	on-going
2. Magat Watershed Development Program	NIA	under study
3. Tree Farm Development Plan	KKK Bureau of Forest Development	on-going
4. Agro-Forestry Development	Ministry of Agriculture KKK Bureau of Forest Development	on-going
5. Human Re-settlement Plan	Ministry of Human Settlement	on-going
6. Land Reformation	Ministry of Agrarian Reform	on-going
7. Kaigin System Control	Bureau of Forest Development	on-going

3. DEVELOPMENT APPROACH

The Team, from the initial survey stage, focused on the western hill area to establish an integrated agriculture development plan under the Project.

The basic concept of the plan is to implement the scheme with due consideration of possible conflicts of the various development objectives of the above agencies. To this end, the development plan for this section of the Project area will incorporate the advices and directives of these agencies, with the overall objective to propose a plan which will benefit residents of the entire area, not just a few minority groups.

In developing the integrated agriculture approach the following points must be born in mind.

i) reduction of animal grazing land in fallow fields due to increase in crop occupancy;

ii) a small increase in landless farmers due to land acquisition for irrigation facilities;

iv) necessity to create employment opportunities; and,

v) expansion of income difference among landowners, lessee and landless farmer.

At the time of full development of Stage I, it is estimated that the surplus labor force will become 15.3% in the peak month of February, represented as jobless farmers. This unemployed labor force will directly affect landless farmers who compose 49.6% of total farm households. Major beneficiaries are assumed to be 34.6% of land holders of which 13.1% are owner cultivators and 18.4% of which 11.3% are amortizing owners.

4. DEVELOPMENT PLAN

(1) Objectives

With upland development the following objectives are expected to be achieved;

i) expansion of employment opportunities;

ii) increase of farmers' income;

iii) improvement of farmers' livelihood;

iv) increase in the purchasing power of area residents;

v) land conservation; and,

vi) cultivation of water resources for irrigation and domestic water supply.

Particularly in Central Luzon, improvement and stabiliztion of socio-economic conditions is important from the viewpoint of national policy.

At the time of planning for hill area development the following factors should be taken into consideration;

i) high efficiency of land conservation;

ii) high efficiency of watershed cultivation;

iii) adaptability of other regional develoment plans;

iv) consideration of high labor intensity for employment opportunities;

v) consideration of high potential of secondary processing for enhancing the value added to products; and,

vi) adaptability to regional demand and formation of production centers for existing industry.

(2) Problems to be Resolved and Supporting Organizations

To ensure the success of this development plan there are several points that require clarification;

i) dissolution of exclusive possession of upland area;

ii) minimum investment for physical infrastructures;

iii) capitalization for development; and,

iv) technical assistance.

Each of the above should be dealt with as explained briefly below.

i) The Ministry of Natural Resorces and related agencies for upland re-development have the principal policy of promoting dendrological vegetation. Development agencies concerned should avoid accommodating the small number of current land occupants at the expense of serving the more numerous small-scale farmers.

ii) To promote this plan, primary minimum investment will be needed for physical infrastructures such as farm ponds, small facilities for watering, soil conservation measures, tree planting for wind breaks and fences, and nurseries. If cashew trees are to be cultivated in an envisaged area of 400 hectares, 225 tons of shell oil extraction, and about 1,500 tons of husking and roasting facilities will be required.

iii) & iv) In regard to financial as well as technical aspects of upland development, it is recommended that a project coordination committee be established with the membership of KKK, NIA, BFD, MA, financial lending institutions and official as well as private agencies.

(3) The Plan

Bearing in mind the factors and conditions discussed above the Team has studied the methodology for development and formulated a development plan as presented below.

(a) Dendrological Forest This area envisions a re-forestation plan for ipil-ipil in the area of higher altitude, steep gradient, varied undulation and numerous rock outcroppings. Ipil-ipil has high economic value as firewood, charcoal material, pulp material, and chip material as well as for its leaves which can be utilized as green manure and animal feed. The Government of the Philippines is now planning to construct a pellet factory for ipil-ipil leaves to be used as swine feed in the area under the KKK Program. Accordingly, this hillside area is anticipated as a supply station of pellet material. Production cost and anticipated return are tabulated in TABLE X-1 and X-2.

(b) Fruit Tree Farm Fruit trees are suited for cultivation on the lower foothills where gradient is gentle. Plantations are envisaged for such crops as mango, avocado and citrus fruits. In the ravine area which is naturally protected from wind, slope cultivation of bananas is feasible. Forest area is suitable for agro-forestry, with planting of coffee trees. On slope portions where comparatively unfavorable land is present due to slope gradient and presence of rock outcroppings, land utilization is possible through cultivation of cashew trees. Before fruit trees reach the fruit bearing stage, stabilization of farmers income can be achieved through intercropping of pineapple.

The proposed area to be developed for fruit trees has been demarcated at about 400ha. The cashew tree has been selected as the type of fruit bearing tree to be introduced. To this end, a special production area is envisioned since currently in the Philippines no such area exists. Estimated

cost and return on cashew production is tabulated in TABLE X-3 and X-4.

Magsaysay is an existing fruit production area and is expected to be the core of fruit tree development. There is also a demonstration farm in the area of high yielding dwarf hybrid coconut (MAWA variety) managed by the Philippine Coconut Authority. Unutilized lower foothill area has good potential for economic production of coconut and tropical kuzu.

(c) Animal Grazing Plan Presently the gentle sloping area of hillside is used as extensive animal grazing area. The Bureau of Animal Industry has been promoting the Animal Dispersal Program to improve human nutrition. Moreover, it is forecasted that in the future after completion of the Project, animal grazing area in the lowlands will be minimized due to higher cropping intensity. Therefore, it is planned to develop 500ha of land in the gentle sloping area of the Project as an intensive animal grazing area. In this case, the target is minimal investment on fencing, shedding, drinking facilities with water supplied from local streams, etc., aimed at achieving maximum benefit at minimal cost. In this area it is estimated that about 700 head of cattle and carabao can be accomodated under natural pasture conditions.

The layout of the hill area development plan is shown in the DRAWINGS, while the proposed land use plan is tabulated on the following page.

Land Use	Proposed Area (ha)
1. Cultivated Area	
a. Irrigated Paddy	30
b. Rainfed Paddy	40
c. Corn, Veg. & Root Crops	110
d. Orchard existing	100[1/]
cashew	400[1/]
Sub-total	680
2. Pasture	500[1/]
3. Non-arable Land	
a. Class 6 Dendro forest	100[1/]
b. Residential Area	20
Sub-total	120
Total	1,300

1/ Total of 1,100ha would be developed under the Project

IPIL-IPIL FUELWOOD PRODUCTION COST

Labor Force

	M.D. (₱ 18.00)	A.M.D. (₱ 36.00)	Total Peso	Annual Labor per 100 ha
1st yr.	118.8 (2.138.40)	4.0 (144)	2,282.4	11,880/400
2nd yr.	22.4	-	403.2	2,240
3rd yr.	22.4		403.2	2.240
4th yr.	22.4	-	403.2	2,240
5th yr.	75.2 (1,353.6)	4.0 (144)	1,497.6	7,520/400

Material Input

(Unit:Pesos/ha)

	Seedling	Fertilizer N P R	Chemical I F P R	Misc.	Total
1st yr.	1,111	-	-	-	1,111
2nd yr.	166	-	-	-	106
3rd yr.	-	-	-	-	-
4th yr.	-	-	-	-	-
5th yr.	-	-	-	25	25

ESTIMATED COST AND RETURN ON IPIL IPIL FUELWOOD PRODUCTION
(5 year period)

YEAR	M/LABOR	A/M/LABOR	MATERIALS	TOTAL	ESTIMATED PRODUCTION BUNCH	ESTIMATED VALUE ₱	NET INCOME
1	2,138.40	144.00	1,111.00	3,393.40	-	-	(-3,393.40)
2	403.20	-	106.00	509.20	-	-	(-509.20)
3	403.20	-	-	403.20	-	-	(-403.20)
4	403.20	-	-	403.20	-	-	(-403.20)
5	1,353.60	144.00	25.00	1,522.60	4,000	4,000	2,477.40

note: M/LABOR: manual labor
A/M/LABOR: animal and/or manual labor

TABLE X-2

CASHEW NUT PRODUCTION COST

Labor Force

	M.D. (₱ 18.00)	A.M.D. (₱ 36.00)	Total Peso	Annual Labor per 400 ha
1st yr.	72.6 (1,306)	26 (936)	2,242	29,040/10,400
2nd yr.	50.6	-	910	20,240
3rd yr.	52.6	-	946	21,040
4th yr.	52.6	-	946	21,040
5th yr.	53.6	-	964	21,440
6th yr.	53.6	-	964	21,440
7th yr.	54.6	-	982	21,040
8th yr.	54.6	-	982	21,840
9th yr.	54.6	-	982	21,840
10 th yr	54.6	-	982	21,840

Material Input

(Unit:Pesos/ha)

	Seedling	Fertilizer			Chemical				Misc.	Total
		N	P	K	I	F	P	R		
1st yr.	584	28	-	-	70	-	-	-	-	682.00
2nd yr.	30	28	-	-	70	-	-	-	-	198.00
3rd yr.	-	156	374.4	320.4	140	86	-	-	30	1,107.6
4th yr.	-	165.55	395.2	338.2	140	86	-	-	55	1,179.95
5th yr.	-	174.45	416.00	356.0	140	86	-	-	65	1,237.45
6th yr.	-	182.95	436.50	373.8	140	86	-	-	80	1,299.55
7th yr.	-	191.65	457.60	391.6	210	172	-	-	100	1,522.85
8th yr.	-	196.00	478.40	409.0	210	172	-	-	130	1,595.80
9th yr.	-	213.45	509.60	436.1	210	172	-	-	160	1,701.15
10th yr.	-	226.50	540.80	462.8	210	172	-	-	200	1,812.10

ESTIMATED COST AND RETURN ON CASHEW PRODUCTION

(By BPI as of 1980)

YEAR	ESTIMATED EXPENSES			ESTIMATED PRODUCTION (kg)		ESTIMATED VALUE (₱)			NET INCOME
	LABOR	MATERIALS	TOTAL	FRUIT	RAW NUTS	FRUIT	RAW NUTS	TOTAL	
1	2,242	682	2,924	-	-	-	-	-	(-2,924)
2	910	198	1,108	-	-	-	-	-	(-1,108)
3	946	1,107.60	2,053.60	-	-	-	-	-	(-2,053.60)
4	946	1,179.95	2,125.95	1,108	138.5	277	831	1,108	(1,017.95)
5	964	1,237.45	2,201.45	2,216	277	554	1,662	2,216	14.55
6	964	1,299.55	2,263.55	4,432	554	1,108	3,324	4,432	2,168.45
7	982	1,522.85	2,504.85	6,648	851	1,662	4,986	6,628	4,143.15
8	982	1,595.80	2,577.80	8,864	1,108	2,216	6,648	8,864	6,286.20
9	982	1,701.15	2,683.15	11,080	1,385	2,770	8,310	11,080	8,396.85
10	982	1,812.10	2,794.10	13,296	1,662	3,324	9,972	13,296	10,501.90

1. Estimated No. of Raw Nuts/kg: 200 pcs.
2. Estimated No. of Fruit (apples)/kg: 25 pcs.
3. Estimated Value of Fruit (apples)/kg: ₱0.25
4. Estimated Value of Raw Nuts/kg: ₱6.00
5. Total No. of Trees/ha: 277 trees (6 x 6m)
6. Commencement of Investment Return at 8th Year with Maximum Capital @ Approx. ₱5,508.80

APPENDIX I - XI

ORGANIZATATION AND MANAGEMENT

APPENDIX I-XI

ORGANIZATION AND MANAGEMENT

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APPENDIX I-XI

ORGANIZATION AND MANAGEMENT

1. PRESENT ORGANIZATION FOR IRRIGATION PROJECT

1.1 National Irrigation Administration (NIA)

The NIA is given responsibilities for investigation, planning, designing, construction, procurement, operation and maintenance for all the foreign assisted and locally funded national projects. In the case of the communal irrigation systems, NIA is responsible for the same except for operation and maintenance.

