Seasonal fishing in operated in the San Antonio Swamp (about 13,400 ha) and Candaba Swamp (11,100 ha). Fishing season starts when the water level of the swamps go down after the rainy season and fishes come down to the lowest parts of the swamps. The swamps are usually owned by a few land-owners. For example, the Candaba Swamp of 5,800 ha is divided by 187 private land-owners/1. They charge the fish catch of 85% as fishing fee to the people who want to catch fish in the swamp during this season. But, during the rainy season, free fishing in allowed to the people when the swamp is filled up with water. The carrying capacity of the Candaba Swamp was estimated at about 360 kg/ha in the Study Report of PD/CS Area Development Project in 1977/2 without any basic data. On the other hand, according to the fish catch record prepared by one of the land-owner/3, the carry capacity is estimated at only 32.2 kg/ha as shown in Table 2.1.

The gap of the estimation is too big. But the latter estimation seems to be more realistic, because the number of adult fishes for spawning at the beginning of rainy season in very few as the result of overfishing in the remained narrow and shallow water area of the swamp at the end of dry season.

To increase the productivity of these inland waters, BFAR Region III has been yearly stocking about a million of carp and tilapia fingerlings during recent ten years/3. But it does not seem to have been fruitful to the middle and lower reaches of the Pampanga River and Swamps. The reason is that, at present, the most productive fish in the area is not those stocked by BFAR but Japanese crucian carp (Caracius auratus, locally named as pararac), which was carried off from the pond in Barrio Sibul, Bulacan by the floodwater in 1972 and has acquired the strongest ecological nitche in the Pampanga River system within recent ten years/4.

2.3 Fish Culture

In the Philippines, the policies, programs and priorities for aqucuaculture development was set forth in the Presidential Decree No. 704 of 1975. This Decree emphasizes the following objectives for fisheries development, of which these are relevant to aquaculture:

(1) Attainment of self-sufficiency

(2) Export promotion

/1: List of Private Owned Fishpond Operators, compiled from city/municipal records on declaration of real property, 1980, BFAR Region III

/2: Fisheries Development Study, 1977, PD/CS Development Project

/3: Report of Annual Fingering Production, 1974-1981, Magsaysay Memorial Fish Nursery Station, BFAR Region III

/4: Technical Paper Series, Vol. 4, No. 2, 1980, BFAR

(3) Development of rural area

(4) Initiation of impact projects

To answer these national policies, the administration and promotion of fishery development is vested on BFAR. Accordingly, at present, almost all kind of inland waters except rivers are the target waters for the development of fish culture. Fish culture activities in the objective area are as follows:

(1) Some owners of Candaba Swamp constructed dikes and enclosed lower parts of the swamp. They stock fish fingerlings and try to feed them to increase fish production before they harvest in dry season. Unfortunately, this practice was stopped because of lack of hatchery technics and operation budget/1.

(2) The cage culture project at Pantabangan Reservoir showed a higher total yield than predicted by the Freshwater Fish Culture Center of Central Luzon State University (CLSU)/2.

This project is still under experimental stage. The technical data are not fully collected yet for the feasibility study.

(3) Ricefield fish culture seems to have great potentiality to answer the national policies for fishculture development.

Significant progress was achieved with the growing of high-yielding, insect-resistant rice varieties in paddies with fish/3. Results of trials indicated good rice production without use of insecticides. Rice-fish culture project was started in 1977. Standing crops of Tilapia mossambica and Cyprinus carpio averaged 69 to 208 kg/ha/season in the experimental stage.

A nation-wide field testing program for ricefield fish culture was conducted in the country in 1978 prior to field demonstration. Yield of fish averaged 201 kg/ha/season/4, as shown in Table 2.2. It shows 310 to 590 kg/ha/season in the objective area Pampanga. But, in 1979, it reached only 96 kg/ha/season/5. It seems that the technology of ricefield fish culture has not been established yet

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/1: Personal Communication, one of the officer of BFAR Region III

/2: List of Private Owned Fishpond Operators, compiled from city/municipal records on declaration of real property, 1980, BFAR Region III

/3: Rice-fish Culture and Green Revolution, 1976, Grover, J.H., FAO Technical Conference on Aquaculture, Kyoto, Japan

/4: Annual Report, 1978, MOA

/5: RDC Report to the President, 1979, Regional Development Council, NEDA, Region III, San Fernando Pampanga among the people in the objective area. Following constraints were listed up by a officer of BFAR, Region III; 1) difficulty of its propagation to land owners, 2) lack of fingerlings, 3) no technical innovation against application of agriculture chemicals. In Nueva Ecija, there is some movement to overcome these constraints by establishing a close communication system based on SAMAHANG NAYONG unit.

(4) Freshwater pond is called as back-yard fishpond in the Green Revolution Project. It is not popular yet in the objective area. The result of field testing program was 30 to 1,500 kg/ha/year/1 as shown in Table 2.3. These results are much lower than that of the experiment (more than 3,000 kg/ha/year) conducted in fertilized ponds by using mono sex tilapia/2. But this project seems to be hopeful because the price of tilapia is quite attractive, (₱14-15/kg), compared with that of rice. At present, its pond management system such as production technics and economics, fingerling supply system etc. seems not to be established yet. In 1980, the area of 1,100 ha was used for freshwater culture by 1,300 farmers.

(5) Brackish delta area of 28,500 ha in the study area was used as milkfish pond. As of 1980, its average productivity was 1,125 kg/ha/year/3, sales of which was estimated at ₱10,150/ha/year. The effect of land use for milkfish culture in equivalent to rice production of 7 tons/ha/year. The productivity of a milkfish pond is strongly influenced by the salinity of the pond water and soil condition/4. In the study area, the upper part of the Delta shows lower productivity than that of the lower Delta. The municipalities comprising the Lower Delta and Upper Delta are classified as follows/5:

Upper Delta - Balagtas, Bocaue, Marilao, Guagua, Sexmoan, Minalin, San Fernando, Bacolor

Lower Delta - Paombong, Meycauayan, Valenzuela, Guiguinto, Malolos, Bulacan, Hagonoy, Macabebe, Masantol, Obando

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/1: Socio-economic Profile, 1978, Province of Pampanga

/2: Culture on male Tilapia mossanbica produced through artificial sex reversal, 1976, FAO Technical Conference on Aquaculture, Kyoto, Japan

/3: Annual Report, 1980, BFAR Region III

/4: Technical Report, 1977, First ASEAN Meeting of Experts on Agriculture

/5: Fisheries Development Study, 1977, PD/CS Development Project

Recently, the prices of tilapia and milkfish are almost same. Accordingly, some pond-owners of the upper delta are trying to culture tilapia to overcome the low productivity of milkfish. In the lower delta, the greatest constraint of milkfish culture is flood damage the cost of which is estimated at ₱3,889/ha in 1980 as shown in Table 2.4.

To avoid this damage, some flood control measures should be taken. The River will be diverted, made straight or widened. In any cases, it will be more or less dredged. Dredging near the river mouth seems to induce seawater intrusion and negatively influence to rice production, ground water, etc. But, for the milkfish culture, stronger seawater intrusion might be more beneficial. According to our assessment survey of the Labangan Floodway, the construction of which was started in early 1970, following matters are clarified by the interview to the caretakers:

a. Frequency of flood has decreased since the start as shown in Fig. 2.1 of the construction.

b. In the upper location such as St. 6, 7, 8 and 9, the increase of production after the construction was clearly observed, because the previous flora of filamentous algae (lumut) has changed to the favorable flora (lab-lab) for milkfish by the stronger salt intrusion as shown in Table 2.5. The production increase has two aspects. One is the increase of production of 10-20% per harvest, the other is the increase of harvest times from 2 times to 2.5 times. It means the production increased about 35-50% from the original level.

c. In the lower location, the influence was not so clearly observed, but it was observed that the caretakers can control their ponds in good condition (to make grow lab-lab) more easily, compared with the previous time.

d. During the flood in 1980, some areas such as St. 2, 5, 9, 10 and 13 was not affected by the flood. Those areas have strong and tall dikes or locate in the lowest part of the Delta.

e. Almost all the fishes in the pond will escape from the pond once it is flooded even in few inches.

From these informations, it is concluded that the flood control by dredging or floodway gives much benefit to the fishpond operation.

CHAPTER 3 DEVELOPMENT PROSPECT AND RECOMMENDATION

3.1 Development Prospect

As described in Chapter 1, the main purpose of the inland fisheries study is to find development items for the better use of the Pampanga River system on the premise of the performance of some irrigation or flood control developments.

In the irrigation and flood control sectors, there are following two development plans which will strongly influence the ecosystem of the River:

(1) The proposed diversion dam will form a year-round reservoir of about 2,000 ha at the confluence of the main stream and the Rio Chico River. At the same time, this location is at the lowest part of the San Antonio Swamp and the entrance of the North Candaba Swamp during flood time.

Accordingly, the main function of the proposed reservoir from view point of inland fisheries in the supply source of enough amount of adult fishes to the swamps for the spawning at the beginning of rainy season.

By the construction of this reservoir, the fish production of the swamps and rivers will be increased without fish stock measure by the Government.

(2) The proposed flood control plan will not only protect the fishpond area and induce the benefit of ₱3,889/ha but also increase the productivity of fishpond of the upper delta by inducing the stronger seawater intrusion. Based on the result of assessment survey of the Labangan Floodway, it can be expected to the production increase of 35-50% in case of the upper delta area.

3.2 Recommendation

(1) The proposed diversion dam reservoir will have a influential role to the ecosystem of the Pampanga River system. Accordingly, following items are recommended for the protection and management of the reservoir:

a. To set year-round fish sanctuary of about 1,000 ha as shown in Fig. 2.

b. To set fishery regulation on the minimum mesh of gill net and bamboo fence and prohibition of dinamite fishing in the reservoir.

c. To establish a permanent research station to collect basic data on the ecosystem of the River system.

(2) According to the flood control plan, the river bed downstream of Masantol will be dredged. Accordingly, it is recommended that some suitable branches along the said main stream between 4-10 km from the estuary should be provided by watergates, dredged and widened to introduce the high salined water to the fishpond of the upper delta.

CHAPTER 4 BENEFIT FROM RIVER EXCAVATION

Fish pond in the upper delta area will get benefit from river excavations of the Pampanga River. The productivity of fish pond in the upper delta is lower than that of the lower delta area. But it will be improved by salinity increase of fish pond by seawater intrusion by the river excavation of flood control practice. This is indirectly evidenced from the assessment survey result of the channel excavation of the Labangan Floodway. The salinity of fish ponds in the upper delta area have been increased as high as that in the lower delta area after the construction of the Floodway as shown in Table 4.1. And, as the result of salinity increase, the flora of fish pond in the upper delta area has changed from lumot, filamentous green algae, to lab-lab, microbenthic algae, which is the typical flora of fish ponds in the lower delta area. Accordingly, it is considered that the pond condition in the upper delta area along the said Floodway has become same as that in the lower delta area.

Based on this fact, it is expected that the productivity of fish pond in the upper delta area along the Pampanga River will be also increased as high as that in the lower delta area after the channel excavation. The comparison of net income of fish ponds between in the upper area and lower area is shown in Table 4.2.

Table 2.1 FISH PRODUCTION IN CANDABA SWAMP/1
(1975)

(Unit: kg)

Fish Type/2	1974		1975	Total
	Nov.	Dec.	Jan.	
Bulig	97	1,026	382	1,505
Bulilis	16	131	72	219
Carpa	248	975	180	1,403
Common Carp	125	1,118	440	1,683
Carp (I)	0	90	0	90
Carp (II)	0	295	0	295
Carp (III)	0	375	0	375
Carp (silver)	30	0	0	30
Fighting Fish	300	993	310	1,603
Gorami	150	2,355	210	2,715
Hito (Catfish)	0	164	36	200
Pacut	64	495	60	619
Total	1,030	8,017	1,690	10,737

Remarks: /1: Fish catch record prepared by one of the land owners of Candaba Swamp, who owns its 330 ha.

/2: Fish types were not identified by scientific names.

/3: Productivity of the area was estimated at 32.2 kg/ha.

Table 2.2 RICE-FISH CULTURE: RICE AND FISH YIELD IN TRIALS CONDUCTED (1978)

Region/Province		Species Used	Yield of Fish (kgs)	Percent Reco-very	Culture days	Yield of Rice/ha (150 kgs - 1 cav)	
						Rice with Fish	Rice without Fish
1.	Pangasinan	Tilapia nilotica	128	73	90	117	187
2.	N. Vizcaya	Tilapia nilotica	104	74	116	85	91
	N. Vizcaya	Tilapia nilotica	75	76	118	77	84
3.	Pampanga	Tilapia nilotica	590	98	100	100	108
	Pampanga	Tilapia nilotica	310	95	66	95	96
4.	Batangas	Tilapia nilotica	164	71	65	98	104
5.	Sorsogon	Tilapia mossambica	188	85	115	88	31.2*
	Camarines Sur	Tilapia mossambica	238	95	98	115	114
6.	Iloilo	Tailapia mossambica	141	77	87	122	121
	Iloilo	Tilapia mossambica	143	83	77	126	119
	Iloilo	Tilapia mossambica	184	87	80	116	121
7.	Negros Occ.	Tilapia nilotica	113	51	72	141	145
	Negros Occ.	Tilapia nilotica	183	73	71	115	124
8.	Leyte	Common Carp	299	73	104	95	106
9.	Zamboanga	Tilapia nilotica	295	76	75	112	107
10.	Bukidnon	Common Carp	114	43	70	103	101
	Bukidnon	Tilapia mossambica	103	81	65	83	85
	Bukidnon	Tilapia nilotica	156	57	78	103	101
11.	Davao Norte	Tilapia mossambica	138	91	90	100	106
	Davao Del Sur	Common Carp	343	98	100	218	237
	Average Yield/ha		201	78	87	113	119

Note: * Result of this particular trial was not included in the computation.

Table 2.3 FISH PRODUCTION RECORD: MARATAF PROJECT AREA (1976-1977)

Location	Green Revolution Project (Backyard Fishpond)						
	Number of Cooperator	Area (m^2)	Species Stocked (pcs)	Number of Stock (pcs)	Production (kg)	Production (kg/ha)	Value (₱)
A. Magalang							
Speed Fishpond							
1. San Agustin	1	1,300	Tilapia	1,500	135	1,040	405
2. Sto. Rosario	4	1,390	Tilapia-Carp	2,000	180	1,290	543
3. Ayala	1	408	Tilapia	500	45	1,130	135
4. San Jose	1	500	Tilapia	500	45	900	133
5. San Antonio	11	500	Tilapia	500	45	900	135
6. San Francisco	1	500	Tilapia	500	45	900	135
7. Sta. Cruz	1	500	Tilapia	300	27	540	0
8. San Vicente	1	300	Carp	500	45	1,500	135
B. Arayat							
1. Candating	1	350	Carp	300	27	770	21
2. Panlinlang	1	1,000	Carp	500	45	450	135
3. Lacmit	1	300	Tilapia	500	45	1,500	135
4. Plazang Luma	1	5,000	Tilapia	1,200	108	260	324
5. Cacutud	1	430	Tilapia	500	45	1,050	135
6. San Mateo	1	29,000	Tilapia	1,000	90	30	270
7. Bitas	1	500	Tilapia	500	45	900	135
Total	20	41,900		10,800	972	232	2,916

Table 2.4 FLOOD DAMAGE TO FISHPOND IN THE DELTA (1976-1980)/1

Items	1979 May	1977 Nov.	1978 Nov./2	1979	1980 Nov.
1. Name of Typhoon	Didang	Unding	Heling & Iling	-	Aring
2. Location of Damage Sampling	All Bulacan	All Bataan	All Bataan	-	Hagonoy Bulacan
3. Affected Area covered by Interview Survey (ha)	687	493	(901)	-	756
4. Producer's Price of Marketable Milkfish (₱/ha)	1.22	2.05	(1.43)	-	3.01
5. Fish Quantity of Damage (x 10^3 pcs)	4,849	1,223	787	-	3,609
6. Value of Damage					
to Production (x 10^3₱)	1,821	1,269	549	-	2,768
(₱/ha)	2,650	2,574	609	-	3,662
to Facilities (x 10^3₱)	367	388	122	-	171
(₱/ha)	534	787	135	-	227
to Total (x 10^3₱)	2,188	1,657	671	-	2,939
(₱/ha)	3,184	3,361	744	-	3,889

Sources: Survey reports on typhoon damage to fishpond by Provincial Fishery Office, Bulacan in 1976 and 1980, Bataan in 1977 and 1978.

Remarks: /1: Based on the data obtained from interview to pond operators.

/2: This data was not used for the estimation of flood damage because of its abnormally low damage compared with affected area.

Table 2.5 CHLORINITY OF FISHPONDS AND RIVERS ALONG THE LABANGAN FLOODWAY/1

(Unit: mg/ℓ)

Sampling Point		Chloride
St. 2	(Rearing pond)	25,000
St. 3	(")	30,000
St. 8	(Fingerling pond)	14,000
St. 8	(River)	3,600
St. 9	(Rearing pond)	16,000
St. 10	(Nursery pond)	21,500
St. 10	(River)	1,900
St. 11	(Rearing pond; Lumut)	6,100
St. 11	(Rearing pond; Lab-lab)	7,500
St. 12	(Rearing pond)	22,000
St. 12	(River)	11,000

Remarks: /1: Sampling time is not same in each water sample.

Table 4.1 SALINITY OF FISH POND

Location/2	Chloride (mg/ℓ)
St. 1 (Upper pond)	-
St. 2 (")	-
St. 3 (")	30,000
St. 4 (")	-
St. 5 (Lower pond)	25,000
St. 6 (Upper pond)	16,000
St. 7 (")	17,500
St. 7 (River water)	3,600
St. 8 (Upper pond)	22,000
St. 9 (")	14,000
St. 10 (")	11,000
St. 10 (River water)	1,900
St. 11 (Upper pond)	7,500
St. 12 (Lower pond)	21,500
St. 12 (River water)	2,300
St. 13 (Lower pond)	15,500

Remarks: /1 : Water samples were collected during interview survey and analyzed by METROPOLITAN WATERWORKS AND SEWERAGE SYSTEM, RP.

/2 : Sampling locations are shown in Fig. 3.6.1 in the Interim Report.

Table 4.2 THE UNIT VALUES OF MILK FISH PRODUCTION

Item	Unit	Upper Area	Lower Area	Average
Productivity/1	Kg/ha/year	940	1,310	1,125
Fish Price/2	₱/Kg	9.0	9.0	9.0
Gross Income	₱/ha/year	8,481	11,819	10,125
Production Cost/3	₱/ha/year	7,157	7,157	7,157
Net Income	₱/ha/year	1,324	4,662	2,968

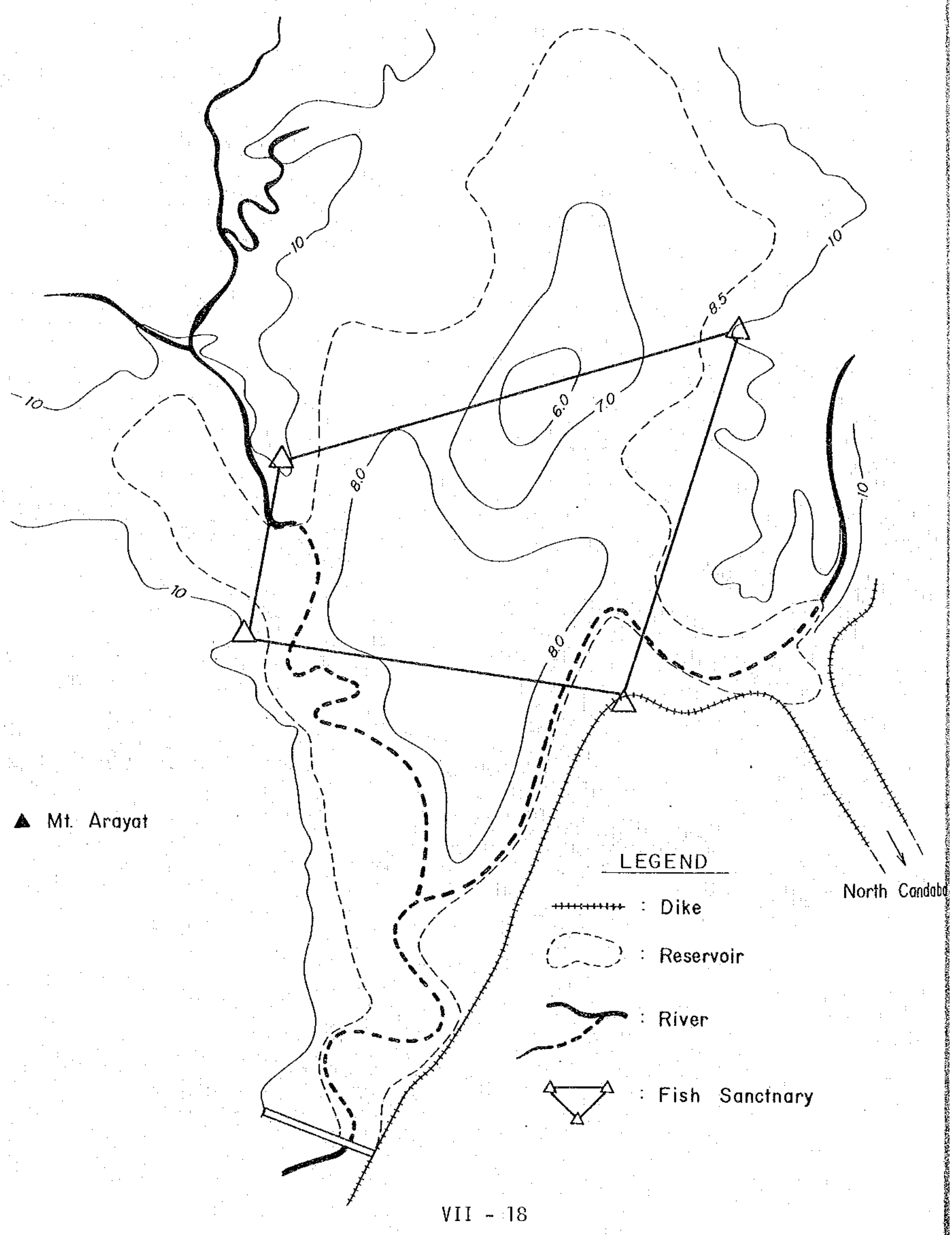
Remarks /1 : Average productivity is referred from Annual Report of BFAR, Region III, 1979. Productivities of upper and lower areas are estimated from the survey result made by UNDP group in 1975, in which the productivities of upper and lower areas were estimated at 700 kgs/ha and 1,100 kgs/ha respectively when the average productivity was 900 kgs/ha in 1975.

/2 : Average producer's price as of 1980.

/3 : Average production cost is estimated from that of ₱3,469/ha in 1973 by the annual increase rate of 32.2% in 1974 and 7.7% during 1975-1980 (Ref. Table 3.6.1 in the Interim Report).

Fig. 2.1 LABANGAN FLOODWAY AND WATER CHANNEL SYSTEMS OF FISHPONDS

Fig. 3.1 RECOMMENDED AREA FOR YEAR ROUND FISH SANCTUARY IN DIVERSION DAM RESERVOIR



APPENDIX VIII
SEAWATER INTRUSION

APPENDIX VIII SEAWATER INTRUSION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX VIII SEAWATER INTRUSION

CHAPTER 1 INTRODUCTION

The implementation of the projects for both flood control and irrigation will promote seawater intrusion to the Pampanga River. As a result, the production from fishpond will be increased owing to supply of high salined water to fishpond, on the other hand, it may give adverse effect to water intake on the downstream reaches and to ground water. The adverse effect varies depending on the volume of excavation of low-water channel by flood control project and intake water volume by irrigation project.

This Appendix VIII presents the analysis of adverse effect on seawater intrusion due to implementation of the projects and some countermeasures to the salinity pollution. The data on salinity and seawater intrusions under the existing conditions are not included in this Appendix. They are described in Appendix II.

CHAPTER 2 SEAWATER INTRUSION DUE TO IMPLEMENTATION OF PROJECTS

2.1 Salt Wedge on River after Excavation of Channel

Excavation of low-water channel by flood control project will promote seawater intrusion to the river. In order to know the seawater intrusion to the Pampanga River and the Labangan Floodway after excavation of low-water channel, the salt wedge on the river is estimated for various streamflow at the time of high and low tides with regard to the following channel conditions:

River		Channel Condition
1. Pampanga River	:	Excavated channel by basic flood control plan
2. Pampanga River	:	Excavated channel by stepwise flood control plan
3. Pampanga River	:	Excavated channel by first phase, stepwise flood control plan
4. Labangan Floodway	:	Excavated channel by MPW second stage plan

Using the equations as described in Chapter 2, Appendix II, the form and length of salt wedge are calculated for the condition after excavation of channel. The calculated results are shown in Table 2.1. Fig. 2.1 shows the estimated profile of salt wedge for the channel conditions of the existing and after excavation.

2.2 Distance and Period of Seawater Intrusion

2.2.1 Seawater Intrusion due to Flood Control Project

To know the frequency of seawater intrusion to the Pampanga River and the Labangan Floodway after excavation of the low-water channel, the seawater intrusion distance and its affected period are estimated by the same procedure as described in Chapter 2, Appendix II using the correlation curves between discharge and seawater intrusion distance with regard to channel bottom and 1 m below water surface as shown in Fig. 2.2, applying 10-day average discharge during the period from 1968 to 1978.

The estimated distance and its affected period in terms of average are shown in Table 2.2 together with the results of the analysis for the existing channel condition. The location of the affected area is shown in Fig. 3.1.

2.2.2 Seawater Intrusion due to Irrigation Project

Diverting water in the upstream by irrigation project will promote seawater intrusion to the river. The adverse effect varies depending on volume of intake water. In order to know the seawater intrusion to the Pampanga River due to diverting water, the distance and its affected period of seawater intrusion are estimated with regard to the proposed diversion dam and pump schemes, applying 10-day average discharge after diverting water at Arayat during the period from 1968 to 1978 as shown in Table 2.3.

The estimated distance and affected period in terms of average with the irrigation projects are shown in Table 2.4.

2.2.3 Seawater Intrusion due to both Flood Control and Irrigation Projects

The seawater intrusion to the Pampanga River will be further extended by the implementation of the projects for both flood control and irrigation. To know the extent of seawater intrusion to the Pampanga River, the distance and its affected period are estimated for the conditions with the projects by the same procedure as mentioned in the foregoing section.

The estimated distance and its affected period in terms of average with the flood control and irrigation projects are shown in Table 2.5.

Fig. 2.3 shows the profile of the estimated salt wedge in terms of annual average on the Pampanga River under the present condition and after completion of the projects for flood control and irrigation.

CHAPTER 3 ADVERSE EFFECT AND COUNTERMEASURE TO SALINITY POLLUTION

3.1 Adverse Effect

As mentioned in Chapter 2, the seawater intrusion to the Pampanga River due to the implementation of the projects for both flood control and irrigation are analysed applying the streamflow during the period from 1968 to 1978. The results of analysis are summarized in Table 3.1 and described below;

a. The salinity condition near the water surface would not be much changed by the implementation of the projects for both flood control and irrigation.

b. Due to excavation of low-water channel by the flood control project, the seawater intrusion near the channel bottom will be extended to about 7 km in the basic plan and about 4 km in the stepwise plan.

c. Due to diverting water in the upstream by the irrigation project, the seawater intrusion near the channel bottom will be extended to about 6 km in the diversion dam scheme and about 5 km in the pump scheme.

d. In the case of the condition after completion of the projects for both flood control and irrigation, the seawater intrusion near the channel bottom will be extended as follows:

Flood Control Plan	Irrigation Scheme	
	Diversion Dam	Pump
Basic Plan	10 km	9 km
Stepwise Plan	8 km	8 km

The new intrusion of seawater at the channel bottom of the river has a possibility to raise the salinity pollution to the ground water in the vicinity of river course where the seawater will intrude. The behavior of polluted ground water is usually defined by many factors such as location and depth of intake well, intake water volume from a well, elevation of ground water surface, geological condition, permeability of ground and so on. Those factors can be only studied by the field survey in vast area including boring test, hydraulic well test, long term field observation of ground water and others.