The NIA's regional offices (RIO) are established in each of the 12 regions to implement mainly locally funded national projects. The same are also responsible for activities carried out by the provincial irrigation offices established in most provinces. The major role of the Provincial Irrigation Offices (PIO) is to provide technical assistance for planning, design 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 the farmers irrigators' association for appropriate supervision and for O & M activities.

The organization of NIA is depicted in FIG. XI-1.

1.2 Farmers Irrigators' Association

In the proposed Project area, there are 45 small CIS and one federal CIS composed of 30 small CIS. Each CIS organizes a farmers irrigators' association (FIA or CIA). The federal CIS called Bayombong, Solano, Bagabag, Colocol Federation of Farmers Irrigation Association is the largest irrigators' association in the Province and covers more than 3,000ha.

The details of the major role and activities of the farmers irrigators' association at present for the Nueva Vizcaya Province was discussed in APPENDIX I-VII.

2. PROPOSED ORGANIZATION FOR STAGE I DEVELOPMENT

2.1 Project Execution

Stage I development composed of agricultural development and construction of river embankments will be executed by NIA which will be responsible for the entire stage of pre-project planning and designing, as well as for construction.

For overall execution of the proposed Project, NIA will appoint a Project Manager under the Asst. 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 Asst. Administrator for Operation.

2.2 Organization for Construction Stage

The appointed Project Manager will be directly reponsible for implementation of the Project and for coordination activities of all relevant agencies and farmers irrigators' association. He will be chief of the Project Construction Office which consists of the main office and 7 site offices. The proposed organization chart for the construciton stage is presented in FIG. WI-2.

2.3 Organization for Operation and Maintenance Stage

2.3.1 Project Operation and Maintenance Office

With the progress of the construction works, a part of the Project Construction Office (O & M Office). According to the proposed implementation schedule presented in the MAIN TEXT, 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 of the new system. Regarding river embankment, NIA will transfer the control to MPWH after construction completion for operation and maintenance.

The proposed organization chart and the staff necessary for the Project O & M Office are presented in FIG. XI-3 & 4 and TABLE XI-1. The proposed plan for O & M Organization was prepared based on the current practice applied to the NIA's medium scale irrigation project.

The Office consists of 4 sections, namely, O & M, Collection Service, Agriculture Development and Administration sections.

2.3.2 Roles of the O & M Office

The proposed major roles of the aforementioned sections are as follows:

(1) The Administrative Section is responsible for all administrative activities of the O & M office.

(2) The O & M section is responsible for the following activities:

- estimation of the diversion water requirement by using micro-computors and preparation of the water distribution schedule based on the cropping schedule obtained from farmers irrigators' asociations (FIA) through senior water management technicians;
- control and observation of the major irrigation facilities down to the turnout of on-farm ditches; and,
- 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.

(3) The Collection Service section is responsible for collecting irrigation fees through the federal FIA and for processing data on the said office's computor.

(4) The Agriculture Development section is responsible for assisting and advising farmers in the introduction of irrigated agricultural techniques at the farm level.

(5) The Hill Area Development Section will act as a task force for development in close connection with the relevant agencies. The detailed organization will be set up during the detail design stage.

3. FARMERS IRRIGATORS' ASSOCIATION

3.1 Proposed Farmers Irrigators' Association

As is clearly shown in FIG. VII-11 (1 of 2), TABLE VII-1 and VII-11, all the 75 existing CIS are integrated in the proposed system. The command area of these CIS varies from 25ha to 3200ha and each has its own respective communal irrigation association.

FIG. XI-5 shows the proposed integrated farmers irrigators' association for the overall project. In this figure, only the colocol system is sufficiently organized for the proposed Project. Farmers Irrigators' Groups (FIG) cover an average 50ha, Farmers Irrigators' Association (FIA) an average 750ha and Federal FIA an average 3,000ha. CIS other than Colocol are organized only at the FIG or FIA level, and therefore, organization of higher level associations is recommended during the pre-project stage.

3.2 Water Management of On-Farm Facilities

The items present on the following page were carefully considered in introducing a new water management system into existing FIA.

i) Since the proposed irrigation system was planned based on due consideration of the existing system in order to integrate them with minimum disturbance, existing FIA, which more or less cover 75% of the Project area, will continue to engage in O & M work for the new system as before. The FIA will be responsible for determining the rotation schedule and necessary area to be irrigated and for informing the appropriate O & M Office of the same through the water management technician

ii) Operation and maintenance work for on-farm level facilities will be conducted by the FIA. Therefore the O & M Office will be fully responsible to train members of the FIA concentrating efforts on the equalization of water distribution utilizing existing regulation facilities effectively;

iii) To this end, the staff of the O & M Office should conduct periodical inspection of the said facilities and advise FIG on appropriate management tehcniques based on the O & M Manual to be prepared during the detail design stage by the consultant;

iv) In accordance with the level of FIA water management technique improvement, it will be preferable to transfer administration of certain major irrigation facilities to the FIA from NIA except that of the for diversion dam.

4. OPERATION AND MAINTENANCE COSTS AND IRRIGATION FEES

4.1 Operation and Maintenance Costs

Annual O & M cost for the irrigation project was estimated at US$0.29 million as indicated in TABLE XI-2 based on NIA's 1983 total budget for projects in the country. O & M cost/ha was thus determined at US$23 which is slightly higher than the overall national average of about US$20 pump irrigation system.

In general, the appropriate O & M cost for gravity irrigation systems shoud not exceed the total investment cost. In this Project the said cost was estimated at about 0.5%.

4.2 Irrigation Fees

According to the figures indicated in TABLE XI-3, the collection goal is about 125% of the total O & M budget including contingencies. Applying the said percentage to the proposed Project, the collection goal is estimated at US$29/ha which is equivalent to 3.5 cvs./ha based on the support price of ₱1.7/kg announced as of December 1, 1982. Irrigation fees currently collected for national irrigation systems are predominantly 3 cvs. for dry season and 2 cvs. for wer season, while in the UPRIS, irrigation fees are 3.5 and 2.5 cvs. respectively due to implementation of a new system.

There are a number of existing CIS in the Project area with differing incremental benefit targets according to the irrigation water shortage. Upon completion of the proposed Project, however, the proposed irrigation fee will preferably be equal for the entire area regardless of the present degree of water shortage. Therefore prior to project implementation, it is strongly recommended that NIA obtain the agreement of the proposed irrigators' association with regards to the above condition.

A farm budget analysis which examined the application of a 6 cvs. irrigation fee in the proposed project indicated that the Project would still be justifiably feasible.

PERSONNEL REQUIREMENT FOR OPERATION & MAINTENANCE

Item	Unit Annual Salary (₱)	Total (₱)
1 - Project Manager	26,400	26,400
2 - Asst. Irrigation Engineer	15,300	30,600
Administrative Section		
1 - Cashier	12,300	12,300
2 - Accounting Clerk	9,800	9,800
2 - Clerk	8,200	16,400
2 - Storekeeper	6,600	13,200
2 - Janitor	6,600	13,200
3 - Security Guard	8,800	26,400
2 - Aide	6,600	13,200
1 - Electrician	8,800	8,800
1 - Radio Operator	9,700	9,700
9 - Driver	9,800	88,200
Operation and Maintenance Section		
4 - Sr. Water Management Technician	14,000	56,000
12 - Water Master	10,500	126,000
19 - Gatekeeper	7,900	150,100
72 - Ditch Tender	7,300	525,600
1 - Electromechanical Engineer	16,000	16,000
2 - Mechanic	10,000	20,000
1 - Heavy Equipment Operator	10,800	10,800
2 - Aide	6,600	13,200
Collection Service Section		
1 - Collecting Officer	12,000	12,000
1 - Bill Collector	10,800	10,800
3 - Billing Clerk	8,600	25,800
Agricultural Development Section		
1 - Agric. Extension Specialist	21,500	21,500
1 - Agronomist	17,500	17,500
5 - Agric. Liaison Officer	14,500	72,500
	Sub total	1,346,000
	Total[1/]	2,480,000

1/ Including escalation (1982-83), GSIS, Fund, COLA, other allowance and insurance, etc. (84.4%)

ANNUAL OPERATION AND MAINTENANCE COST

	Item	Cost Amount (₱'000)	Cost Per ha (₱/ha)
1.	Personnel Services[1/] (94.1%)[2/]	2,480	
2.	Contractual Services (0.5%)[2/]	13	
3.	Collection Bonus (0.8%)[2/]	21	
4.	Other O & M Expenses (4.6%)[2/]	121	
	Sub Total	2,635	
5.	Emergency and Contingencies	265	
	Total	2,900	230

1/ See TABLE X-1.

2/ According to the Proposed O & M Budget for National Irrigation Systems for FY 1983, the percentage for these items are obtained from the average of 5 similar projects. (TABLE X-3)
But above item 5 is additional.

O & M BUDGET FOR NATIONAL IRRIGATION SYSTEMS FOR FY 1973

(₱ '000)

Name of Project[1] (Region)	Service Area(ha)	Personnel Services	Contractual Services	Collection Bonus	Other O&M Expenses	Total Budget	Collection Goal	Collection Efficiency(%) 1980	1981	O/M Cost ₱/ha
A. Project(II)	10,534	1,895	-	-	78	1,973	2,387	45	52	187
B. Project(II)	10,926	1,076	-	32	80	1,188	2,577	62	54	109
C. Project(IV)	14,758	2,311	20	45	84	2,460	2,800	101	87	167
D. Project(VI)	12,790	1,665	-	-	93	1,758	2,600	40	58	137
E. Project(VI)	11,779	1,688	17	-	88	1,793	2,801	33	55	152
Total	60,787	8,635	37	77	423	9,172	13,156	58	63	151
Proportion(%)		(94.1)	(0.5)	(0.8)	(4.6)	(100)				
Region II Total[2]	82,426	9,510	-	245	1,007	10,762	26,798	44	61	131
Proportion(%)		(88.3)	(-)	(2.3)	(9.4)	(100)				
National Total[3]	492,107	85,650	1,001	680	12,669	100,000	137,770	53	59	203
Proportion(%)		(85.5)	(1.0)	(0.7)	(12.7)					
Emergency and Contingencies						10,000				

1/ Gravity irrigation system with a scale between 10,000 to 15,000 ha.
2/ Pump irrigation system excluded.
3/ Pump irrigation system included.

ORGANIZATION CHART OF NIA

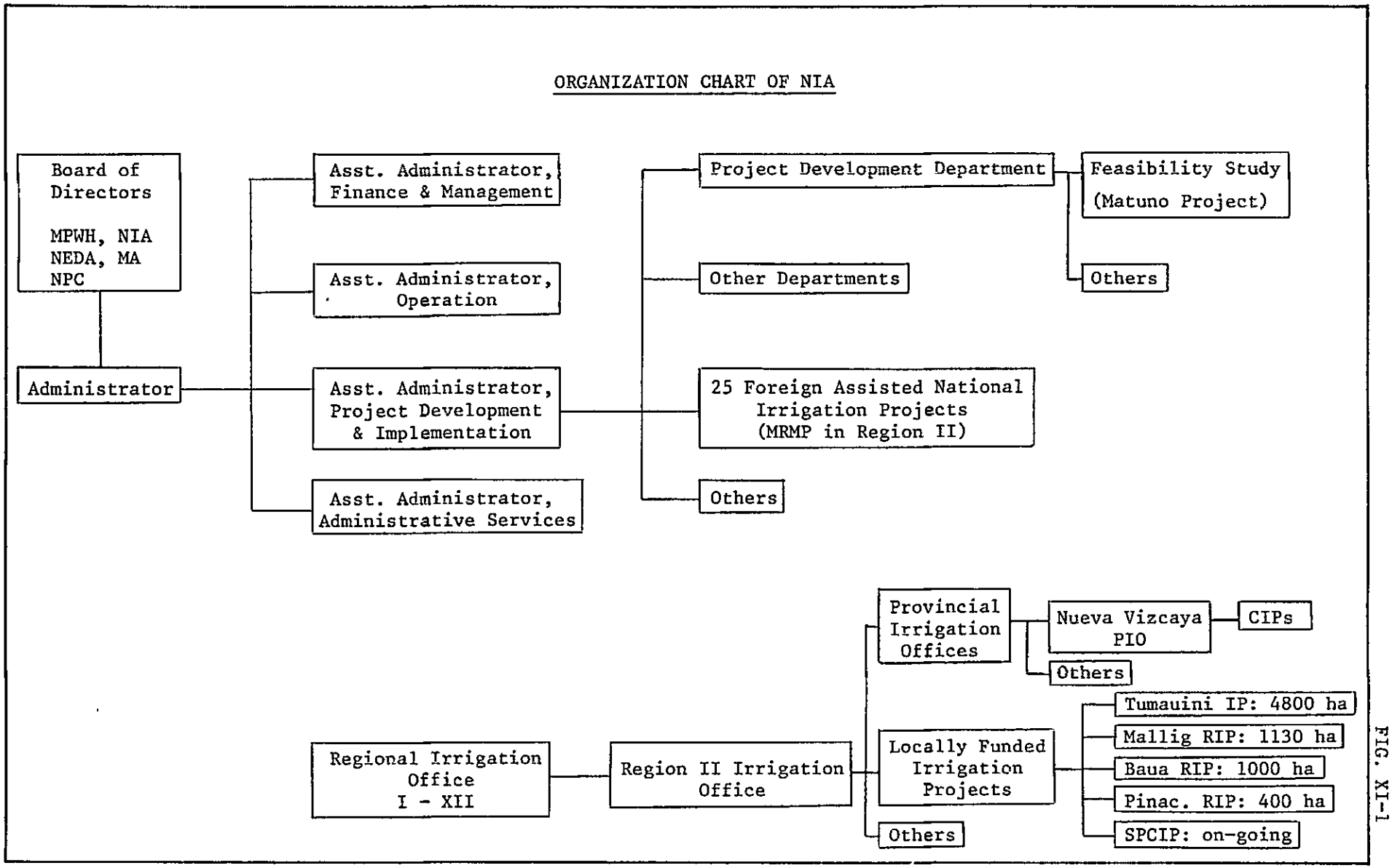


FIG. XI-1

PROPOSED ORGANIZATION CHART FOR PROJECT CONSTRUCTION STAGE I DEVELOPMENT

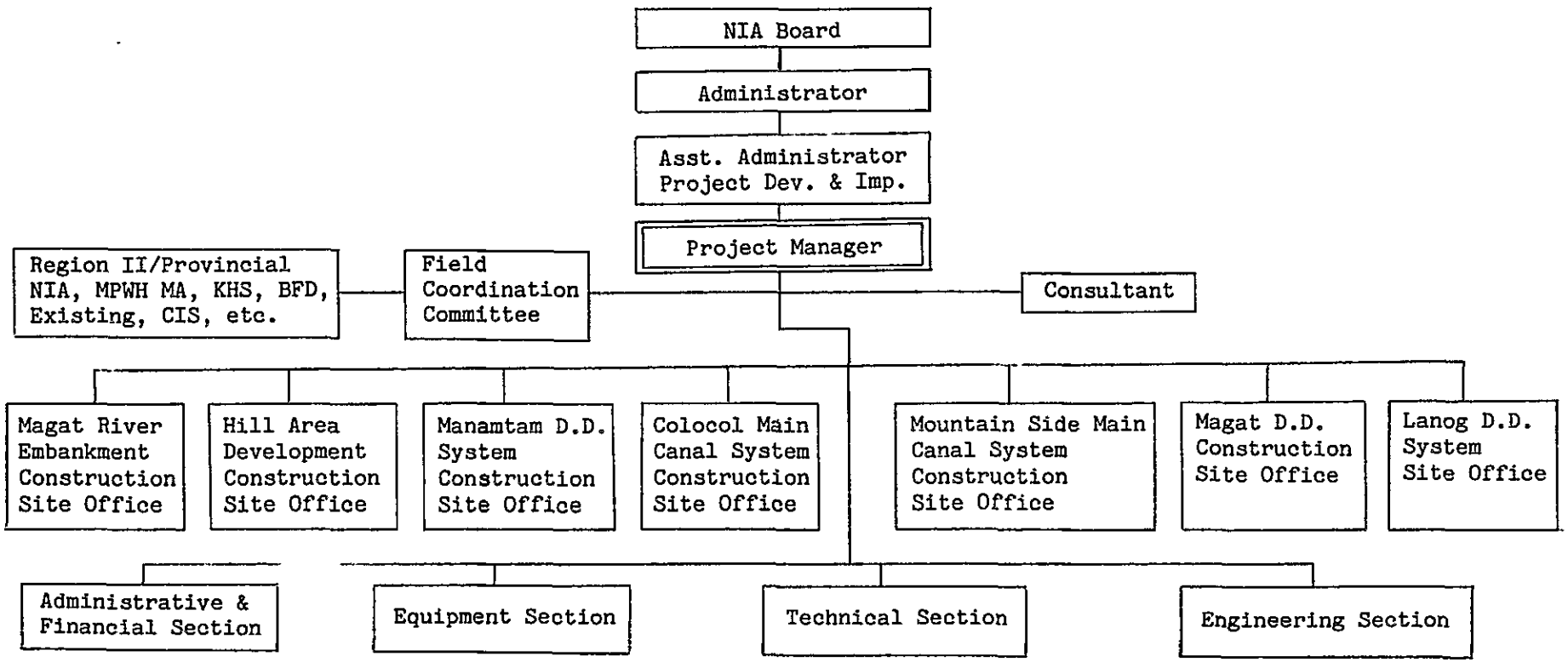
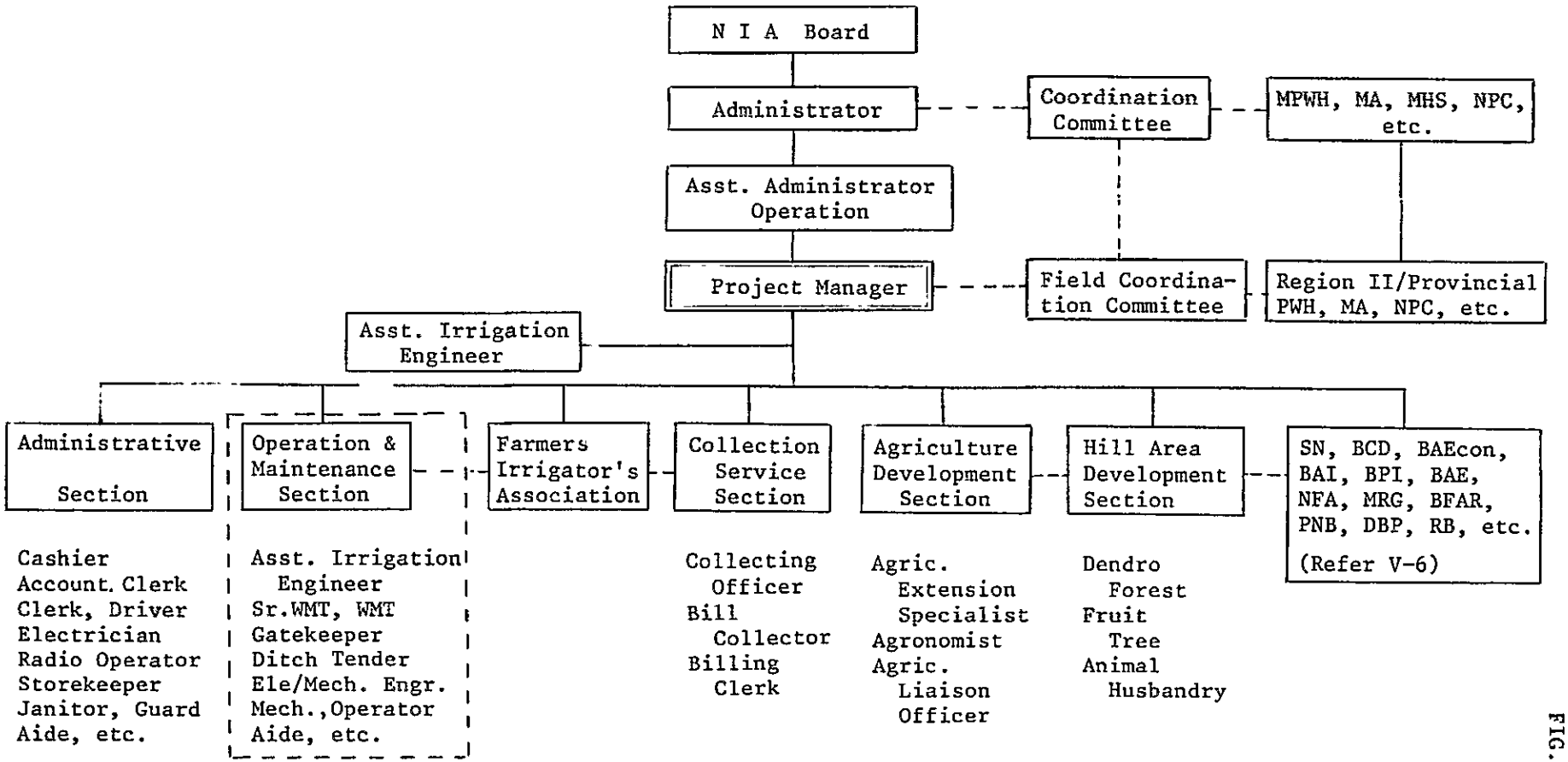