The new salinity polluted area due to the implementation of the projects is roughly estimated at 10 km^2 on the both sides of the Pampanga River between the Sulipan and San Simon Bridges based on the results of the analysis mentioned above as shown in Fig. 3.1.

3.2 Salinity Control Gate

One of the solution of salinity pollution problems is construction of salinity control gates in the downstream of the Pampanga River and the Labangan Floodway. The tentative structure design of the salinity control gates with steel type gate for the Pampanga River and the Labangan Floodway are made as shown in Figs. 3.2 and 3.3 respectively. For the Labangan salinity gate, the rubber type gate (so-called rubber dam) instead of steel type gate is designed as shown in Fig. 3.4, as the water depth at the gate site is smaller than 5 m.

The construction cost of those gates are roughly estimated as shown in Table 3.2. They are as follows:

Gate		Construction Cost (₱10^3)
1. Pampanga Salinity Gate	(steel type) :	167,000
2. Labangan Salinity Gate	(steel type) :	53,000
3. - do -	(rubber type) :	48,300

3.3 Small Water Supply System

Although the salinity control gate will give to stop perfectly the seawater intrusion, much fund will be required to construct the gate. One of the economical countermeasure for salinity pollution problem is to construct the facility of small water supply system for the area to be polluted.

The construction cost for the facility of the small water supply system is estimated assuming that the water to be supplied would be taken from ground water constructing the deep wells. The maximum water consumption is estimated at 1.2 m^3/min on the left side area and 3.3 m^3/min on the right side area respectively based on the following assumption:

a. The population for water to be supplied is assumed at 25,000 persons consisting of 6,600 persons on the left side area and 18,000 persons on the right side area.

b. The daily maximum water consumption is assumed at 200 l/day/person.

The required construction cost for the facility of the water supply system is roughly estimated at ₱10,650,000 as shown in Table 3.3.

Table 2.1 (1) MAXIMUM POINT OF SEAWATER INTRUSION ON PAMPANGA RIVER (EXCAVATED CHANNEL BY BASIC FLOOD CONTROL PLAN)

(Unit: km)

Discharge (m^3/s)	Maximum Point of Seawater Intrusion from Rivermouth			
	h = 1m/1	h = 2m/2	h = 3m/3	Bottom/4
1. At Time of High Tide				
2	42.0	-	-	46.8
5	18.8	45.4	-	46.6
10	8.2	32.7	46.2	46.2
20	3.8	20.3	38.4	44.8
30	2.2	14.5	31.6	42.1
40	1.3	11.1	25.4	37.9
50	1.0	9.6	21.6	33.1
2. At Time of Low Tide				
2	40.4	-	-	46.5
5	18.0	45.2	-	46.2
10	7.7	32.6	-	45.4
20	4.6	22.4	37.0	38.0
30	2.9	16.8	30.0	32.0
40	1.8	12.1	22.9	26.0
50	1.3	9.8	18.0	21.7
3. Average of Above				
2	41.2	-	-	46.7
5	18.4	45.3	-	46.4
10	8.0	32.7	-	45.8
20	4.2	21.4	37.7	41.4
30	2.6	15.7	30.8	37.1
40	1.6	11.6	24.2	32.0
50	1.2	9.7	19.8	27.4
4. Extension due to Excavation				
2	0	-	-	0
5	0	0	-	0
10	0	0	-	0
20	1.6	5.1	5.0	0.4
30	1.6	8.4	13.6	10.0
40	0.9	7.8	14.9	17.4
50	0.7	7.8	-	19.6

Remarks: /1: at 1m below water surface
/2: at 2m below water surface
/3: at 3m below water surface
/4: at channel bottom

Table 2.1 (2) MAXIMUM POINT OF SEAWATER INTRUSION ON PAMPANGA RIVER (EXCAVATED CHANEL BY STEPWISE FLOOD CONTROL PLAN)

(Unit: km)

Discharge (m^3/s)	Maximum Point of Seawater Intrusion from Rivermouth			
	h = 1m	h = 2m	h = 3m	Bottom
1. At Time of High Tide				
2	42.0	-	-	46.8
5	18.8	45.4	-	46.6
10	8.2	32.7	46.2	46.2
20	3.5	20.3	38.4	45.0
30	2.2	15.4	32.0	42.4
40	1.3	11.1	25.4	35.7
50	0.8	7.5	17.3	26.1
2. At Time of Low Tide				
2	40.4	-	-	46.6
5	18.0	45.2	-	46.2
10	9.0	32.6	45.4	45.4
20	4.6	20.2	32.0	37.0
30	2.6	14.0	20.4	27.4
40	1.4	9.2	13.7	18.4
50	0.8	5.5	7.8	10.6
3. Average of Above				
2	41.2	-	-	46.7
5	18.4	45.3	-	46.4
10	8.6	32.7	45.8	45.8
20	4.1	20.3	35.2	41.0
30	2.4	14.7	26.2	34.9
40	1.4	10.2	19.6	27.1
50	0.8	6.5	12.6	18.4
4. Extension due to Excavation				
2	0	-	-	0
5	0	0	-	0
10	0	0	-	0
20	1.5	4.0	3.1	0
30	1.4	7.4	9.0	7.8
40	0.7	6.4	10.3	11.1
50	0.3	4.6	-	10.6

Table 2.1 (3) MAXIMUM POINT OF SEAWATER INTRUSION ON PAMPANGA RIVER (EXCAVATED CHANNEL BY FIRST PHASE, STEPWISE FLOOD CONTROL PLAN)

(Unit: km)

Discharge (m^3/s)	Maximum Point of Seawater Intrusion from Rivermouth			
	h = 1m	h = 2m	h = 3m	Bottom
1. At Time of High Tide				
2	42.0	-	-	46.8
5	18.8	45.4	-	46.6
10	8.2	32.7	-	46.4
20	2.8	18.3	36.2	45.2
30	1.6	11.8	26.6	38.8
40	1.0	8.1	19.0	30.0
50	0.8	6.3	14.6	20.4
2. At Time of Low Tide				
2	40.4	-	-	46.5
5	18.0	45.2	-	46.2
10	7.7	32.6	-	45.4
20	2.7	18.0	31.6	36.7
30	1.5	10.9	20.7	22.7
40	1.0	6.5	11.6	12.2
50	0.8	3.8	7.1	7.4
3. Average of Above				
2	41.2	-	-	46.7
5	18.4	45.3	-	46.4
10	8.0	32.7	-	45.9
20	3.3	18.2	33.9	41.0
30	1.6	11.4	23.7	30.1
40	1.0	7.3	15.3	21.1
50	0.8	5.1	10.9	13.9
4. Extension due to Excavation				
2	0	-	-	0
5	0	0	-	0
10	0	0	-	0
20	0.7	1.9	1.2	0
30	0.6	4.1	6.5	3.0
40	0.3	3.5	6.0	5.1
50	0.3	3.2	-	6.1

Table 2.1 (4) MAXIMUM POINT OF SEAWATER INTRUSION ON LABANGAN FLOODWAY (EXCAVATED CHANNEL BY MPW 2ND STAGE PLAN)

(Unit: km)

Discharge (m^3/s)	Maximum Point of Seawater Intrusion from Rivermouth			
	h = 1m	h = 2m	h = 3m	Bottom
1. At Time of High Tide				
2	-	-	-	-
5	13.0	-	-	24.7
10	3.6	13.3	-	16.1
20	0.9	5.3	10.0	11.2
30	0.7	2.5	5.8	8.0
2. At Time of Low Tide				
2	18.0	-	-	18.0
5	7.5	-	-	15.6
10	2.3	10.1	-	12.5
20	0.7	4.0	7.7	8.2
30	0.6	1.9	4.7	6.0
3. Average of Above				
2	-	-	-	-
5	10.3	-	-	20.2
10	3.0	11.7	-	14.3
20	0.8	4.7	8.9	9.7
30	0.7	2.2	5.3	7.0
4. Extension due to Excavation				
2	-	-	-	-
5	0	-	-	0
10	2.1	6.5	-	3.3
20	0.2	3.2	4.7	2.7
30	0.3	1.4	3.2	2.0

Table 2.2 (1) ANNUAL AVERAGE SEAWATER INTRUSION DISTANCE AND ITS AFFECTED PERIOD ON PAMPANGA RIVER (EXCAVATED CHANNEL)

Item	Year											
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Average
1. At Channel Bottom												
A. Existing Channel												
Distance (km)	22.6	23.3	34.6	13.7	20.8	34.4	36.5	7.6	26.0	26.4	4.2	22.7
Period (day)	230	230	15	100	100	200	150	130	100	150	50	145
B. Excavated Channel												
a. Basic Plan with 100-yrDesign Flood												
Distance (km)	30.7	30.1	38.8	25.0	28.3	35.1	40.0	19.6	32.3	33.3	12.5	29.6
Period (day)	250	250	160	110	120	230	150	160	110	150	100	163
b. Stepwise Plan with 20-yr Design Flood												
Distance (km)	27.0	27.8	37.1	20.0	26.5	35.1	39.1	14.6	29.2	30.5	9.2	26.9
Period (day)	250	240	160	110	110	220	150	150	110	150	80	157
c. First Phase, Alternative-3 of Stepwise Plan												
Distance (km)	23.7	24.9	34.9	16.0	22.3	34.2	37.4	11.7	28.5	28.3	7.5	24.6
Period (day)	250	240	160	110	110	200	150	140	100	150	70	153
2. At 1m below Water Surface												
A. Existing Channel												
Distance (km)	1.1	1.2	1.6	0.7	0.9	3.5	2.2	0.4	1.2	1.7	0.3	1.3
Period (day)	210	220	160	80	100	200	150	120	100	130	50	138
B. Excavated Channel												
a. Basic Plan with 100-yr Design Flood												
Distance (km)	2.1	2.4	3.3	1.5	2.1	4.5	4.0	1.0	2.6	2.9	0.7	2.5
Period (day)	250	230	160	100	100	200	150	140	100	150	60	149
b. Stepwise Plan with 20-yr Design Flood												
Distance (km)	2.0	2.1	3.1	1.1	1.8	4.4	3.8	0.7	2.2	2.6	0.4	2.2
Period (day)	230	230	160	100	100	200	150	130	100	150	60	146
c. First Phase, Alternative-3 of Stepwise Plan												
Distance (km)	1.5	1.6	2.4	0.9	1.4	3.9	3.1	0.6	1.8	2.2	0.4	1.8
Period (day)	230	230	160	100	100	200	150	130	100	150	60	146

Table 2.2 (2) ANNUAL AVERAGE SEAWATER INTRUSION DISTANCE AND ITS AFFECTED PERIOD ON LABANGAN FLOODWAY (EXCAVATED CHANNEL)

Item	Year											
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Aver-age
1. At Channel Bottom												
A. Existing Channel												
Distance (km)	12.5	16.9	7.8	4.5	5.7	10.0	14.8	10.3	11.5	16.3	13.6	11.3
Period (day)	330	340	340	330	320	350	330	360	340	360	320	338
B. Excavated Channel by MPW Second Stage Plan												
Distance (km)	14.4	17.7	9.2	6.2	7.6	12.9	15.5	13.1	13.2	17.7	15.1	13.0
Period (day)	330	340	340	330	320	350	330	360	340	360	320	338
2. At 1m below Water Surface												
A. Existing Channel												
Distance (km)	4.9	9.5	3.6	0.4	0.7	1.2	8.9	2.0	4.6	8.0	6.3	4.6
Period (day)	290	320	250	220	230	320	280	360	300	350	300	293
B. Excavated Channel by MPW Second Stage Plan												
Distance (km)	6.0	10.0	3.8	0.7	1.2	3.1	9.2	3.1	5.4	8.8	7.2	5.3
Period (day)	290	330	250	220	240	320	280	360	310	350	300	295

Table 2.3(1) 10-DAY AVERAGE RIVER DISCHARGE OF PAMPANGA RIVER AT CONFLUENCE OF MAASIM RIVER AFTER DIVERTING WATER BY IRRIGATION PROJECT OF DIVERSION DAM SCHEME

(Unit: m^3/s)

Year	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1968	1 - 10	33.7	18.9	17.0	23.4	23.5	8.8	51.3	583.4	1,514.2	967.5	50.1	159.8
	11 - 20	27.8	11.8	26.3	21.2	16.6	8.9	55.3	589.5	915.2	421.8	43.3	38.5
	21 - 31	21.5	12.5	21.9	21.0	18.4	15.8	483.2	1,096.4	679.9	149.9	36.2	24.4
1969	1 - 10	28.6	18.6	13.7	19.4	17.2	16.4	55.8	1,564.3	332.9	395.8	43.6	39.1
	11 - 20	29.6	14.8	14.1	20.9	16.0	56.9	53.3	829.3	613.8	255.1	20.9	68.0
	21 - 31	19.4	14.8	20.8	14.6	13.7	28.9	422.9	193.4	346.1	123.4	117.7	30.5
1970	1 - 10	24.0	12.6	12.6	28.2	17.5	15.6	77.3	249.1	1,798.4	452.5	709.4	303.5
	11 - 20	19.8	12.6	13.2	28.6	13.7	135.7	221.0	369.5	1,212.0	1,115.7	329.2	188.1
	21 - 31	14.2	13.7	18.0	23.4	14.2	109.3	141.5	580.9	434.3	716.4	534.4	123.9
1971	1 - 10	76.9	37.4	30.8	35.0	87.1	360.2	404.7	644.0	274.8	410.4	161.4	509.8
	11 - 20	62.3	35.2	61.0	33.9	113.7	679.2	824.8	614.2	288.3	1,946.1	143.9	283.4
	21 - 31	46.7	34.1	37.1	28.6	88.2	629.9	1,217.1	140.9	363.7	718.1	593.7	317.6
1972	1 - 10	791.6	93.7	31.5	43.8	20.9	67.2	784.4	2,245.9	671.8	251.5	187.0	113.2
	11 - 20	174.4	80.8	28.9	34.1	17.5	69.7	2,340.8	1,755.3	864.2	105.3	114.3	72.1
	21 - 31	115.1	32.9	43.6	28.8	61.6	114.4	2,361.9	1,508.3	582.3	79.1	84.9	33.7
1973	1 - 10	21.0	14.8	14.2	12.7	10.1	12.9	21.5	71.8	424.2	425.5	69.2	102.3
	11 - 20	19.0	16.4	14.0	14.1	13.7	14.8	151.5	161.2	245.4	1,791.2	57.8	57.7
	21 - 31	19.6	15.8	12.5	9.3	12.1	19.3	85.2	661.0	153.4	804.4	701.0	24.5
1974	1 - 10	18.8	11.1	14.4	15.6	26.1	250.0	124.1	631.7	398.1	120.7	1,560.7	402.4
	11 - 20	10.5	10.5	13.4	16.5	17.4	564.7	371.0	1,525.8	301.3	1,156.7	1,162.9	461.3
	21 - 31	10.5	10.0	15.1	24.8	41.9	73.9	702.7	1,637.3	130.5	1,209.6	470.6	288.1
1975	1 - 10	176.8	113.5	38.7	49.1	48.1	112.6	114.0	108.3	186.9	195.2	206.4	37.0
	11 - 20	125.9	63.3	38.6	48.0	40.0	645.2	54.9	495.6	217.8	109.4	43.3	116.1
	21 - 31	194.7	63.7	45.6	44.2	56.5	119.6	48.2	340.8	360.2	429.8	17.4	450.7
1976	1 - 10	241.6	60.6	28.4	20.8	22.6	321.3	1,313.5	403.8	467.1	666.7	426.7	106.6
	11 - 20	184.4	35.2	27.8	34.5	36.5	284.4	332.0	760.4	627.0	453.0	406.5	109.1
	21 - 31	106.2	18.8	21.4	20.2	2,030.7	304.5	273.1	676.0	776.6	431.8	217.1	80.3
1977	1 - 10	89.4	28.4	17.1	20.9	14.8	47.0	104.4	435.9	759.8	595.4	125.0	248.8
	11 - 20	85.2	14.4	17.4	19.1	11.1	38.7	117.8	398.3	865.8	295.2	262.3	147.1
	21 - 31	50.7	15.3	20.6	18.0	38.8	73.5	281.3	510.2	732.7	166.2	1,037.0	149.9
1978	1 - 10	91.3	96.9	39.4	67.0	80.6	130.9	199.3	338.6	1,281.8	1,220.8	2,027.7	492.8
	11 - 20	101.9	78.5	47.7	73.8	24.4	188.3	364.3	786.1	1,056.0	1,274.6	550.3	436.1
	21 - 31	99.6	65.4	58.1	78.2	48.5	251.0	589.8	1,320.5	1,271.6	743.1	475.8	354.9