FIG. XI-2

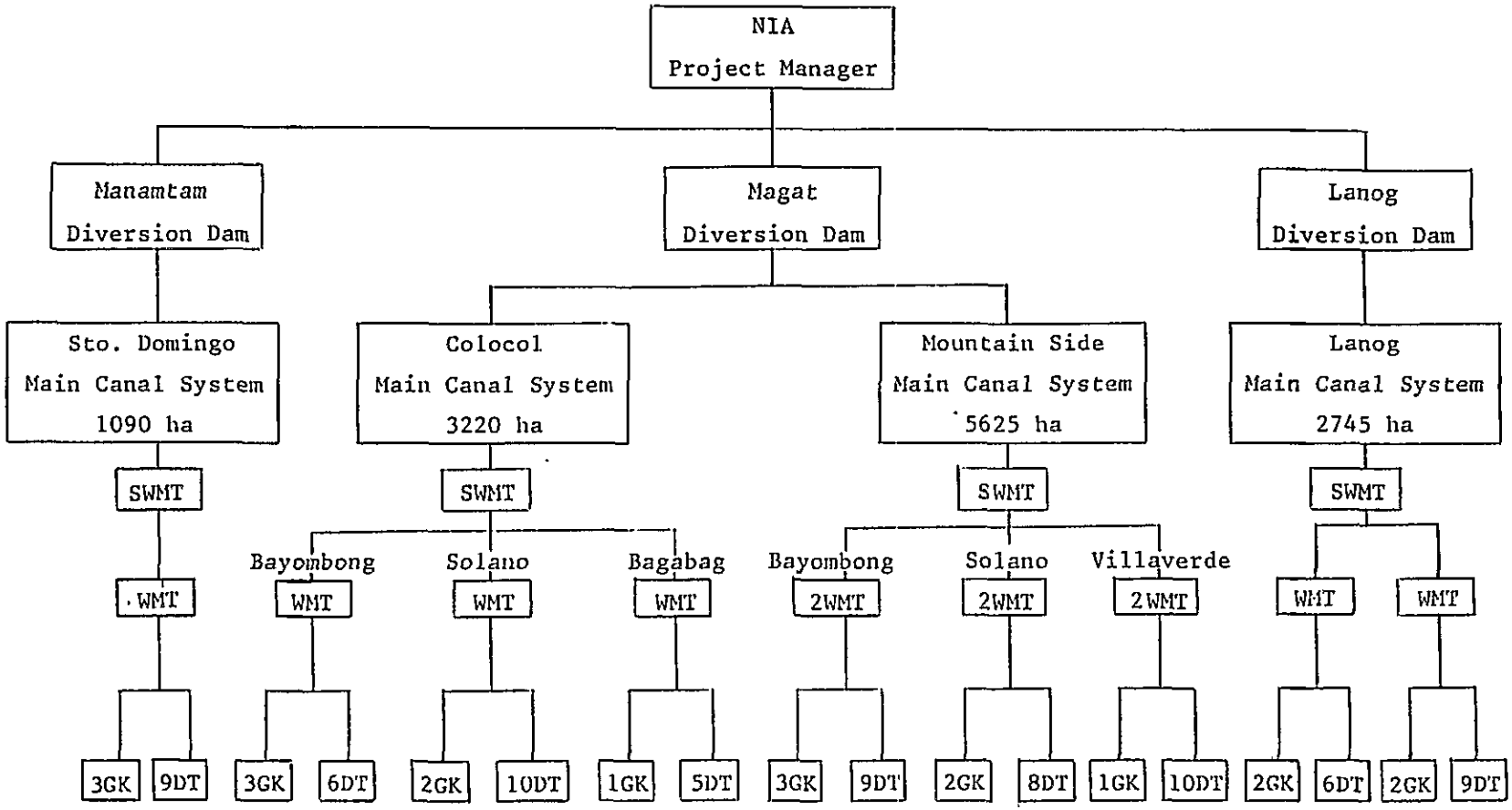
PROPOSED ORGANIZATION CHART FOR OPERATION AND MAINTENANCE
FOR
STAGE I DEVELOPMENT



Note: -O & M for river embankment will be under MPWH, Region II
-O & M organization for Hill Area Development will further be adjusted in the detail design stage

FIG. XI-3

PROPOSED ORGANIZATION FOR OPERATION AND MAINTENANCE



SWMT: Senior Water Management Technician
WMT: Water Master (Water Management Technician)
2GK: 2 Gatekeepers
8DT: 8 Ditch Tenders

FIG. XI-4

PROPOSED INTEGRATED FARMERS IRRIGATORS' ASSOCIATION

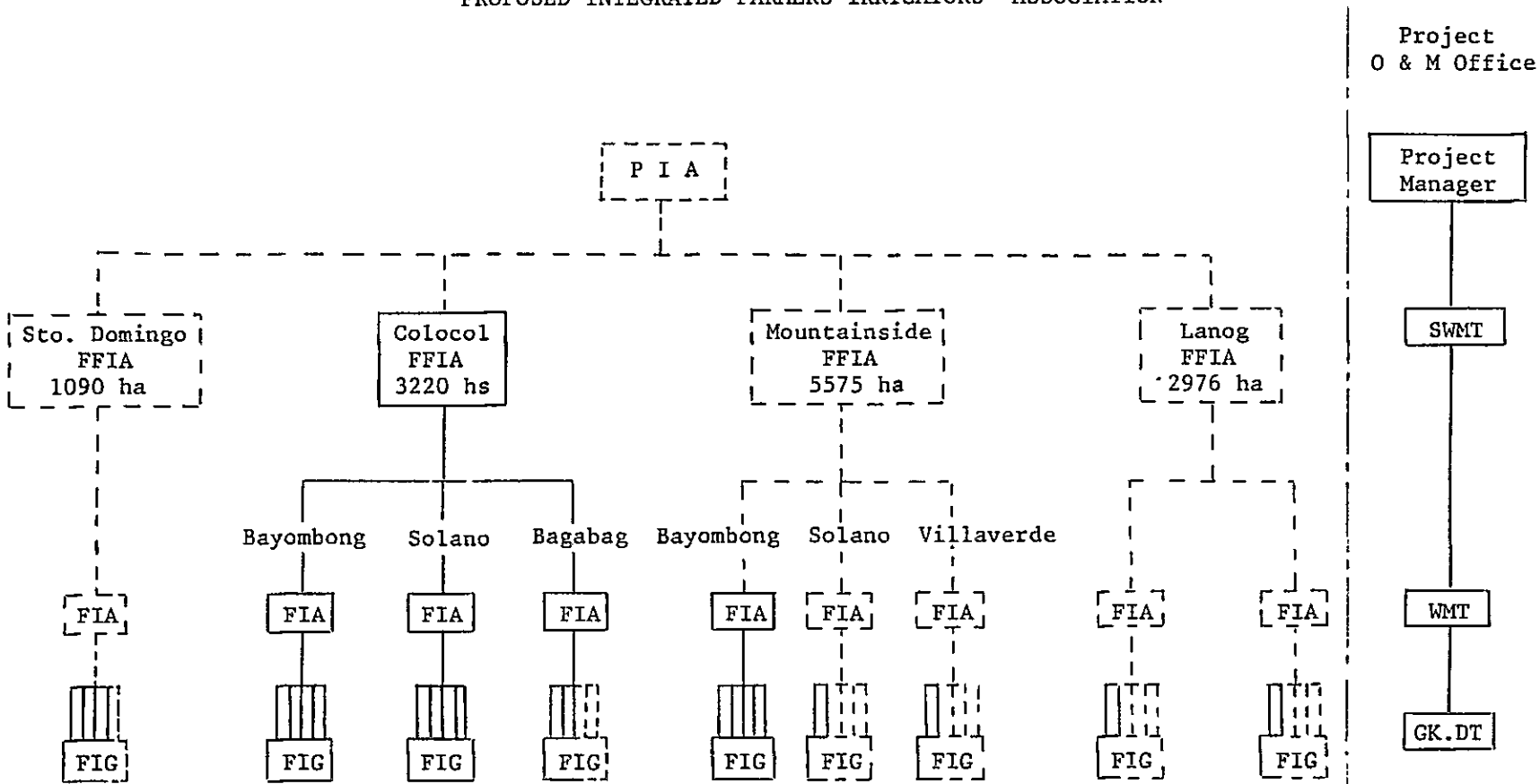


FIG: Farmers Irrigators' Group (Averagely 50 ha)
FIA: Farmers Irrigators' Association (Averagely 750 ha)

FFIA: Federal FIA (1090 - 5575 ha)
PIA: Project IA (12,680 ha)

Note: ▭ existing organization to be integrated into the new system with minimum adjustment
⬚ to be newly organized

FIG. XI-5

APPENDIX I - XII

IMPLEMENTATION SCHEDULE

AND COST ESTIMATE

APPENDIX I-XII

IMPLIMENTATION SCHEDULE AND COST ESTIMATE

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APPENDIX I-XII

IMPLEMENTATION SCHEDULE AND COST ESTIMATE

1. MAIN FEATURES OF STAGE I DEVELOPMENT

The development features of Stage I development, consisting of agriculture and flood protection, are presented in TABLE XII-1.

2. PROJECT IMPLEMENTATION

2.1 Mode of Implementation

Mode of construction for Stage I development is categorized as follows:

(1) International Competitive Bidding (ICB)

ICB including Philippine contractors and suppliers will be applied to all main works and procurement of major equipment except those items inlcluded in (2), (3) and (4) below.

(2) Local Competitive Bidding (LCB)

LCB is applied to specialized and minor works such as portions of surveys and investigations, rehabilitation of access roads, etc.

(3) International Shopping (IS)

IS will be applied for procurement of minor equipment, such as laboratory equipment, vehicles and other equipment for the expatriate consultant, minor equipment for O & M, etc.

(4) Force Account (FA)

Force account will be applied only to specialized work such as entire or part of a survey or investigation, etc. On-farm development construction may be conducted by local farmers under the direction of NIA.