Table 2.3(2) 10-DAY AVERAGE RIVER DISCHARGE OF PAMPANGA RIVER AT CONFLUENCE OF MAASIM RIVER AFTER DIVERTING WATER BY IRRIGATION PROJECT OF PUMP SCHEME

(Unit: m^3/s)

Year	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1968	1 - 10	39.2	25.7	17.2	21.6	25.3	13.6	43.9	583.3	1,514.0	965.2	62.7	168.1
	11 - 20	34.7	16.6	24.8	21.2	21.5	9.6	52.5	589.3	913.7	419.9	63.1	39.8
	21 - 31	27.1	14.4	19.3	21.0	23.7	17.3	484.0	1,096.7	678.3	153.3	46.2	28.8
1969	1 - 10	34.3	25.9	13.7	21.0	19.0	16.4	51.8	1,564.0	332.8	393.3	57.1	46.1
	11 - 20	36.4	14.8	12.8	25.1	22.5	58.0	52.1	830.0	611.9	251.7	30.3	68.7
	21 - 31	25.7	14.8	18.5	18.8	19.7	28.0	422.3	204.9	345.2	130.2	124.8	35.2
1970	1 - 10	29.6	15.7	12.6	26.5	19.3	18.4	70.5	248.8	1,515.8	449.6	717.3	311.1
	11 - 20	24.8	12.6	13.2	28.6	17.9	135.9	218.0	370.2	1,210.4	1,114.7	326.1	186.7
	21 - 31	17.4	13.7	15.9	23.4	14.7	109.3	142.2	580.9	432.3	719.5	505.1	126.8
1971	1 - 10	82.0	43.6	31.4	33.1	88.8	363.9	400.8	644.5	273.4	409.7	172.3	515.3
	11 - 20	68.2	39.7	60.0	33.9	116.3	626.6	822.2	613.7	285.6	1,944.7	153.8	290.2
	21 - 31	51.8	35.1	35.1	28.6	93.1	629.6	1,216.5	139.2	362.3	721.4	598.5	319.7
1972	1 - 10	799.9	104.9	31.7	42.1	22.6	70.4	782.6	2,245.4	671.8	247.8	198.8	120.3
	11 - 20	180.5	85.6	27.4	34.1	23.0	82.0	2,339.7	1,755.8	863.2	102.2	124.5	73.5
	21 - 31	120.6	34.7	41.7	28.8	68.5	114.1	2,362.0	1,507.8	580.1	85.2	94.5	37.2
1973	1 - 10	26.0	21.7	14.2	12.7	10.1	12.9	18.0	72.0	424.0	423.6	80.7	108.7
	11 - 20	23.0	18.9	14.0	14.1	13.7	14.6	147.7	162.6	243.5	1,782.1	67.5	58.7
	21 - 31	19.6	15.8	12.5	9.3	12.4	20.3	86.0	660.5	150.5	807.7	705.4	28.4
1974	1 - 10	23.9	11.1	17.1	13.7	27.8	251.9	118.9	634.4	397.6	117.3	1,565.8	408.1
	11 - 20	16.4	10.5	12.4	16.5	18.2	567.5	368.3	1,526.1	298.6	1,156.7	1,169.6	461.4
	21 - 31	10.5	10.0	13.5	24.8	40.8	75.9	702.7	1,637.1	127.7	1,211.9	477.5	289.5
1975	1 - 10	181.4	120.1	39.4	47.2	49.8	115.2	108.5	109.0	187.9	192.2	212.9	44.3
	11 - 20	131.8	68.0	37.3	48.0	45.2	80.8	51.5	496.4	216.5	108.0	51.6	115.9
	21 - 31	189.8	64.8	48.8	66.2	63.5	119.0	47.9	339.4	357.9	432.5	22.8	449.8
1976	1 - 10	265.8	67.5	28.7	19.1	24.3	326.1	1,310.3	403.8	466.9	664.4	438.4	117.1
	11 - 20	190.8	40.0	26.2	34.5	40.2	285.3	328.9	760.9	626.6	450.3	41.2	110.1
	21 - 31	112.1	20.9	18.7	20.2	2,032.7	304.1	274.5	675.5	774.6	437.6	226.5	83.7
1977	1 - 10	93.9	35.3	18.2	19.0	16.5	50.9	97.8	436.1	760.8	591.3	136.6	258.1
	11 - 20	90.6	20.0	16.1	19.1	13.4	39.2	115.7	398.7	864.8	291.5	269.8	153.6
	21 - 31	55.4	15.4	18.4	18.0	46.0	75.5	281.1	509.8	731.5	172.7	1,044.5	154.6
1978	1 - 10	97.2	104.0	39.8	65.1	82.3	134.6	190.6	337.4	1,284.5	1,219.4	2,039.2	501.9
	11 - 20	108.9	83.5	46.5	73.8	62.3	177.7	361.5	788.1	1,054.8	1,267.0	559.7	437.3
	21 - 31	105.9	66.5	55.6	78.2	54.0	252.1	590.4	1,323.4	1,268.9	747.9	475.2	359.0

Table 2.4 ANNUAL AVERAGE SEAWATER INTRUSION DISTANCE AND ITS AFFECTED PERIOD ON PAMPANGA RIVER AFTER DIVERTING WATER BY IRRIGATION PROJECT (EXISTING CHANNEL CONDITION)

Item	Year											
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Average
1. Diversion Dam Scheme												
A. At Channel Bottom												
Distance (km)	33.1	33.2	41.1	18.5	25.8	39.3	40.8	12.2	29.9	33.8	11.3	28.9
Period (day)	250	240	160	110	100	220	150	160	110	150	70	156
B. At 1m below Water Surface												
Distance (km)	2.8	2.8	3.8	0.8	1.2	4.0	4.5	0.7	1.5	2.6	0.7	2.3
Period (day)	250	240	160	110	110	220	150	150	110	150	150	155
2. Pump Scheme												
A. At Channel Bottom												
Distance (km)	30.5	30.0	39.7	18.5	25.6	39.9	40.0	11.0	27.7	32.4	6.3	27.4
Period (day)	250	240	160	100	100	210	150	150	120	150	70	155
B. At 1m below Water Surface												
Distance (km)	1.1	1.2	1.6	0.7	0.9	3.5	2.2	0.4	1.2	1.7	0.3	1.3
Period (day)	210	220	160	80	100	200	150	120	100	130	50	138

Table 2.5 (1) ANNUAL AVERAGE SEAWATER INTRUSION DISTANCE AND ITS AFFECTED PERIOD ON PAMPANGA RIVER BY IMPLEMENTATION OF PROJECTS FOR BOTH FLOOD CONTROL AND IRRIGATION

Item	Year											
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Average
1. Diversion Dam Scheme												
A. At Channel Bottom												
a. Excavated Channel by Basic Plan												
Distance (km)	38.3	37.2	40.2	28.8	25.8	38.6	40.4	26.4	33.7	36.9	17.1	33.0
Period (day)	250	250	170	120	160	240	160	160	120	160	110	173
b. Excavated Channel by Stepwise Plan												
Distance (km)	36.4	35.2	39.8	24.7	25.3	37.5	39.6	20.8	34.3	35.0	13.4	31.1
Period (day)	250	250	170	120	140	240	160	160	110	160	100	169
c. Excavated Channel by First Phase, Stepwise Plan												
Distance (km)	34.6	33.5	39.1	20.2	21.8	36.9	38.9	16.6	31.8	33.4	13.6	29.1
Period (day)	250	250	170	120	140	240	160	160	110	160	80	167
B. At 1m below Water Surface												
a. Excavated Channel by Basic Plan												
Distance (km)	4.0	3.7	5.2	1.8	2.1	5.0	5.6	1.4	3.0	4.0	1.3	3.4
Period (day)	250	250	160	110	130	230	150	160	110	150	70	161
b. Excavated Channel by Stepwise Plan												
Distance (km)	3.9	3.5	5.1	1.5	1.8	5.0	5.6	1.1	2.8	3.8	1.0	3.2
Period (day)	250	250	160	110	130	230	150	160	110	150	70	161
c. Excavated Channel by First Phase, Stepwise Plan												
Distance (km)	3.3	3.1	4.5	1.1	1.5	4.7	5.1	0.9	2.1	3.3	0.8	2.8
Period (day)	250	250	160	110	120	220	150	160	110	150	70	159

(to be continued)

Table 2.5 (2) ANNUAL AVERAGE SEAWATER INTRUSION DISTANCE AND ITS AFFECTED PERIOD ON PAMPANGA RIVER BY IMPLEMENTATION OF PROJECTS FOR BOTH FLOOD CONTROL AND IRRIGATION

Item	Year											
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Average
2. Pump Scheme												
A. At Channel Bottom												
a. Excavated Channel by Basic Plan												
Distance (km)	36.5	35.6	40.0	27.5	27.6	37.5	40.0	23.6	32.7	35.8	14.4	32.0
Period (day)	250	250	170	120	140	240	160	170	130	160	110	173
b. Excavated Channel by Stepwise Plan												
Distance (km)	34.2	34.3	39.3	25.6	26.3	38.0	39.3	19.1	32.8	33.6	11.6	30.2
Period (day)	250	240	170	110	130	230	160	160	120	160	90	165
c. Excavated Channel by First Phase, Stepwise Plan												
Distance (km)	32.2	31.0	38.3	20.9	22.7	37.4	38.4	15.0	30.1	32.1	9.6	28.0
Period (day)	250	250	170	110	130	230	160	160	120	160	80	165
B. At 1 m below Water Surface												
a. Excavated Channel by Basic Plan												
Distance (km)	3.4	3.3	4.6	1.7	2.1	5.0	5.5	1.3	2.9	3.8	0.9	3.1
Period (day)	250	250	170	110	120	230	150	160	120	150	70	162
b. Excavated Channel by Stepwise Plan												
Distance (km)	3.2	3.0	4.6	1.4	2.0	5.0	5.4	0.9	2.6	3.3	0.5	2.9
Period (day)	250	250	160	110	110	220	150	160	120	150	70	159
c. Excavated Channel by First Phase, Stepwise Plan												
Distance (km)	2.7	2.7	4.0	1.0	1.4	4.5	4.9	0.8	2.0	3.1	0.5	2.5
Period (day)	250	240	160	110	110	220	150	160	120	150	70	158

Table 3.1 DISTANCE AND AFFECTED PERIOD OF SEAWATER INTRUSION ON PAMPANGA RIVER (AVERAGE 1968 - 1978)

Channel Condition	Discharge Condition					
	Present		Diversion Dam Scheme/1		Pump Scheme/2	
	Intruded Distance	Affected Period	Intruded Distance	Affected Period	Intruded Distance	Affected Period
	(km)	(day)	(km)	(day)	(km)	(day)
1. At Channel Bottom						
a. Existing Channel	22.7	145	28.9	156	27.4	155
b. Improved Chanel/3 (Basic Plan)	29.6	163	32.7	173	32.0	173
c. Improved Channel/4 (Stepwise Plan)	26.9	157	30.5	169	30.2	165
d. Improved Channel/5 (First Phase, Stepwise Plan)	24.6	153	29.1	167	28.0	165
2. At 1m below Water Surface						
a. Existing Channel	1.3	138	2.3	155	2.0	150
b. Improved Channel (Basic Plan)	2.5	149	3.4	161	3.1	162
c. Improved Channel (Stepwise Plan)	2.2	146	3.2	161	2.9	159
d. Improved Channel (First Phase, Stepwise Plan)	1.8	146	2.8	159	2.5	158

Remarks:
/1: Diversion dam scheme of irrigation project
/2: Pump scheme of irrigation project
/3: Improved channel by basic flood control plan with 100-yr design flood
/4: Improved channel by stepwise flood control plan with 20-yr design flood
/5: Improved channel by first phase, stepwise plan corresponding 10-yr flood

Table 3.2 CONSTRUCTION COST OF SALINITY CONTROL GATE

Item	Unit	Q'ty	Unit Price (₱)	Amount (₱x10^3)
1. Pampanga River				
- Earth work	10^3m^3	480	20,000	9,600
- Foundation	L.S.	1		35,300
- Main structure	L.S.	1		45,400
- Bed protection	L.S.	1		24,700
- Steel gate	ton	1,040	50,000	52,000
- Total				167,000
2. Labangan River (with steel gate)				
- Earth work	10^3m^3	150	20,000	3,000
- Foundation	L.S.	1		12,600
- Main structure	L.S.	1		16,800
- Bed protection	L.S.	1		8,100
- Steel gate	ton	250	50,000	12,500
- Total				53,000
3. Labangan River (with rubber gate)				
- Earth work	10^3m^3	150	20,000	3,000
- Foundation	L.S.	1		10,100
- Main structure	L.S.	1		15,100
- Bed protection	L.S.	1		8,100
- Rubber gate	m	80	150,000	12,000
- Total				48,300

Table 3.3 CONSTRUCTION COST OF FACILITY FOR SMALL WATER SUPPLY SYSTEM

Item	Unit	Q'ty	Unit Price (₱)	Amount (₱x10^3)
Right Side Area				
- Pump (ø100 mm)	Set	3	28,300	85
- Service pipe (ø100 mm)	10^{3}m	10	165	1,650
" (ø50 mm)	10^{3}m	20	60	1,200
- Earth work	10^{3}m	30	15	450
- Elevated water tank	L.S.	1	400,000	400
- Well (depth: 40 m)		1	330,000	330
- Miscellaneous (30% of above)				1,235
- Sub-total				5,350
Left Side Area				
- Pump (ø100 mm)	L.S.	1	28,300	28
" (ø50 mm)	L.S.	1	18,300	18
- Service pipe (ø100 mm)	10^{3}m	10	165	1,650
" (ø50 mm)	10^{3}m	20	60	1,200
- Earth work	10^{3}m	30	15	450
- Elevated water tank	L.S.	1	400,000	400
- Well (depth: 40 m)		1	330,000	330
- Miscellaneous (30% of above)				1,224
- Sub-total				5,300
Total				10,650

Fig. 2.1(1) ESTIMATED PROFILE OF SEAWATER INTRUSION ON PAMPANGA RIVER (CALCULATION RESULT)

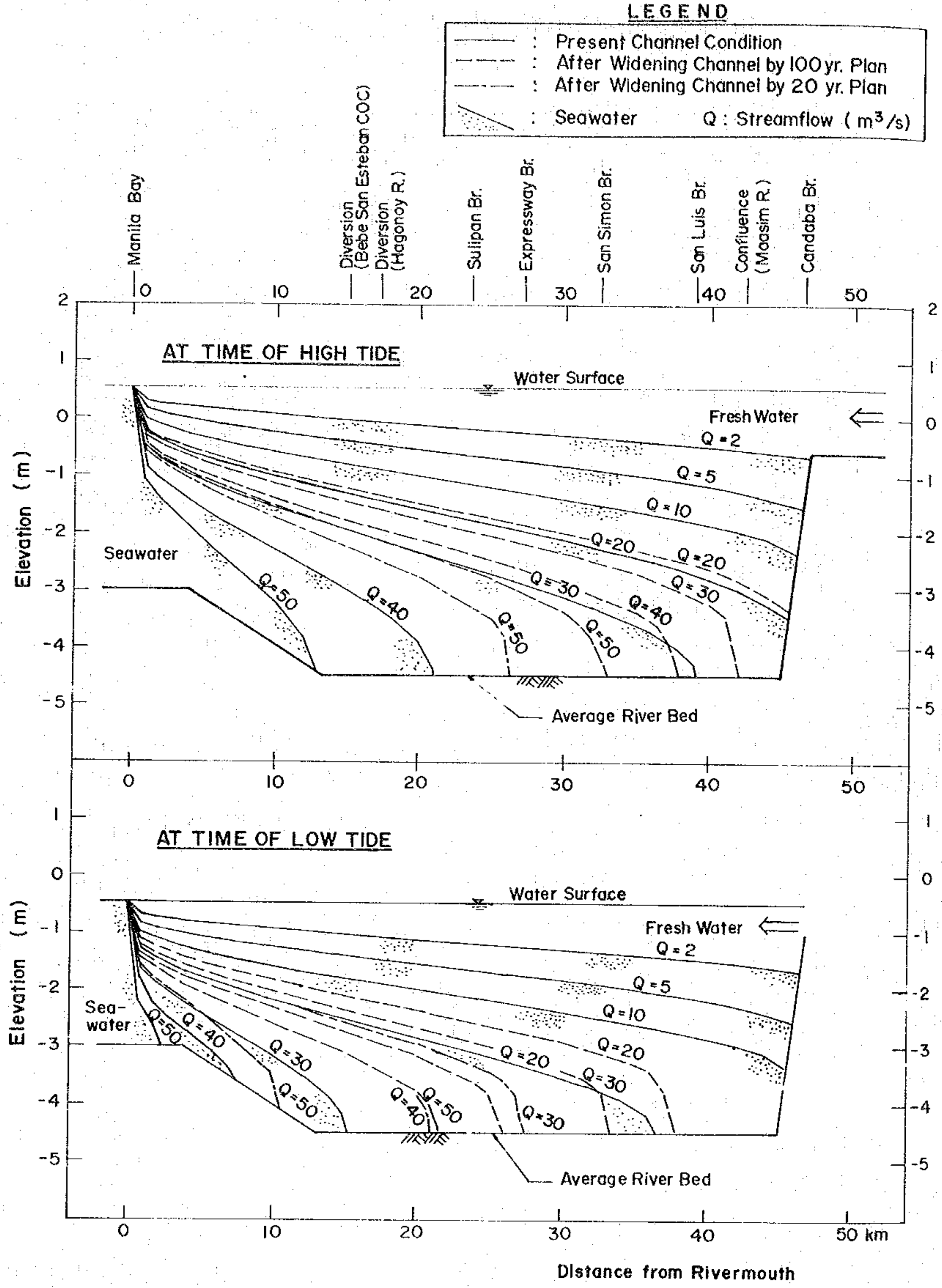


Fig. 2.1(2) ESTIMATED PROFILE OF SEAWATER INTRUSION ON LABANGAN FLOODWAY (CALCULATED RESULT)

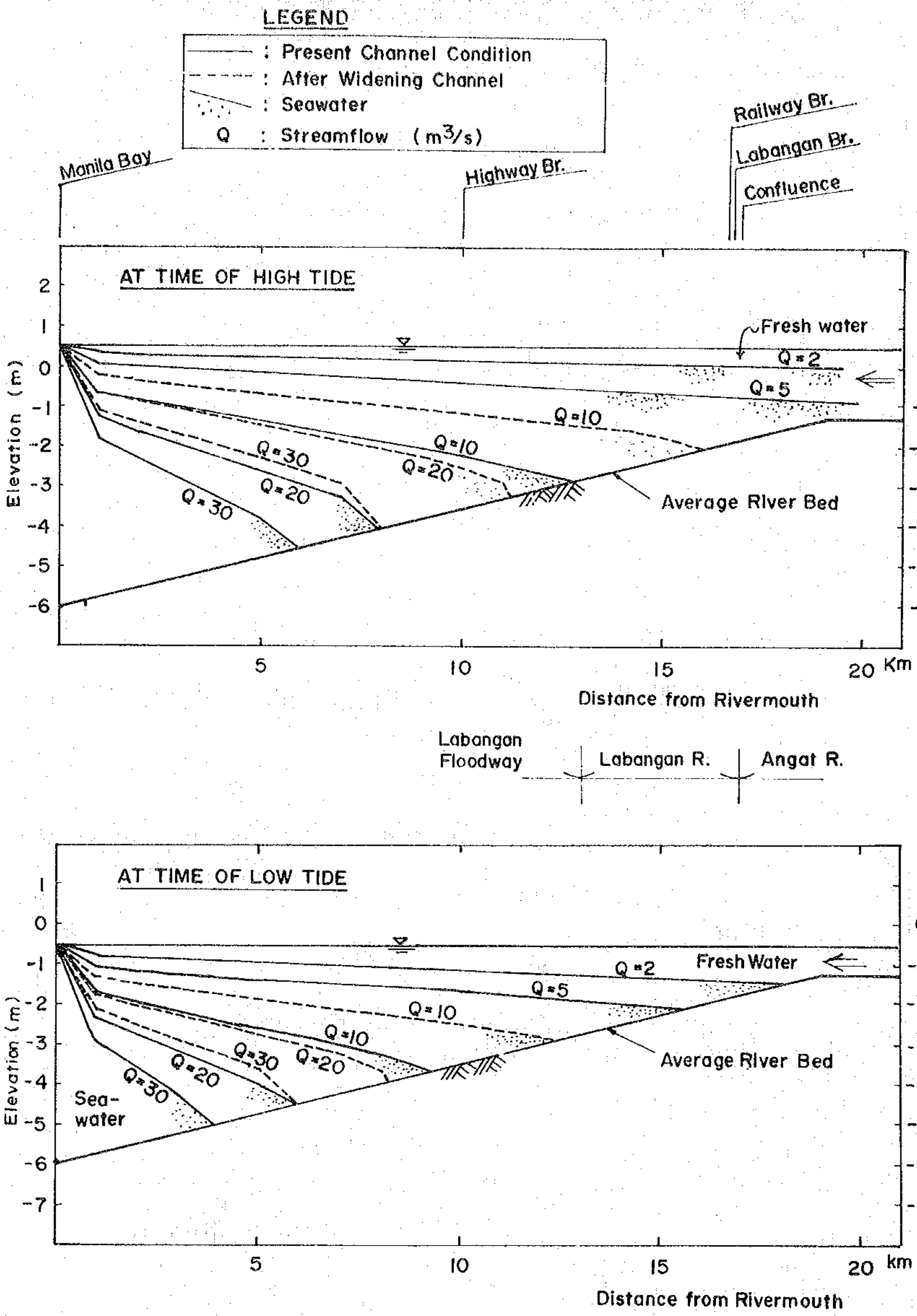


Fig. 2.2 (1) RELATION CURVE BETWEEN RIVER DISCHARGE AND INTRUSION DISTANCE OF SEAWATER AT CHANNEL BOTTOM UNDER MEAN TIDE CONDITION

Pampanga River

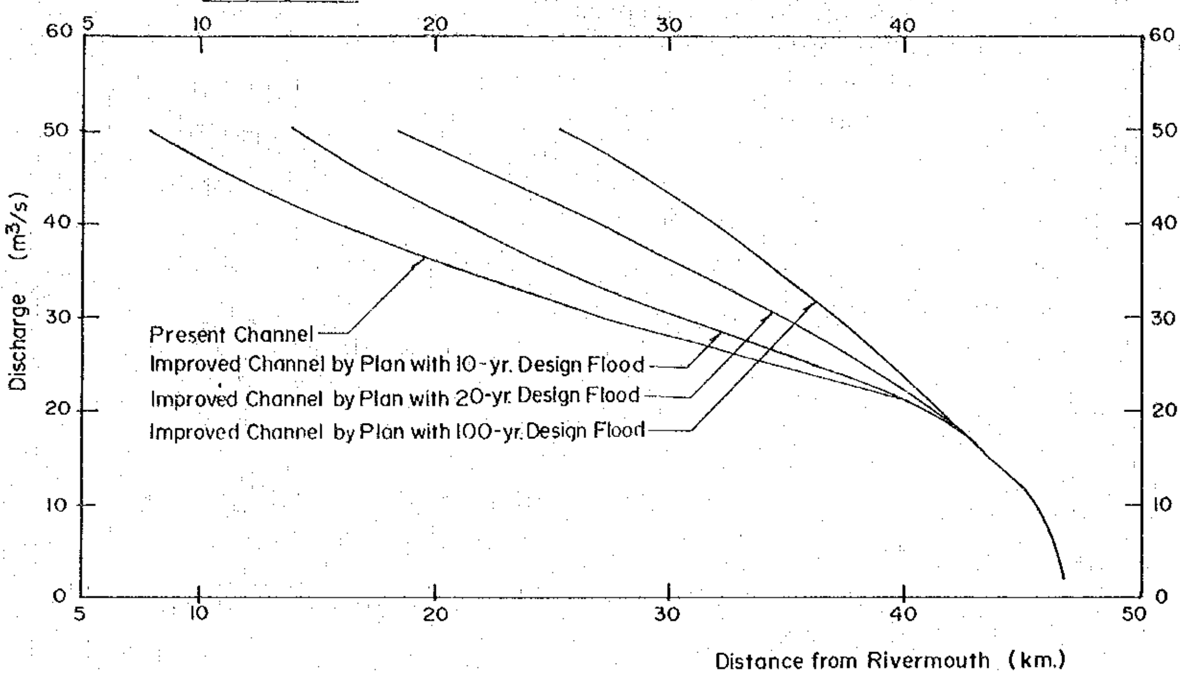


Fig. 2.2 (2) RELATION CURVE BETWEEN RIVER DISCHARGE AND INTRUSION DISTANCE OF SEAWATER AT 1 M BELOW WATER SURFACE UNDER MEAN TIDE CONDITION