2.2 Implementation Schedule

2.2.1 Pre-Project Stage

Commencement of construction is tentatively scheduled for 1986 after a 2-year pre-project stage as discussed in detail in Chapter 7 of the MAIN REPORT, especially those works concerning strengthening of present organizations, and collection of essential data on present socio-economic and irrigation activities. During the said stage, NIA, assisting PID, will define the boundaries of the total command area of existing CIS and plot the alignment of existing systems on 1/4,000 and 1/10,000 topographical maps.

In the second year of the pre-project stage, actual activities such as additional surveys, investigations, detail design, etc. will commence.

During the pre-project stage, revision of the existing cadastral maps most of which were surveyed in the 1920's is strongly recommended in order to plan and design on-farm facilities.

2.2.2 Construction Stage

The construction schedule is prepared as depicted in Volume 1, MAIN TEXT, and is designed for smooth implementation, demonstration effect, prompt realization of project benefit, etc.

2.2.3 During and After Construction Stage

For prompt realization of Project benefit, construction of on-farm facilities is planned one year after construction of the main and lateral canal systems. Realization of Project benefit can thus be expected from the third year of construction, even before construction completion of the Magat Diversion Dam, the first of the 3 proposed diversion dams. In accordance with this construction schedule, expected irrigation benefits will begin as presented in the following table.

Construction Year	Completed Area	% of Benefit
1st	0	0
2nd	3,481	0
3rd	7,053	7.8
4th	11,989	23.6
Last Year	12,680	53.0
6th	- do -	81.6
7th	- do -	95.7
8th	- do -	100.0

Complete realization of target yeilds can be expected after the build-up stage, 2 years after completion of construction. The build-up stage was determined according to present irrigation conditions and management techniques.

In order to carry out post evaluation, a bench mark survey of agricultural conditions will be conducted by NIA specialists before and after the Project.

2.3 Training

In order to expediate Project Implementation, a total of 14 man-months are proposed for NIA personnel training courses overseas. 6 man-months have been tentatively allocated for the detail design stage, and 8 man-months for construction supervision.

3. COST ESTIMATE

All construction costs are estimated according to current prices as of May 1983. Physical contingency was estimated at 10% of the total cost, composed of direct construction, land acquisition, equipment and engineering administration. Price contingency was estimated according

to 5% and 8% per annum for foreign and local currency portions respectively after examination of future cost escalation factors prepared by ADB for civil works and manufactured goods.

The majority of costs were estimated on the contract basis except costs of on-farm development which were estimated in reference to NIA's force account rate.

Contract cost consists of direct cost, 10% overhead, 10% profit and 3% tax on the same, while force account cost consists of the direct cost and 10% of the same. Since contract work is conducted by ICB, 25% of the cost composed of overhead, profit and tax is allocated to the foreign currency component.

After reviewing the breakdown of unit rates prepared by the NIA counterpart, the applied unit rate was determined based on the adjustment of the above allocation.

The foreign currency ratio of each unit rate indicated in TABLE XII-12 was obtained in accordance with the following NIA criteria analized by the World Bank.

	Item	Foreign Component	Local Component
1.	Cement	75	25
2.	Steel Products	80	20
3.	Fuel and Oil	50	50
4.	Equipment Rental	75	25
5.	Lumber and Aggregate	0	100
6.	Labor	0	100
7.	Gate (domestic)	90	10
8.	Imported Gate, Equipment & Material	100	0

The above approach follows procedural guidelines suggested by NIA counterparts, and current general practices in international project formulation.

Accordingly, the ratio of foreign and local currency components was estimated at 53.4 and 46.6% respectively for overall Project cost for Stage I development which is esimated at US$53.6 million. Breakdown of Project cost is presented from TABLE XII-2 to XII-11.

4. DISBURSEMENT SCHEDULE

TABLE XII-13 presents the disbursement schedule prepared for Stage I development in accordance with the implementation schedule and Project cost.

5. ANNUAL OPERATION AND MAINTENANCE COST

Annual operation and maintenance cost is estimated at US$0.29 million, details of which are discussed in APPENDIX I-XI and TABLE XI-2.

6. REPLACEMENT COST

Gates with accessories are to be replaced once in 25 years and O & M equipment once in 10 years during a 50-year Project life. The replacement cost is thus estimated at US$0.53 million for O & M equipment and US$2.41 million for gates. Details of gates and O & M equipment are attached in TABLE XII-10 and TABLE XII-14.

7. PHASEWISE IMPLEMENTATION PLAN

7.1 Plan Formulation

For Stage I development which includes irrigation and drainage facilities for 12,680ha, hill area development and Magat River embankment, an implementation shcedule and cost estimation plan have been prepared above. In this section, the Team conducted further study for phasewise implementation of Stage I to introduce a smaller annual investment. In the original implementation schedule, construction was to be completed within 5 years from 1986-90. By the introduction of

phasewise development however, the construction period will be longer, and, accordingly total investment cost will increase due to expansion of the price contingency. However, smaller annual investments would present a more realistic plan in light of the present financial condition of the Philippines.

Considering the project components of Stage I development, implementation was divided into three phases. The proposed components for each phase are presented below.

Phase	Major Components	Irrigation Area (ha)
1st	- Rehabilitation/construction of Colocol main and lateral canals	8,955
	- Magat temporary intake facility	
	- Mountain side main and lateral canals up to Bintawan River (Main canal: M-1, M-2, M-3)	
	- Lanog Diversion Dam	
	- Lanog left and right main and lateral canals	
	- Road and on-farm facilities for the above area	
2nd	- Magat Diversion Dam	9,285
	- Colocol main and lateral canals (remainder of 1st Phase)	
	- Road and on-farm facilities for the above area	
	- Flood embankment for 10-year return period flood	
3rd	- Manamtam Diversion Dam	12,680
	- Sto. Domingo main and Lateral canal	
	- Mountain side main and lateral canals downstream from Bintawan River	
	- Road and on-farm facilities for the above area	
	- Flood embankment for 50-year return period flood	
	- Hill area development	

The proposed plans for each phase were formulated as follows.

(1) 1st Phase

As was revealed through investigation and studies, the areas of Bayombong and Solano have the most productive irrigated paddy in the Project area served by the Colocol Communal Irrigation System. Although the present facilities of the said CIS have deteriorated in several locations, proper rehabiltation of the same will have an immediate corresponding effect on production. In addition, the area is at present the center not only of agricultural development but also of social, economical and administrative activities in the Project area. Accordingly, rehabilitation/construction of Colocol main and lateral canals and mountain side main and lateral canals up to the crossing point with the Bintawan River and related road and on-farm facilities are proposed in the 1st phase. To irrigate the above area, water is taken at Magat Diversion Dam under the proposed Project. In the 1st Phase, however, construction of a Magat Temporary intake facility is proposed to realize immediate benefits with minimum investment.

The proposed Lanog Diversion Dam and related facilities will also be implemented in this phase.

(2) 2nd Phase

In the 2nd Phase, the proposed Magat Diversion Dam will be constructed to ensure a more stable water supply. The portion of the Colocol main and lateral canals not constructed in the 1st Phase will be constructed in the 2nd. This phase also includes the construction of flood embankments for the 10-year return period flood discused in APPENDIX I-VIII FLOOD CONTROL.

(3) 3rd Phase

In the 3rd Phase, the remaining works will be implemented; extension of mountain side main and lateral canals, and construction of Manamtam Diversion Dam and all related facilities. The constructed sections of flood embankments will be enlarged for

the 50-year return period flood. Hill area development will also be included in this phase.

7.2 Impementation Schedule

Under phasewise development, the following implementation schedule is proposed:

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993
1st Phase	==========	==========	==========						
2nd Phase				==========	==========	==========			
3rd Phase							==========	==========	==========

In the original plan, the proposed implementation period including detail design was 6 years, while in the phasewise development plan a 9 year period is proposed. The proposed, pre-project stage will occur in 1984 as in the original plan. Implementation of each phase will be overlapped for smooth execution.

7.3 Cost Estimate

Based on the estimated breakdown cost for the original plan, the finacial costs for the three phases were obtained and tabulated in TABLES XII-16. According to the estimation, financial construction cost for 1st, 2nd and 3rd-phase is 27,723 (F.C. 14,572, L.C. 13,151), 17,090 (F.C.9,444, L.C. 7,646) and 17,607 (F.C. 8,613, L.C. 8,994) respectively totalling 62,420 (F.C. 32,629, L.C. 29,791) in US$1,000. The total financial construction cost of US$62.42 million is about 15% higher than that for the original plan because of an increase in price contingency due to the extended implementation schedule.

MAIN FEATURES OF STAGE I DEVELOPMENT

(1) Diversion Dam

	Diversion Dam	Magat Diversion Dam	Lanog Diversion Dam	Manamtam Diversion Dam
1)	Water Source	Magat River	Lanog River	Matuno River
2)	Irrigable Area (ha)	11,590 1/	(2,745) (Return flow)	1,090
3)	Dam Length (m)	305	35	127
4)	Crest Elevation (m)	EL 273.6	EL 230.3	EL 354.0
5)	Weir Height (m)	1.6	1.8	2.5
6)	Type			
	Fixed Portion (m)	Concrete 228m	-	Concrete 118m
	Spillway Gate B x H (m)	Steel Flap 30 x 1.6 x 2 sets	Rubber 35 x 1.8	-
	Scoring Sluice Gate b x H (m)	13 x 1.95	-	5 x 2.5
7)	Intake Structure			
	Design Discharge (m^3/S)	21.4	1.61 (left bank) 3.88 (right bank)	2.18
	Gates (B x H m)	3.85 x 1.5 x 4sets	1.5 x 0.8 x 2sets 2.0 x 1.0 x 2sets	2.0 x 1.5
8)	Head Diversion Structure Gates (B x H m)	4.3 x 2.8 x 1 set 3.2 x 2.2 x 1 set	-	-

1/ consists of

- 5,625ha for mountain side new main canal including 188ha for mountain side of Uddiawan;
- 3,220ha for Colocol existing canal; and,
- 2,745 ha for return flow area extending downstream of Lanog River. Deficit of return flow is supplied by Magat Diversion Dam through mountain side main canal and Bintawan River.