Pampanga River

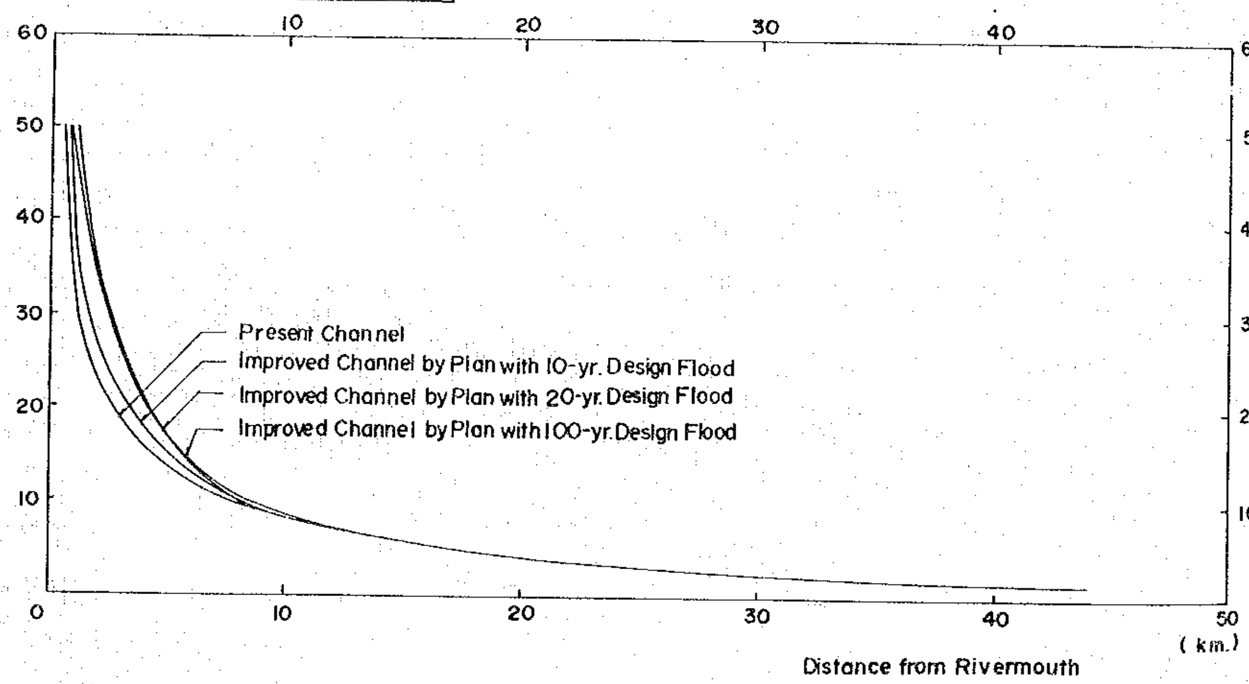


Fig. 2.2 (3) RELATION CURVE BETWEEN RIVER DISCHARGE AND INTRUSION DISTANCE OF SEAWATER AT CHANNEL BOTTOM UNDER MEAN TIDE CONDITION

Labangan River

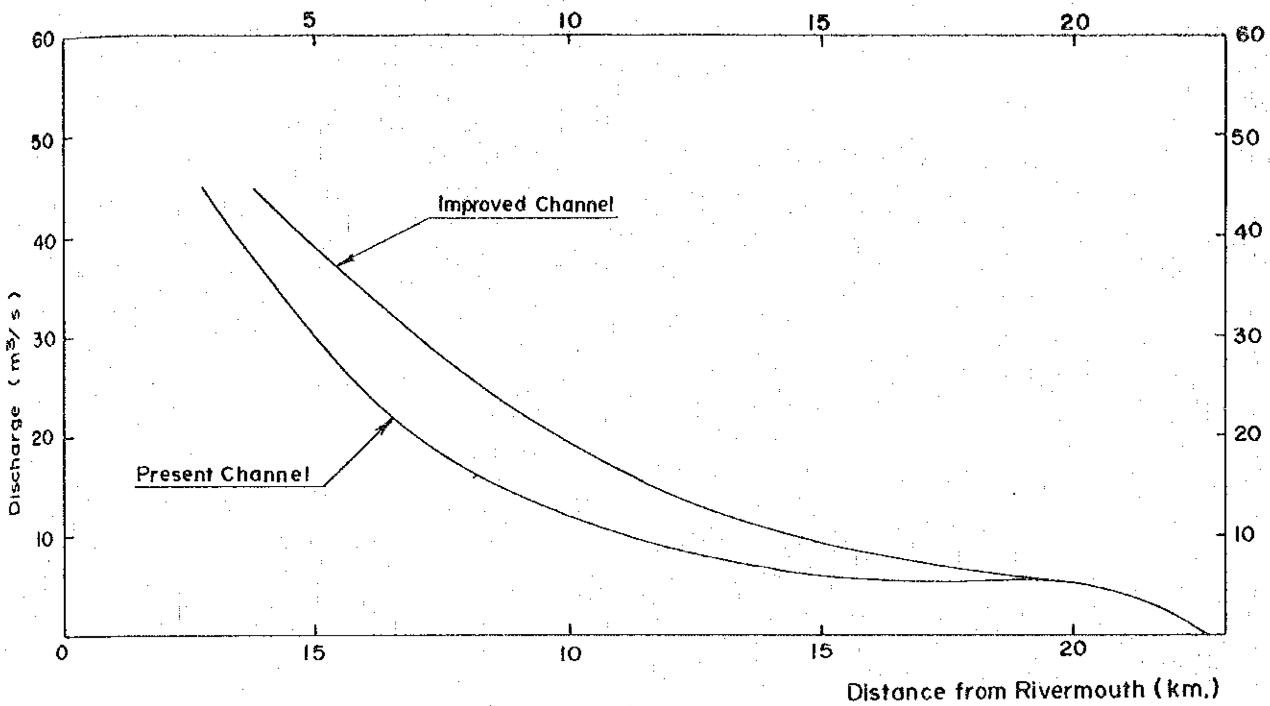


Fig. 2.2 (4) RELATION CURVE BETWEEN RIVER DISCHARGE AND INTRUSION DISTANCE OF SEAWATER AT 1M BELOW WATER SURFACE UNDER MEAN TIDE CONDITION

Labangan River

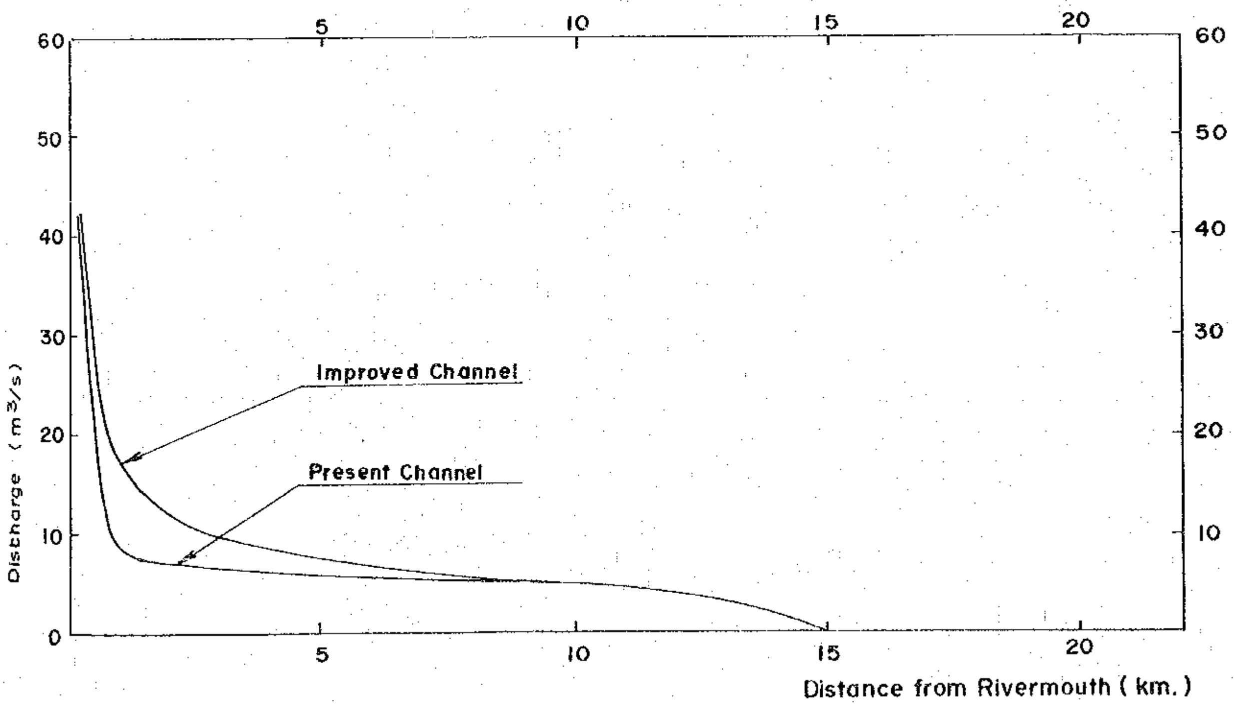


Fig. 2.3 ESTIMATED PROFILE OF SEAWATER INTRUSION IN ANNUAL AVERAGE ON PAMPANGA RIVER

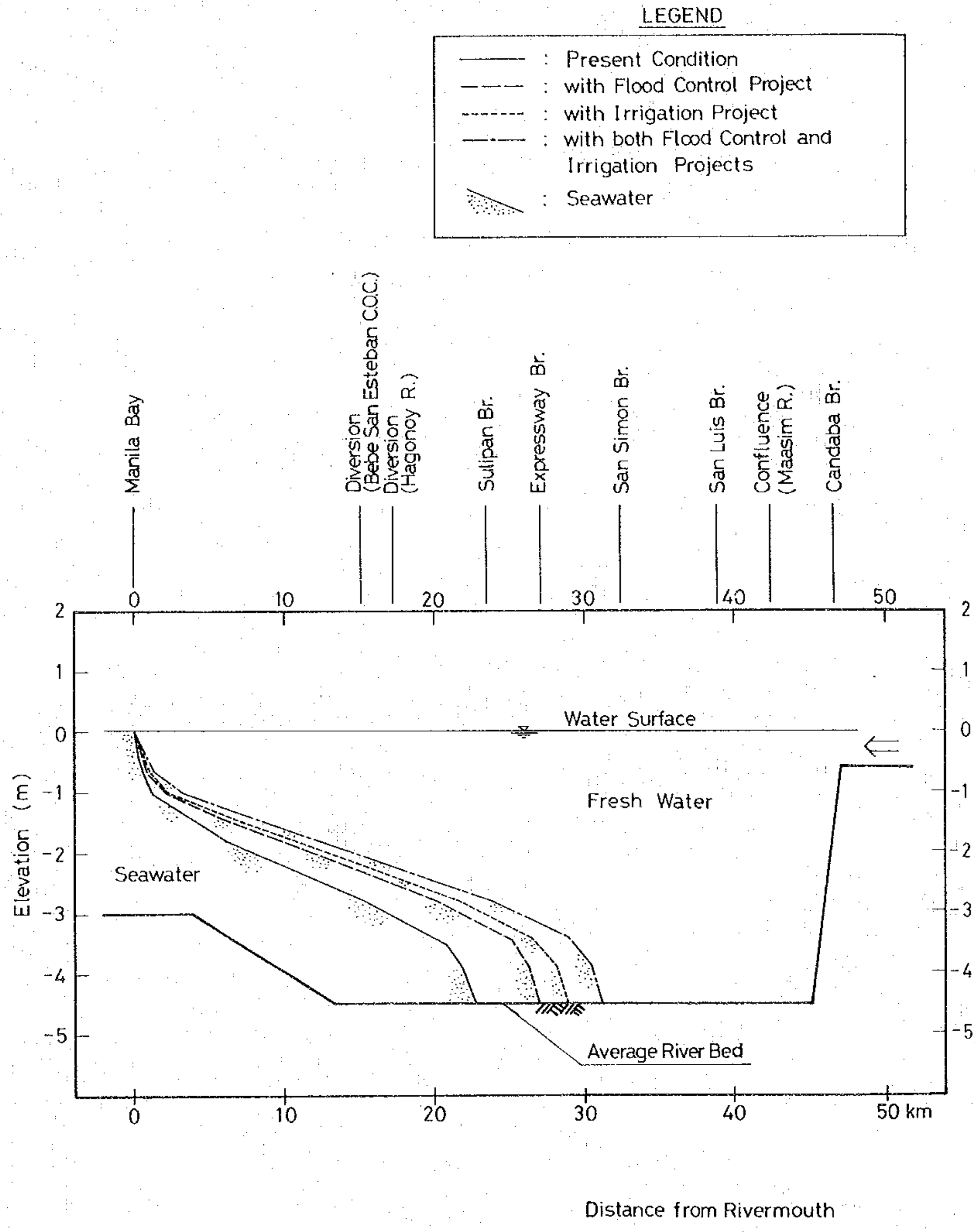


Fig. 3.1 ESTIMATED POLLUTION AREA BY SALINITY

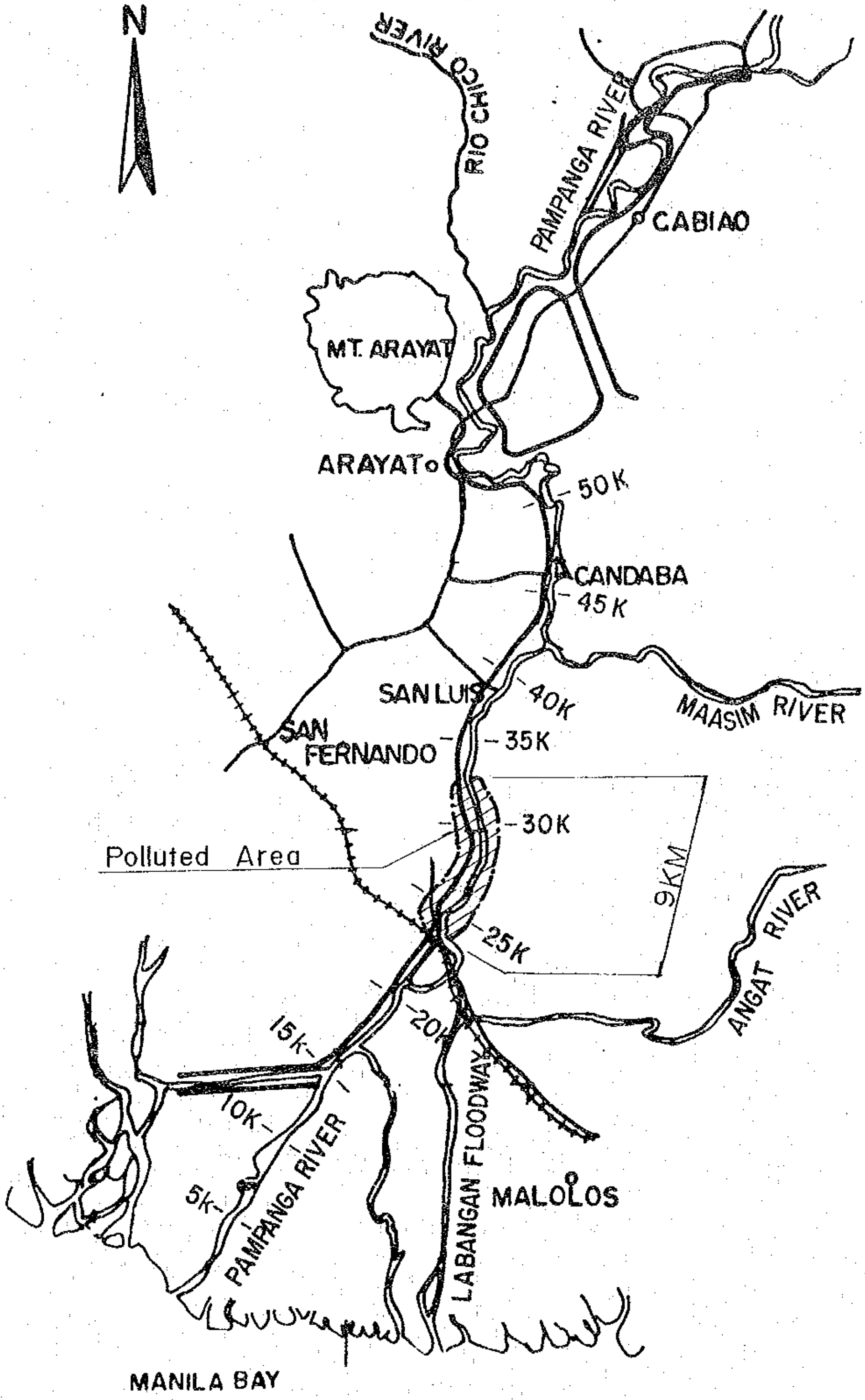


Fig. 3.2(1) PAMPANGA SALINITY CONTROL GATE (1)