TABLE XII-1
(2 of 5)

MAIN FEATURES OF STAGE I DEVELOPMENT

(2) IRRIGATION SYSTEM

Item	Mountain side Main Canal	Colocol Main Canal	Lanog Main Canal	Sto. Domingo Main Canal	Total
1) Source of irrigation water	Magat River	Magat River	Magat River	Matuno River	
2) Net irrigation area	5,625 ha	3,220ha	2,745ha	1,090ha	12,680 ha
3) Maximum diversion water requirement	14.964cu.m	6.440cu.m	5.490cu.m	2.180cu.m	21.4 cu.m
4) Irrigation facilities					
Main canal	1 Nos.	1 Nos.	2 Nos.	1 Nos.	
- Type of canal	Trapezoidal Unlined	Trapezoidal Riprap lined	Trapezoidal Unlined	Trapezoidal Unlined	
- Side slope of canal	1.5:1	1.5:1	1.5:1	1.5:1	
- Length	26,050 m	21,100 m	22,000 m	21,200 m	90,350 m
Lateral canal & Sub lateral canal	29 Nos.	29 Nos.	19 Nos.	15 Nos.	
- Type of canal	Trapezoidal Unlined	Trapezoidal Unlined	Trapezoidal Unlined	Trapezoidal Unlined	
- Side slope of canal	1.5:1	1.5:1	1.5:1	1.5:1	
- Length	78,100 m	60,100 m	37,350 m	17,850 m	193,400 m
Related structures					
- Headgate & parshall flume	1 Nos.	1 Nos.			
- Double orifice	142 Nos.	99 Nos.	85 Nos.	42 Nos.	368 Nos.
- Fixed proportional divisor	7 Nos.	14 Nos.	2 Nos.	1 Nos.	24 Nos.
- Check	143 Nos.	100 Nos.	85 Nos.	42 Nos.	370 Nos.
- Chute	8 Nos.	24 Nos.	15 Nos.	20 Nos.	67 Nos.
- Vertical drop	316 Nos.	226 Nos.	146 Nos.	59 Nos.	747 Nos.
- Wasteway	5 Nos.	4 Nos.	5 Nos.	3 Nos.	17 Nos.
- Syphon	13 Nos.	7 Nos.	5 Nos.	8 Nos.	33 Nos.
- Drainage culvert	10 Nos.	—	2 Nos.	—	12 Nos.
- Bridge	19 Nos.	9 Nos.	6 Nos.	2 Nos.	36 Nos.
- Pipe road crossing	31 Nos.	38 Nos.	20 Nos.	11 Nos.	100 Nos.
- Drain inlet	27 Nos.		22 Nos.	20 Nos.	69 Nos.

MAIN FEATURES OF STAGE I DEVELOPMENT

(3) Drainage System

Unit: meter

	Newly Constructed	Rehabilitation	Existing	Total
1) Main Canal	2,400	16,500	46,470	65,370
2) Lateral Canal	19,850	13,400	96,300	129,550
3) Drop Structure				208 nos.
4) Drainage Culvert (except all culverts crossing irrigation system)				3 nos.

(4) Road

See Table. TABLE VII-17

(5) On-Farm Development	m/50 ha
1) Main Farm Ditch	800
2) Supplementary Farm Ditch	2,500
3) Farm Drain	2,500
4) Farm Road	1,250

(6) Hill Area Development

1) Development Area	Dendro Forest	100 ha
	Fruit Tree Farm	400 ha
	Animal Grazing	500 ha
2) Farm Road Construction		
5m width and 3.5m width Gravel Paved		20,000m
3) Barbed Wire Fence (H = 1.5m)		18,000m
4) Livestock Water Supply (7.5m x 5.5m)		2 nos.

(7) Flood Protection

1) River Embankment

Crest Width: 6m, Average Height: 2.98m
Slope 1 : 2, Gabion Revetment up to H.W.L. 13,500m

2) Drainage Outlet (with Miter and Slide Gate)

2.4m x 2.4m x 22m x 3 span	4 nos.
1.2m x 1.2m x 22m x 1 span	10 nos.

MAIN FEATURES OF STAGE I DEVELOPMENT

(8) Land Acquisition — Unit: ha

Item	Right of Way (1) Proposed	Right of Way (2) Present	Land Acquisition (1) - (2)
1) Irrigation System			
Main Canal			
M - 1	7.0	-	7.0
M - 2	16.0	-	16.0
M - 3	17.0	-	17.0
M - 4	14.0	-	14.0
M - 5	5.0	-	5.0
C - 1	6.0	6.0	-
C - 2	11.0	11.0	-
C - 3	11.0	11.0	-
C - 4	13.0	8.0	5.0
LL - 1	6.0	1.0	5.0
LL - 2	7.0	4.0	3.0
LR - 1	4.0	-	4.0
LR - 2	6.0	-	6.0
LR - 3	6.0	2.0	4.0
S - 1	7.0	-	7.0
S - 2	15.0	7.0	8.0
S - 3	4.0	-	4.0
Sub-total	155.0	50.0	105.0
Lateral Canal			
Canal Type A	16.0	6.0	10.0
B	57.0	14.0	43.0
C	86.0	19.0	67.0
D	36.0	11.0	25.0
Sub-total	195.0	50.0	145.0
2) Drainage System			
Sub-total	130.0	100.0	30.0
3) Road Network (Inspection road is counted in irrigation system)			
Sub-total	50.0	50.0	0.0

MAIN FEATURES OF STAGE I DEVELOPMEMT

Item		Right of Way (1) Proposed	Right of Way (2) Present	Land Acquisition (1) - (2)
4) On-Farm Facilities				
	Sub-total	430.0	355.0	75.0
5) Others				
	Sub-total	10.0	0.0	10.0
Total		970.0	605.0	365.0
6) River Embankment				
Total		23.0	-	23.0

TABLE XII-2
(1 of 2)

FINANCIAL CONSTRUCTION COST FOR STAGE I DEVELOPMENT
(Agriculture and Flood Protection)

(Unit: US$ '000)

	Description	Foreign Cost	Local Cost	Total
1.	Civil Works	18,266.7	13,830.3	32,097.0
	a) Diversion Dams	4,370.0	2,751.0	7,121.0
	b) Irrigation system	7,491.1	5,599.9	13,091.0
	c) Drainage System	2,195.6	1,933.2	4,128.8
	d) Roads	1,506.5	645.7	2,152.2
	e) On-farm	431.6	1,310.1	1,741.7
	f) Hill Area Development	129.3	79.7	209.0
	g) Flood Protection	2,142.6	1,510.7	3,653.3
2.	Land Acquisition		698.4	698.4
3.	O & M Facilities	530.0	300.0	830.0
4.	Administration and Engineering Cost	2,396.0	1,316.0	3,712.0
	Sub-total (1-4)	21,192.7	16,144.7	37,337.4
5.	Physical Contingency	2,119.2	1.614.5	3,733.7
6.	Price Contingency	5,525.2	7,471.2	12,996.4
	Grand Total	28,837.1	25,230.4	54,067.5

TABLE XII-2
(2 of 2)

DIRECT CONSTRUCTION COST FOR STAGE I DEVELOPMENT
(Agriculture and Flood Protection)

(Unit: US$ '000)

	Description	Foreign Cost	Local Cost	Total
1.	Diversion Dam	4,370.0	2,751.0	7,121.0
	Magat Diversion Dam	3,220.0	2,047.0	5,267.0
	Manamtam Diversion Dam	742.0	570.0	1,312.0
	Lanog Diversion Dam	408.0	134.0	542.0
2.	Irrigation Canal and Related Structure	7,491.1	5,599.9	13,091.0
	Main Canal	4,825.7	3,711.3	8,537.0
	Lateral Canal	2,665.4	1,888.6	4,554.0
3.	Drainage System	2,195.6	1,933.2	4,128.8
	Improvement of Lanog River	898.8	914.1	1,812.9
	Drainage System	1,296.8	1,019.1	2,315.9
4.	Road	1,506.5	645.7	2,152.2
5.	On-farm Development	431.6	1,310.1	1,741.7
6.	Hill Area Development	129.3	79.7	209.0
7.	Flood Protection	2,142.6	1,510.7	3,653.3
	Grand Total	18,266.7	13,830.3	32,097.0

TABLE XII-3
(1 of 4)

BREAKDOWN OF DIRECT CONSTRUCTION COST FOR DIVERSION DAM

(Unit: US$ '000)

Work Item	Q'ty	Unit	Foreign	Local	Total
Magat Diversion Dam					
Access Road	200	m	3.8	2.4	6.2
Excavation	118,000	m^3	104.1	108.3	212.4
Compacted Fill	49,700	m^3	40.5	39.0	79.5
Class "A" Concrete	14,520	m^3	1,463.6	1,150.0	2,613.6
Class "B" Concrete	2,510	m^3	195.8	195.8	391.6
Plain Concrete	1,110	m^3	68.4	33.7	102.1
Gabion	7,630	m^2	83.3	57.9	141.2
Water Stop (300)	620	m	6.1	0.7	6.8
Metal Work	20	ton	15.2	5.9	21.1
Gates					
Fixed wheel (13 x 2.50)	1	set	178.7	19.5	198.2
Steel flap (30 x1.60)	2	set	422.4	48.0	470.4
Fixed wheel (3.85 x 1.50)	4	sets	94.7	11.6	106.3
Sub-total			2,676.6	1,672.8	4,349.4
Miscellaneous			80.4	50.2	130.6
Total			2,757.0	1,723.0	4,480.0

TABLE XII-3
(2 of 4)

BREAKDOWN OF DIRECT CONSTRUCTION COST FOR DIVERSION DAM

(Unit: US$ '000)

Work Item	Q'ty	Unit	Foreign	Local	Total
Head Diversion Structure					
Access Road	100	m	1.9	1.2	3.1
Excavation	30,200	m^3	26.7	27.7	54.4
Filling Around Structure	3,400	m^3	2.1	4.0	6.1
Compacted Fill	14,700	m^3	12.0	11.5	23.5
Class "A" Concrete	2,310	m^3	232.8	183.0	415.8
Class "B" Concrete	260	m^3	20.3	20.3	40.6
Plain Concrete	400	m^3	13.9	6.9	20.8
Rubble Masonry	1,740	m^3	56.4	48.0	104.4
Gravel Blanket	510	m^3	3.4	2.7	6.1
Water Stop (200)	230	m	1.2	0.1	1.3
Metal Work	0.5	ton	0.4	0.1	0.5
Gates					
Fixed wheel	1	set	178.7	19.5	198.2
(4.3 x 2.8m)	1	no	49.4	6.0	55.4
-. do -	1	no	28.9	3.5	32.4
Sub-total			449.4	315.0	764.4
Miscellaneous			13.6	9.0	22.6
Total			463.0	324.0	787.0

TABLE XII-4
(3 of 4)

BREAKDOWN OF DIRECT CONSTRUCTION COST FOR DIVERSION DAM

(Unit: US$ '000)

Work Item	Q'ty	Unit	Foreign	Local	Total
Manamtam Diversion Dam					
Access Road	1,100	m	20.9	13.2	34.1
Excavation	40,300	m^3	35.5	37.0	72.5
Compacted Fill	20,600	m^3	16.8	16.2	33.0
Class "A" Concrete	4,520	m^3	455.6	358.0	813.6
Class "B" Concrete	1,470	m^3	114.7	114.6	229.3
Plain Concrete	195	m^3	6.8	3.3	10.1
Metal Work	195	ton	9.1	3.6	12.7
Water Stop (200)	120	m	0.6	0.1	0.7
Gates					
Fixed wheel (5.0 x 2.5m)	1	set	51.2	6.3	57.5
Slide (2.0 x 1.5m)	1	set	9.3	1.2	10.5
Sub-total			720.5	553.5	1,274.0
Miscellaneous			21.5	16.5	38.0
Total			742.0	570.0	1,312.0

TABLE XII-3
(4 of 4)