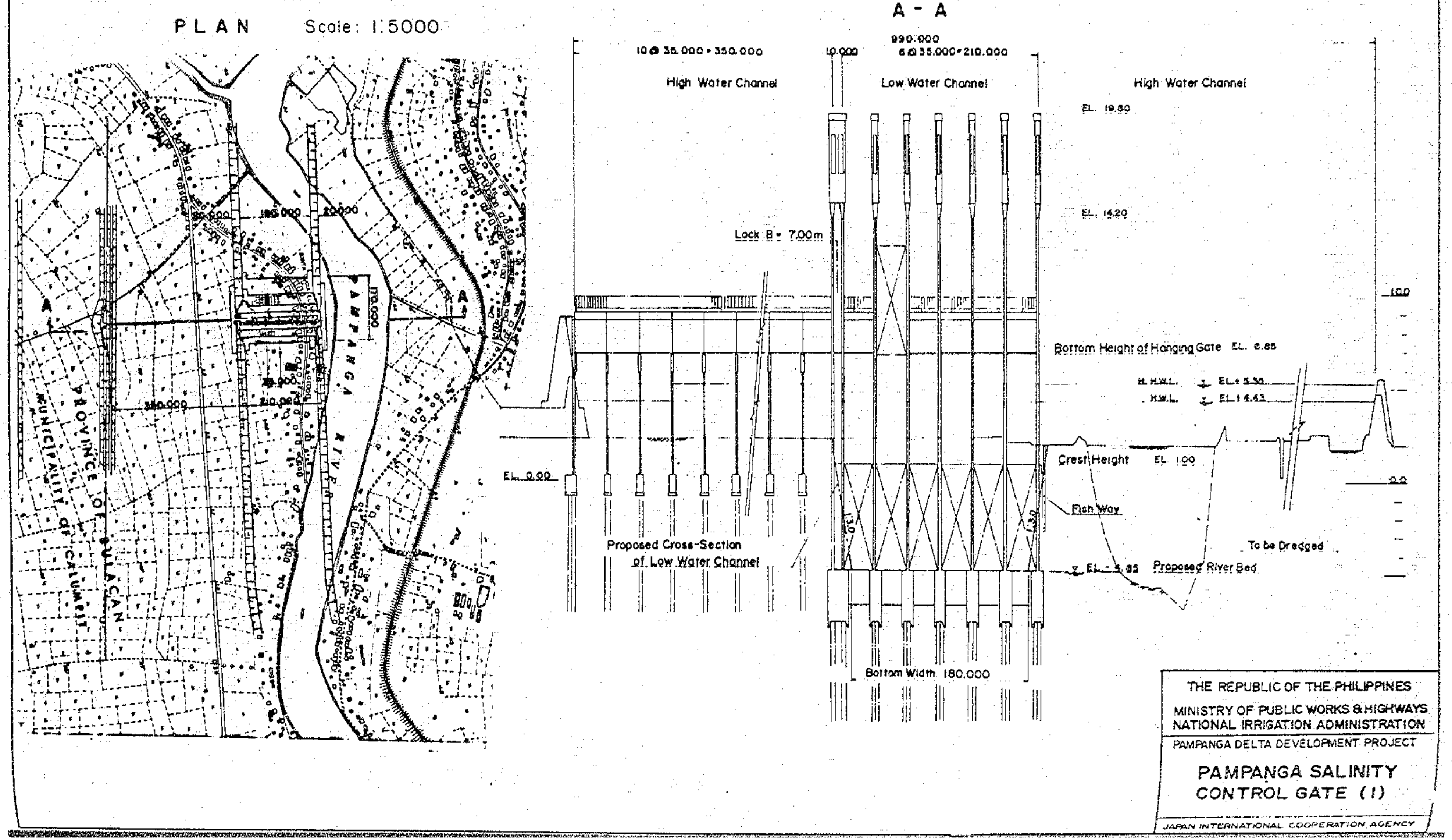
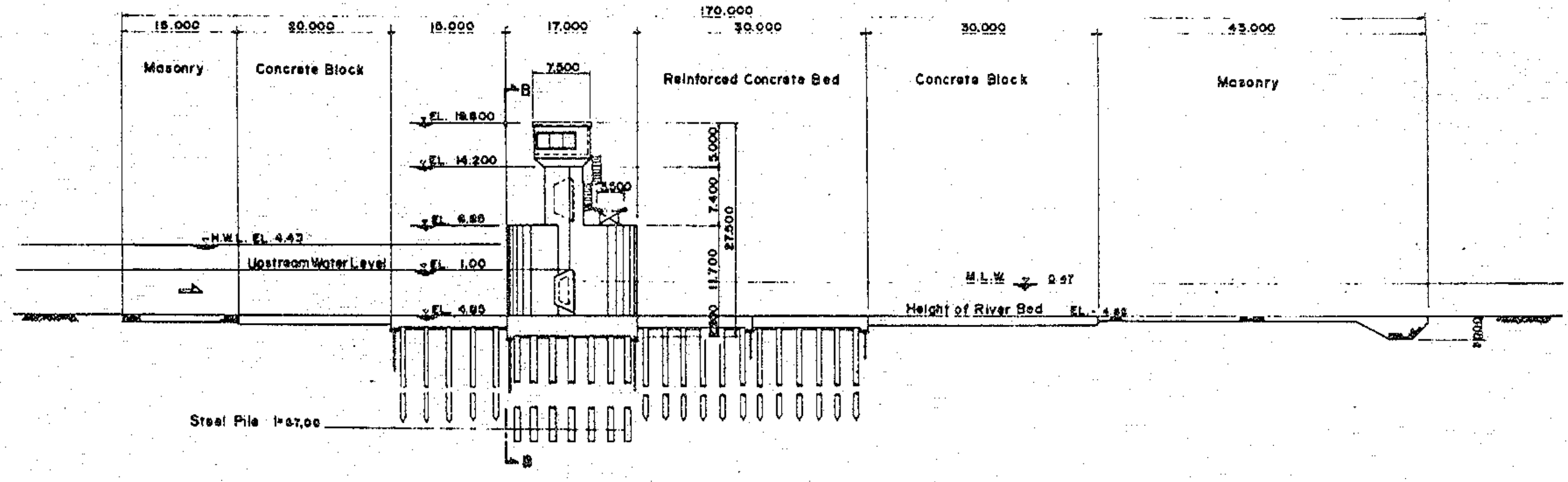
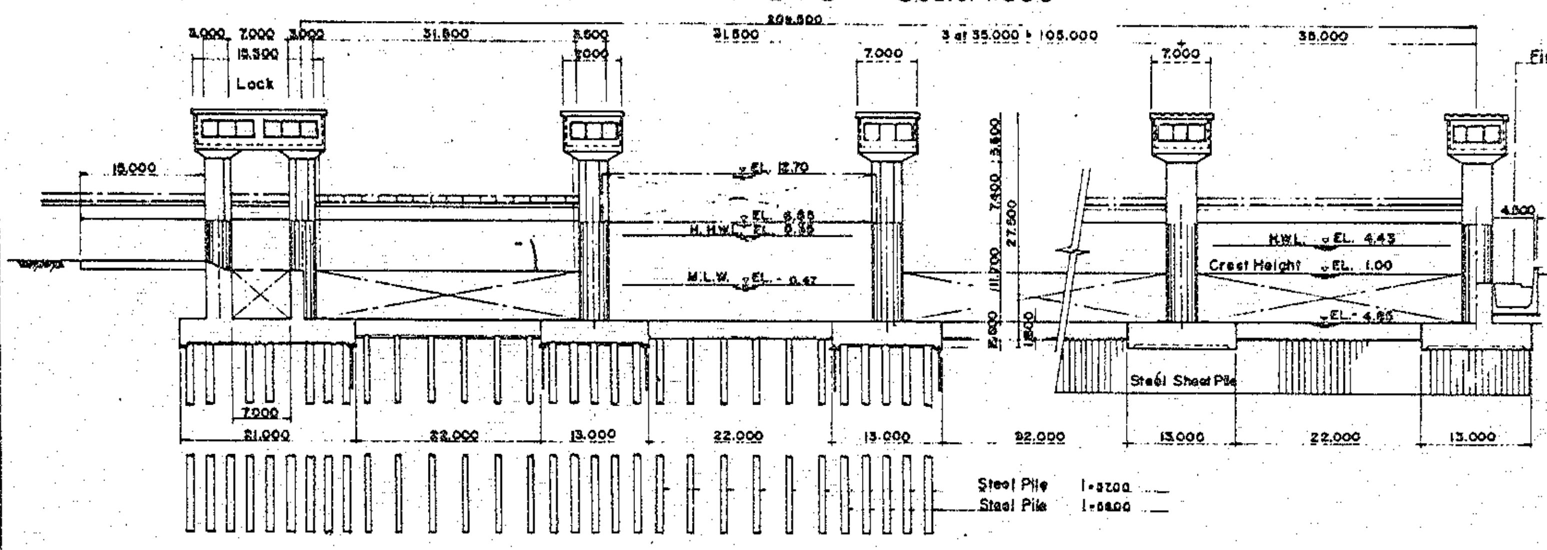


Fig. 3.2(2) PAMPANGA SALINITY CONTROL GATE (2)

PROFILE Scale: 1:300



B - B Scale: 1:300



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MINISTRY OF PUBLIC WORKS & HIGHWAYS
NATIONAL IRRIGATION ADMINISTRATION

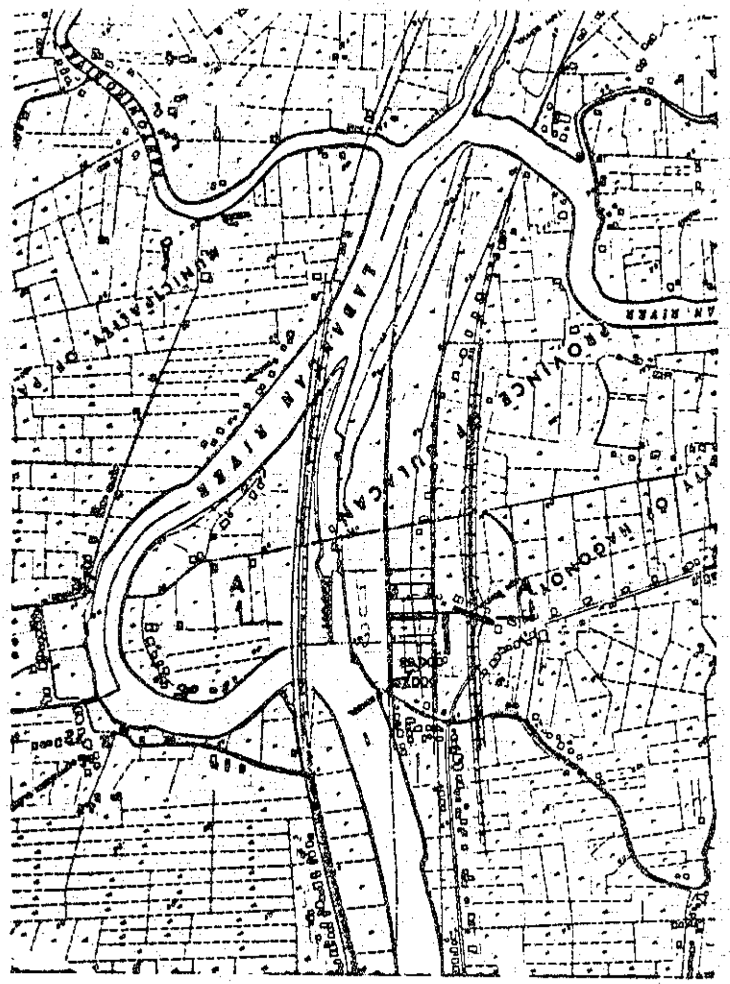
PAMPANGA DELTA DEVELOPMENT PROJECT

PAMPANGA SALINITY CONTROL GATE (2)