BREAKDOWN OF DIRECT CONSTRUCTION COST FOR DIVERSION DAM

(Unit: US$ '000)

Work Item	Q'ty	Unit	Foreign	Local	Total
Lanog Diversion Dam					
Access Road	300	m	5.7	3.6	9.3
Excavation	2,400	m^3	2.1	2.2	4.3
Filling Around Structure	220	m^3	0.1	0.3	0.4
Compacted Fill	870	m^3	0.7	0.7	1.4
Class "A" Concrete	1,120	m^3	112.9	88.7	201.6
Plain Concrete	130	m^3	4.6	2.2	6.8
Grouted Rip-rap	140	m^3	3.4	1.6	5.0
Gabion	260	m^2	2.8	2.0	4.8
Water Stop (200)	50	m	0.2	0.1	0.3
Metal Work	2.5	ton	1.9	0.7	2.6
Slide Gate					
(1.5x 0.8m)	2	sets	7.4	1.0	8.4
(2.0 x 1.2m)	2	sets	14.9	1.9	16.8
Rubber Dam (35 x 1.8m)	1	set	239.4	25.2	264.6
Sub-total			396.1	130.2	526.3
Miscellaneous			11.9	3.8	15.7
Total			408.0	134.0	542.0

TABLE XII-4
(1 of 2)

BREAKDOWN OF DIRECT CONSTRUCTION COST FOR IRRIGATION SYSTEM

(Unit: US$ 000)

Description	Q'ty	Unit	Foreign	Local	Total
Main Canal					
Earth Work					
Excavation	785,800	m^3	693.1	721.3	1,414.4
Compaction fill	911,000	m^3	1,451.2	1,008.5	2,459.7
Class "A" Concrete	13,590	m^3	1,369.9	1,076.3	2,446.2
Grouted Riprap	2,930	m^3	71.7	33.8	105.5
Plain Riprap	74,140	m^3	815.5	667.3	1,482.8
Slide Gate (local)	254	m^3	381.8	42.4	424.2
Pipe Work (concrete)					
42"	547	m	26.5	15.6	42.1
36"	40	m	1.6	1.0	2.6
30"	88	m	2.8	1.8	4.6
24"	190	m	4.5	2.9	7.4
18"	100	m	1.6	1.1	2.7
12"	50	m	0.8	0.5	1.3
Turfing	270,000	m^2		135.0	135.0
Concrete Demo.	500	m^3	4.7	3.8	8.5
Total			4,825.7	3,711.3	8,537.0
Lateral Canal					
Earth Work					
Excavation	42,200	m^3	37.2	38.8	76.0
Compaction fill	692,700	m^3	1,103.5	766.8	1,870.3
Class "A" Concrete	9,370	m^3	944.5	742.1	1,686.6
Grouted Riprap	2,460	m^3	60.2	28.4	88.6
Slide Gate (local)	286	m^3	429.8	47.8	477.6
Pipe Work (concrete)					
30"	1,552	m	49.2	31.5	80.7
12"	1,460	m	22.4	16.3	38.7
Turfing	399,800	m^2		199.9	199.9
Total			2,646.8	1,871.6	4,518.4

TABLE XII-4
(2 of 2)

BREAKDOWN OF DIRECT CONSTRUCTION COST FOR IRRIGATION SYSTEM

(Unit: US$ '000)

Description	Q'ty	Unit	Foreign	Local	Total
Development of Mountain Side Uddiawan					
Earth Work					
Excavation	340	m^3	0.3	0.3	0.6
Compaction fill	5,250	m^3	8.4	5.8	14.2
Class "A" Concrete	83	m^3	8.3	6.6	14.9
Slide Gate (local)	1	m^3	1.5	0.2	1.7
Pipe Work (24" dia)	5	m	0.1	0.1	0.2
Turfing	8,000	m^2	-	4.0	4.0
Total			17.0	18.6	35.6

TABLE XII-5

BREAKDOWN OF DIRECT CONSTRUCTION COST FOR DRAINAGE SYSTEM

(Unit: US$ '000)

Description	Q'ty	Unit	Foreign	Local	Total
Improvement of Lanog River					
Earth Work					
Excavation	393,600	m^3	347.2	361.3	708.5
Compaction fill	117,800	m^3	187.7	130.4	318.1
Class "A" Concrete	3,400	m^3	342.7	269.3	612.0
Grouted Riprap	480	m^3	11.8	5.5	17.3
Concrete Demo.	1,000	m^3	9.4	7.6	17.0
Turfing	280,000	m^2		140.0	140.0
Total			898.8	914.1	1,812.9
Other Drainage Systems					
Earth Work					
Excavation	564,600	m^3	498.0	518.3	1,016.3
Compaction fill	14,000	m^3	22.3	15.5	37.8
Class "A" Concrete	3,210	m^3	323.6	254.2	577.8
Grouted Riprap	17,740	m^3	434.2	204.4	638.6
Concrete Demo.	2,000	m^3	18.7	15.3	34.0
Turfing	22,800	m^2		11.4	11.4
Total			1,296.8	1,019.1	2,315.9

TABLE XII-6

BREAKDOWN OF DIRECT CONSTRUCTION COST FOR ROADS AND ON-FARM DEVELOPMENT

(Unit: US$ '000)

Description	Q'ty	Unit	Foreign	Local	Total
Roads					
Compaction fill: included in estimation of irrigation					
Turfing: included in estimation of irrigation					
Gravel or Selected Mat. Surfacing	195,650	m^3	1,506.5	645.7	2,152.2
Total			1,506.5	645.7	2,152.2
On-farm Area	12,680	ha	431.6	1,310.1	1,741.7
Total			431.6	1,310.1	1,741.7

TABLE XII-7

BREAKDOWN OF DIRECT CONSTRUCTION COST FOR HILL AREA DEVELOPMENT

(Unit: US$ '000)

Work Item	Q'ty	Unit	Foreign	Local	Total
1. Farm Road	20	km			
Excavation	10,000	m^3	8.8	9.2	18.0
Embankment	30,000	m^3	47.8	33.2	81.0
Gravel or Selected Mat. Surfacing	8,300	m^3	63.9	27.4	91.3
2. Pasture Fence	18	km			
Barbed Wire	36,000	m	1.7	0.5	2.2
Wooden Pile	6,200	no	1.4	5.4	6.8
3. Livestock Water Supply	2	no			
Class "A" Concrete	16	m^3	1.6	1.3	2.9
Plain Riprap	10	m^3	0.1	0.1	0.2
Concrete Pipe ø25	20	m	0.3	0.2	0.5
Sub-total			125.6	77.3	202.9
Miscellaneous			3.7	2.4	6.1
Total			129.3	79.7	209.0

TABLE XII-8

BREAKDOWN OF DIRECT CONSTRUCTION COST FOR RIVER EMBANKMENT

(50-year Return Period Flood)

(Unit: US$ '000)

	Description	Q'ty	Unit	Foreign	Local	Total
1.	Civil Works					
	Cleaning and Grubbing	692,675	m^2	86.9	44.7	131.6
	Excavation	468,466	m^3	413.2	430.0	843.2
	Compacting Fill	468,466	m^3	746.3	518.6	1,264.9
	Turfing	83,756	m^2	-	41.9	41.9
	Gabion (t=0.4m)	31,589	m^3	344.8	239.6	584.4
	Class "A" Concrete	1,980	m^3	199.6	156.8	356.4
	Grouted Riprap	340	m^3	8.3	3.9	12.2
	Gate	187	m^2	281.1	31.2	312.3
	Sub-total			2,080.2	1,466.7	3,546.9
	Miscellaneous			62.4	44.0	106.4
	Total			2,142.6	1,510.7	3,653.3
2.	Land Acquisition	23	ha	-	41.4	41.4

TABLE XII-9

BREAKDOWN OF DIRECT CONSTRUCTION COST FOR RIVER EMBANKMENT

(10-year Return Period Flood)

(Unit: US$ '000)

	Description	Q'ty	Unit	Foreign	Local	Total
1.	Civil Works					
	Cleaning and Grubbing	582,389	m^2	73.1	37.6	110.7
	Excavation	315,816	m^3	278.6	289.9	568.5
	Compacting Fill	315,816	m^3	503.1	349.6	852.7
	Turfing	63,206	m^2	-	31.6	31.6
	Gabion (t=0.4m)	26,994	m^3	294.6	204.8	499.4
	Class "A"Concrete	1,980	m^3	199.6	156.8	356.4
	Grouted Riprap	340	m^3	8.3	3.9	12.2
	Gate	187	m^2	281.1	31.2	312.3
	Sub-total			1,638.4	1,105.4	2,743.8
	Miscellaneous			49.2	33.2	82.4
	Total			1,687.6	1,138.6	2,826.2
2.	Land Acquisition	21	ha	-	37.8	37.8

TABLE XII-10

BREAKDOWN OF OPERATION AND MAINTENANCE FACILITIES

(Unit: US$ '000)

Item	Foreign	Local	Total
1. Bulldozer: 11 tons @ 1 no	62.5		
2. Backhoe	62.5		
3. Dump Truck: 4 ton @ 2 nos	31.0		
4. Jeep: 8 nos	125.0		
5. Motorcycle: 24 nos	25.0		
6. Computer	10.5		
7. Radio Set 1/	12.5		
8. Spare Parts & Equipment	66.0		
9. Miscellaneous	135.0		
10. Project Office cum O & M 2/ office		300.0	
Total	530.0	300.0	830.0

1/ 1 center and 7 slave stations

2/ 1,500m^2

TABLE XII-11

BREAKDOWN OF ADMINISTRATION AND ENGINEERING COST

(Unit: US$ '000)

Description	Foreign Cost	Local Cost	Total
1. Pre-Engineering			
Survey	-	53.0	53.0
Geological Investigation	-	52.0	52.0
2. Laboratory Equipment	40.0	-	40.0
3. Government Administration	-	957.0	957.0
4. Engineering Consultant	2,286.0	254.0	2,540.0
5. Training	70.0	-	70.0
Total	2,396.0	1,316.0	3,712.0

TABLE XII-12

UNIT RATE

(Unit: US$)

Item	Unit	Force Account Unit Cost	Force Account Foreign	Contract Work Unit Cost	Contract Work Foreign
Class "A" Concrete	m^3	150.0	47	180.0	56
Class "B" Concrete	m^3	130.0	40	156.0	50
Plain Concrete	m^3	42.0	63	52.0	67
Plain Riprap	m^3	16.5	46	20.0	55
Grouted Riprap	m^3	29.5	61	36.0	68
Rubble Masonry	m^3	49.5	44	60.0	54
Pipe Work (concrete)					
a) 48" dia	m	76.0	55	93.0	63
b) 42" dia	m	63.0	55	77.0	63
c) 36" dia	m	53.0	54	65.0	62
d) 30" dia	m	43.0	53	52.0	61
e) 24" dia	m	32.0	53	39.0	61
f) 18" dia	m	22.0	50	26.5	58
g) 12" dia	m	22.0	50	26.5	58
Cleaning & Grubbing	m^2	0.15	62	0.19	66
Excavation (some indurated)	m^3	1.4	34	1.8	49
Compacting Fill (some hailing)	m^3	2.2	50	2.7	59
Fill Around Structure	m^3	15.5	21	1.8	35
Compacting Fill Only	m^3	1.3	42	1.6	51
Turfing	m^2	-	-	0.5	0
Concrete Demolition	m^3	14.5	47	17.0	55
Gravel or Selected Mat. Surfacing	m^3	9.0	63	11.0	70
Gravel Blanket	m^3	10.0	45	12.0	56
Main Farm Ditch	km	790.0	0	902.0	0
Sup. Farm Ditch	km	640.0	0	730.0	0
Sup. Farm Drain	km	480.0	0	550.0	0
Slide Gate (local)	m^2	-	-	1,670.0	90
Gabion	m^3	-	-	18.5	59
Metal Work	ton	-	-	1,055.0	72
Water Stop (200)	m	-	-	5.5	90
Water Stop (300)	m	-	-	11.0	90

ANNUAL DISBURSEMENT SCHEDULE OF INVESTMENT COST FOR STAGE I DEVELOPMENT

(Unit: US$ '000)

Description	Total			1985			1986			1987			1988			1989			1990		
	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.
1. Pre-Engineering	105.0	-	105.0	105.0	-	105.0															
2. Civil Works																					
a) Diversion Dam	7,121.0	4,370.0	2,751.0				1,031.9	807.0	224.9	2,328.0	1,387.7	940.3	2,974.1	1,730.3	1,243.8	787.0	445.0	342.0	-	-	-
b) Irrigation System	13,091.0	7,491.1	5,599.9				1,337.2	762.2	575.0	3,160.4	1,807.6	1,352.8	3,532.1	2,023.0	1,509.1	4,235.8	2,427.5	1,808.3	825.5	470.8	354.7
c) Drainage System	4,128.8	2,195.6	1,933.2				250.0	140.0	110.0	900.0	446.2	453.8	500.0	280.0	220.0	950.0	503.1	446.9	1,528.8	826.3	702.5
d) Road Network	2,152.2	1,506.5	645.7				150.7	105.5	45.2	452.0	316.4	135.6	581.1	406.7	174.4	796.3	557.4	238.9	172.1	120.5	51.6
e) On-Farm Dev't	1,741.7	431.6	1,310.1				-	-	-	478.1	118.5	359.6	490.8	121.6	369.2	677.9	168.0	509.9	94.9	23.5	71.4
f) Hill Development	209.0	129.3	79.7				-	-	-	-	-	-	-	-	-	-	-	-	209.0	129.3	79.7
g) River Embankment	3,653.3	2,142.6	1,510.7				-	-	-	836.5	490.2	346.3	1,157.5	679.1	478.4	1,157.4	679.1	478.3	501.9	294.2	207.7
Sub-Total	32,097.0	18,266.7	13,830.3				2,769.8	1,814.7	955.1	8,155.0	4,566.6	3,588.4	9,235.6	5,240.7	3,994.9	8,604.4	4,780.1	3,824.3	3,332.2	1,864.6	1,467.6
3. Land Acquisition	698.4	-	698.4				52.9	-	52.9	175.5	-	175.5	185.7	-	185.7	223.1	-	223.1	61.2	-	61.2
4. O/M Equipment	830.0	530.0	300.0				210.0	-	210.0	620.0	530.0	90.0	-	-	-	-	-	-	-	-	-
5. Administration and Engineering	3,537.0	2,326.0	1,211.0	1,103.2	990.0	113.2	483.1	364.0	119.1	604.7	324.0	280.7	572.5	270.0	302.5	493.5	216.0	277.5	280.0	162.0	118.0
6. Training	70.0	70.0	-	30.0	30.0	-	20.0	20.0	-	20.0	20.0	-	-	-	-	-	-	-	-	-	-
Total (1 - 6)	37,337.4	21,192.7	16,144.7	1,238.2	1,020.0	218.2	3,535.0	2,198.7	1,337.1	9,575.2	5440.6	4,134.6	9,993.8	5,510.7	4,483.1	9,321.0	4,996.1	4,324.9	3,673.4	2,026.6	1,646.8
7. Physical Contingency	3,733.7	2,119.2	1,614.5	123.8	102.0	21.8	353.6	219.9	133.7	957.5	544.1	413.4	999.4	551.0	448.4	932.1	499.6	432.5	367.3	202.6	164.7
Total (1 - 7)	41,071.1	23,311.9	17,759.2	1,362.0	1,122.0	240.0	3,889.4	2,418.6	1,470.8	10,532.7	5,984.7	4,548.0	10,993.2	6,061.7	4,931.5	10,253.1	5,495.7	4,757.4	4,040.7	2,229.2	1,811.5
8. Price Contingency	12,996.4	5,525.2	7,471.2	114.6	85.2	29.4	625.8	313.8	312.0	2520.3	1,114.4	1,405.9	3,529.3	1,488.3	2,041.0	4,198.6	1,691.6	2,507.0	2,007.8	831.9	1,175.9
Total	54,067.5	28,837.1	25,230.4	1,476.6	1,207.2	269.4	4,515.2	2,732.4	1,782.8	13,053.0	7,099.1	5,953.9	14,522.5	7,550.0	6,972.5	14,451.7	7,187.3	7,264.4	6,048.5	3,061.1	2,987.4

Replacement Cost of Gates

	Item	Number of Gates	Size (m) B x H	Cost (US$ '000) Foreign	Local	Total
1.	Diversion Dam	1	13 x 2.5	178.7	19.5	198.2
	- Magat	2	30 x 1.6	422.4	48.0	470.2
		4	3,85 x 1.5	94.7	11.6	106.3
		1	4.3 x 2.8	49.4	6.0	55.4
		1	3.2 x 2.2	28.9	3.5	32.4
	- Manamtam	1	5.0 x 2.5	51.2	6.3	57.5
		1	2.0 x 1.5	9.3	1.2	10.5
	- Lanog	2	1.5 x 0.8	7.4	1.0	8.4
		2	2.0 x 1.2	14.9	1.9	16.8
		1 (rubber)	35 x 1.8	239.4	25.2	264.6
2.	Irrigation System (local manufacture)	Total 541m^2		813.1	90.4	903.5
3.	River Embankment (local manufacture)	Total 170m^2		255.5	28.4	283.9
	TOTAL			2,164.9	243.0	2,407.9

TABLE XII-15
(1 of 3)

FINANCIAL CONSTRUCTION COST FOR 1ST PHASE
IN STAGE I DEVELOPMENT

(Unit: US$ '000)

	Description	Foreign Cost	Local Cost	Total
1.	Civil Works	9,761	7,737	17,498
	a) Magat Temporary Intake Facility	175	125	300
	b) Lanog Diversion Dam	408	134	542
	c) Irrigation System			
	Colocol	1,545	1,155	2,700
	Mountain Side and Lanog	4,025	3,009	7,034
	d) Drainage System	1,648	1,452	3,100
	e) Roads	1,018	436	1,454
	f) On-farm	303	920	1,223
	g) Miscellanous	639	506	1,145
2.	Land Acquisition	-	370	370
3.	O & M Facilities	370	210	580
4.	Administration and Engineering	1,129	926	2,055
	Sub-total (1-4)	11,260	9,243	20,503
5.	Physical Contingency	1,126	924	2,050
6.	Price Contingency	2,186	2,984	5,170
	Grand Total	14,572	13,151	27,723

TABLE XII-15
(2 of 3)

FINANCIAL CONSTRUCTION COST FOR 2ND PHASE
IN STAGE I DEVELOPMENT

(Unit: US$ '000)

	Description	Foreign Cost	Local Cost	Total
1.	Civil Works	5,624	3,718	9,342
	a) Magat Diversion Dam	3,220	2,047	5,267
	b) Colocol Irrigation System (remaining)	180	136	316
	c) Drainage System	110	96	206
	d) Roads	46	19	65
	e) On-farm	13	39	52
	f) Flood Embankment (1/10)	1,688	1,138	2,826
	g) Miscellaneous	367	243	610
2.	Land Acquisition	-	123	123
3.	O & M Facilities	32	18	50
4.	Administration and Engineering	714	480	1,194
	Sub-total (1-4)	6,370	4,339	10,709
5.	Physical Contingency	637	434	1,071
6.	Price Contingency	2,437	2,873	5,310
	Grand Total	9,444	7,646	17,090

TABLE XII-15
(3 of 3)

FINANCIAL CONSTRUCTION COST FOR 3RD PHASE
IN STAGE I DEVELOPMENT

(Unit: US$ '000)

	Description	Foreign Cost	Local Cost	Total
1.	Civil Works	4,538	3,556	8,094
	a) Magat Diversion Dam	742	570	1,312
	b) Mountain Side (remaining) and Sto. Damingo Irrigation System	1,740	1,301	3,041
	c) Drainage System	438	385	823
	d) Roads	443	190	633
	e) On-farm	116	351	467
	f) Flood Embankment (1/50)	633	446	1,079
	g) Hill Area Development	129	80	209
	h) Miscellaneous	297	233	530
2.	Land Acquisition	-	205	205
3.	O & M Facilities	128	72	200
4.	Administration and Engineering	478	378	856
	Sub-total (1-4)	5,144	4,211	9,355
5.	Physical Contingency	514	421	935
6.	Price Contingency	2,955	4,362	7,317
	Grand Total	8,613	8,994	17,607

DISBURSEMENT SCHEDULE: PHASE I, II & III

1ST PHASE

DESCRIPTION	1985 (1)	1985 (2)	1986 (1)	1986 (2)	1987 (1)	1987 (2)	1988 (1)	1988 (2)	Total (1)	Total (2)
Foreign	1,239	94	3,344	434	4,335	807	3,468	851	12,386	2,186
Local	1,017	124	2,745	582	3,558	1,100	2,847	1,178	10,167	2,984
Total	2,256	218	6,089	1,016	7,893	1,907	6,315	2,029	22,553	5,170

2ND PHASE

DESCRIPTION	1988 (1)	1988 (2)	1989 (1)	1989 (2)	1990 (1)	1990 (2)	1991 (1)	1991 (2)	Total (1)	Total (2)
Foreign	701	172	2,452	755	2,803	1,046	1,051	464	7,007	2,437
Local	477	194	1,671	881	1,909	1,239	716	559	4,773	2,873
Total	1,178	366	4,123	1,636	4,712	2,285	1,767	1,023	11,780	5,310

3RD PHASE

DESCRIPTION	1991 (1)	1991 (2)	1992 (1)	1992 (2)	1993 (1)	1993 (2)	Total (1)	Total (2)
Foreign	1,415	625	2,263	1,163	1,980	1,167	5,658	2,955
Local	1,158	904	1,853	1,711	1,621	1,747	4,632	4,362
Total	2,573	1,529	4,116	2,874	3,601	2,914	10,290	7,317

Note: (1) = Cost; (2) = Price Contingency