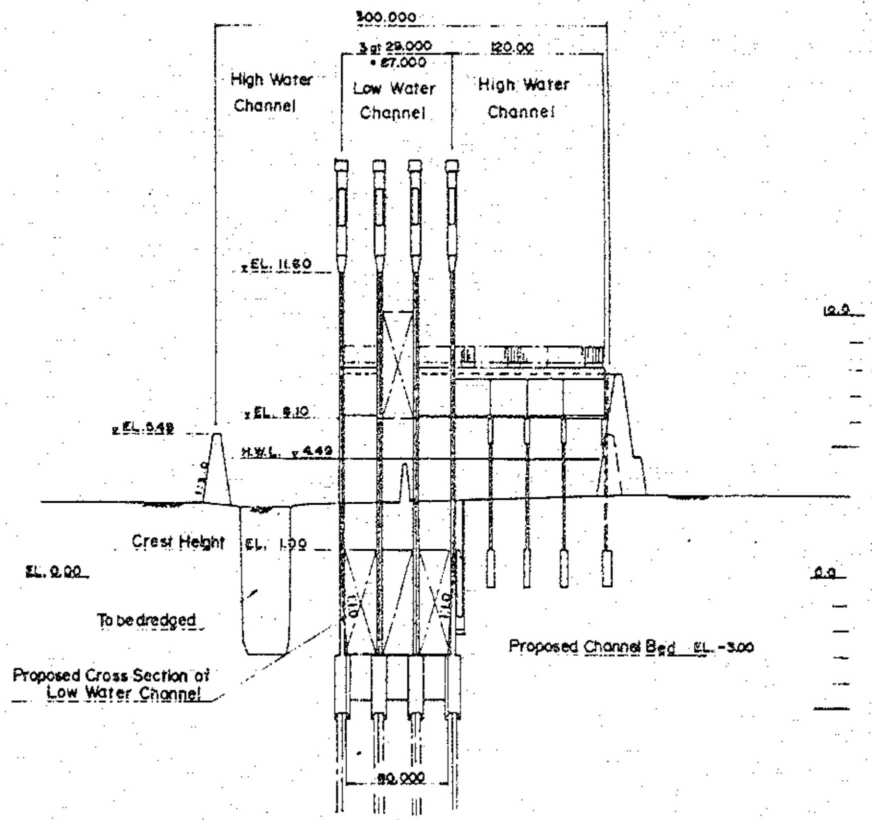
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig.3.3(1) LABANGAN SALINITY CONTROL GATE (1)

PLAN Scale: 1 : 5000



A — A



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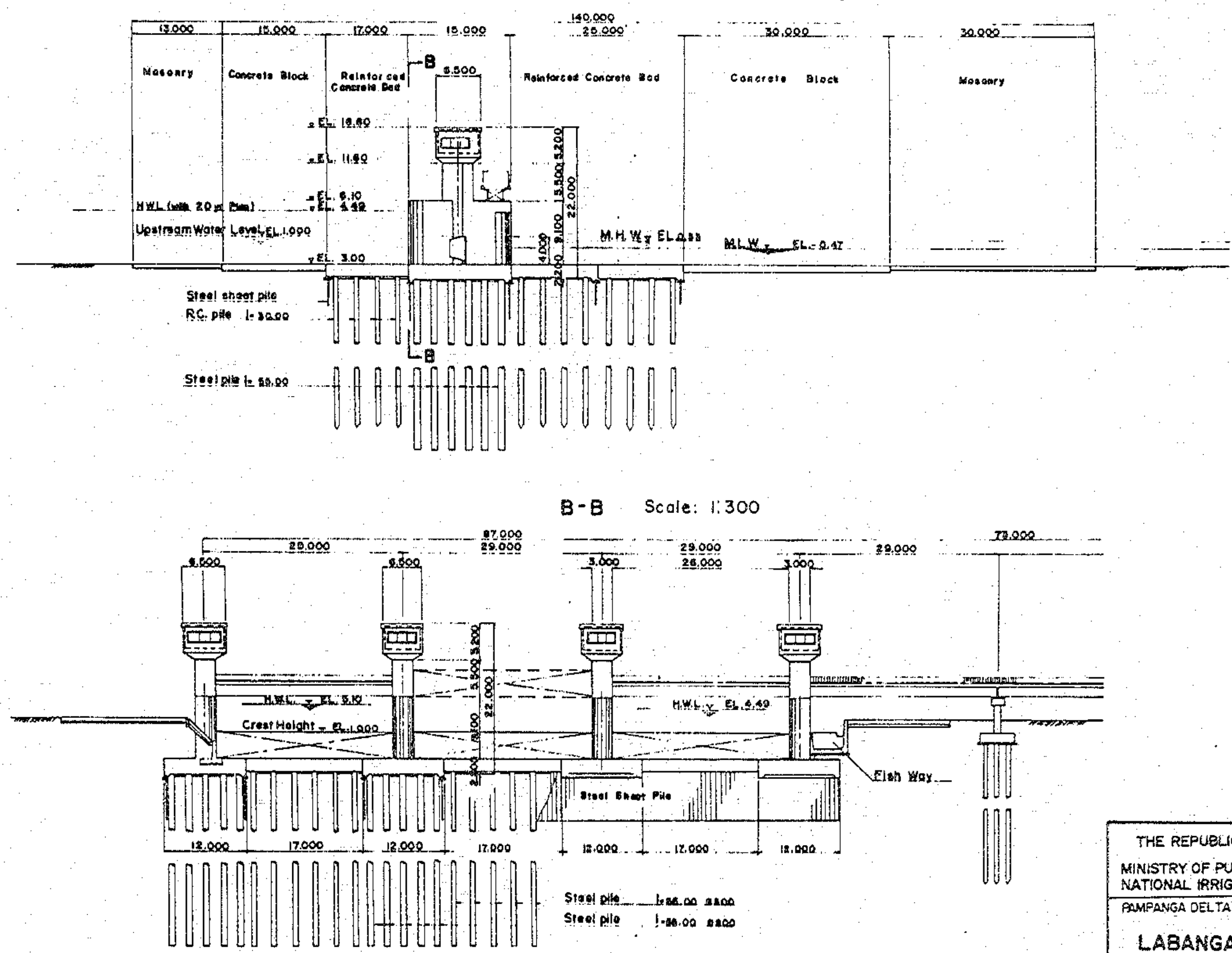
LABANGAN SALINITY CONTROL GATE (1)
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.3 (2) LABANGAN SALINITY CONTROL GATE (2)



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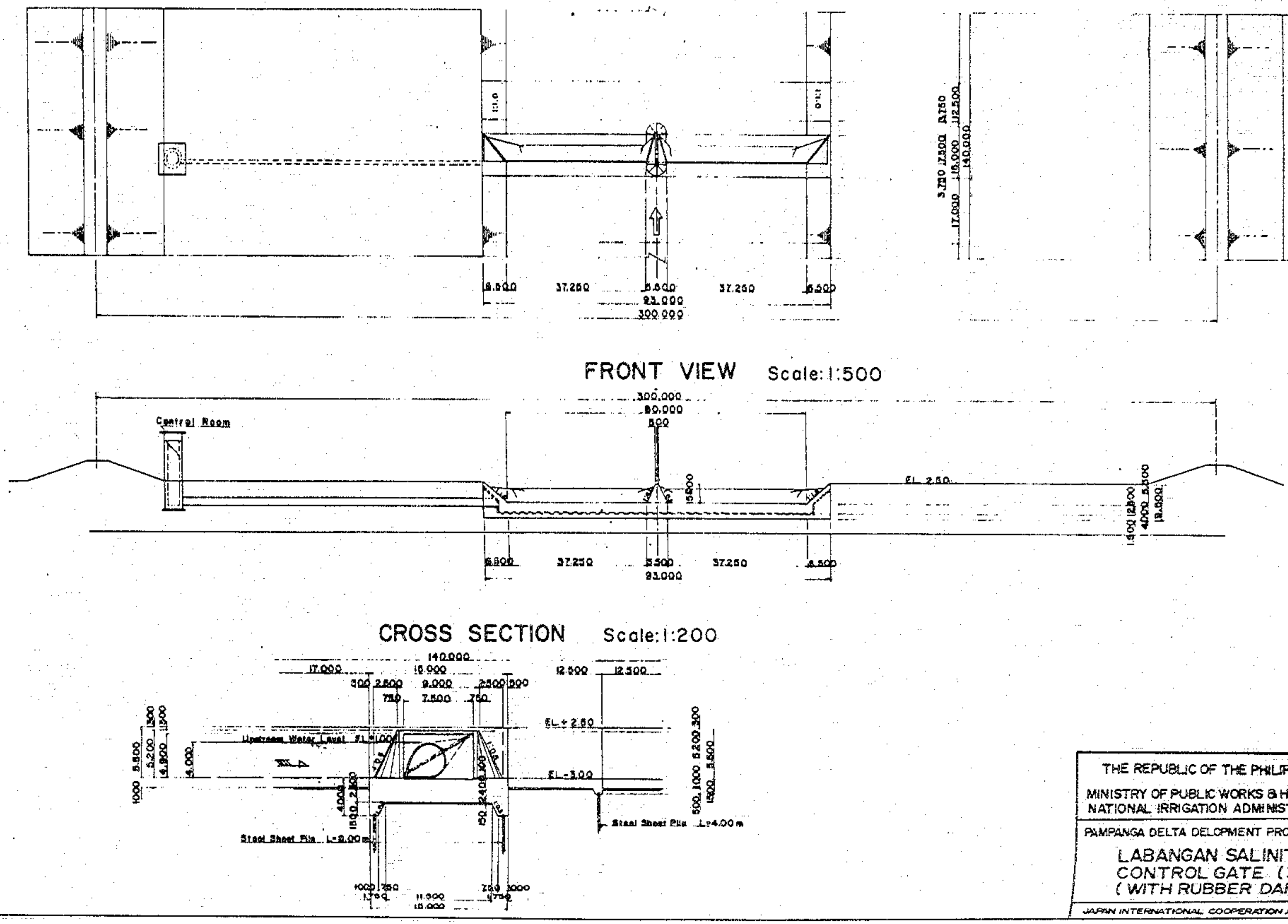
PAMPANGA DELTA DEVELOPMENT PROJECT

LABANGAN SALINITY CONTROL GATE (2)

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.4 LABANGAN SALINITY CONTROL GATE (WITH RUBBER TYPE GATE)



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MINISTRY OF PUBLIC WORKS & HIGHWAYS
NATIONAL IRRIGATION ADMINISTRATION

PAMPANGA DELTA DELOPMENT PROJECT

LABANGAN SALINITY
CONTROL GATE (3)
(WITH RUBBER DAM)

JAPAN INTERNATIONAL COOPERATION AGENCY

APPENDIX IX
ORGANIZATION AND MANAGEMENT

APPENDIX IX ORGANIZATION AND MANAGEMENT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX IX ORGANIZATION AND MANAGEMENT

CHAPTER 1 FLOOD CONTROL PROJECT

1.1 Present Organization

The river administration in the Philippines is centralized under the Ministry of Public Works and Highways (MPWH), and the Ministry have responsibilities in flood control and drainage.

At present, the flood control works of the Pampanga River are being managed under an organization which was established for the implementation of the Pampanga River Control Project in 1950. The organization at present is shown in Fig. 1.1, and the Pampanga River Control System-Project Management Office (PRCS-PMO) is located in Apalit, Pampanga. At present, however, PRCS-PMO deals not only with the construction works but also the operation and maintenance of completed river facilities such as levee, bank protection, flood gate and so on.

1.2 Organization for the Project Execution

The MPWH will entirely be responsible for the implementation of the project, and necessary consultations will be made to the organization concerned. The present organization will be developed for implementing the new project as shown in Fig. 1.2.

The MPWH will be the executing agency for the new project. The Minister will take charge of coordination with all the relevant government agencies and regional administrative organizations in implementing the project.

The project manager will be appointed by the Minister and he will take whole responsibility to the Ministry for the proper implementation of the project. The assistant project manager will be appointed for implementation of the project to support the project manager. The project staff will be also appointed to support the project manager and the assistant project manater. They will support execution of detailed survey, design and planning, preparation of tender documents, specifications for construction works and supervision of execution works.

Foreign consultant will be employed by the executing agencies on an international competitive basis for the assistance in the engineering work to be carried out by the executing agency.

1.3 Organization for Operation and Maintenance

After completion of the flood control facilities, the operation and maintenance of those facilities will be entrusted to the PRCS-PMO under the control of MPWH. The present organization of the PRCS-PMO will be capable to undertake the operation and maintenance.

At present, during flooding time, an emergency force is organized for flood fighting activities as shown in Fig. 1.3. This emergency force would be enforced to cover the whole new project area in the future.

CHAPTER 2 IRRIGATION PROJECT

2.1 Organization for the Project Execution

The National Irrigation Administration (NIA) is given responsibilities for planning, developing, operating and managing all national irrigation systems in the country. NIA's activities are managed by a Board of Directors and an Administrator; the latter is assisted by four Assistant Administrators.

The NIA will become the execution agency for the Proposed Irrigation and Drainage Project. It will be responsible for design, construction of project works and supervision for the Project. The Assistant Administrator for Project development and implementation will be responsible for overall execution of the Proposed Project, who will coordinate activities of all relevant governmental agencies in connection with implementation of the Project.

The Project Execution Office will be established in the project area. A project manager of the proposed project will manage all field works in the Project Execution Office, assisted by three divisions: construction management division, administrative and accounting division and engineering division. Necessary staff will be supplied by the NIA. The proposed organization chart is as shown in Fig. 2.1.

2.2 Organization for Operation and Maintenance

2.2.1 O & M Office

For operation and maintenance purposes, operation and maintenance office will be established and the proposed project area would be administrated by a project manager after the implementation of the Project. The project manager will be responsible for management of the irrigation service area divided into five irrigation districts such as Arayat (1,333 ha), Santa Ana (2,800 ha), San Luis (2,121 ha), Mexico (2,664 ha) and San Simon (2,082 ha) being assisted by four support divisions which deal with administration, collection of irrigation fee, operation and agricultural development. The proposed organization is illustrated on Fig. 2.2. Staff necessary for the office is listed in Table 2.1.

Water management will be carried out for the area more than 50 ha of terminal irrigation unit by the O & M office. In the O & M office, one ditchtender will manage two irrigation units (100 ha), while one water management technician would supervise five ditchtenders (500 ha). One irrigation district supervisor would be in charge of a water management division with five water management technicians (about 2,500 ha). For effective operation of irrigation water supply, measuring device will be installed at one turnout in each irrigation unit (50 ha) at least and irrigation water is recorded. Further the O & M office will install office computer programmed irrigation water distribution diagrams for the irrigation service area according to the irrigation schedule decided in the Coordination Committee mentioned later. It will provide radio operation networks in the irrigation services area in which branches of networks will be established by each 500 ha of irrigation area. Each branch will be facilitated with one set of meteological gauging equipment. The staff of each branch, usually water management technician, will inform daily rainfall and discharge of water to the O & M head office through radio operation network. The head office will calculate and modify diversion water requirement at each irrigation block with 500 ha by the office computer on the basis of the said rainfall and cropping calendar prevailing in the blocks and will direct gate operation at each said block. Through water management technician, gate operation will be directed in the irrigation block at lower level.

From the standpoint of staffing, it is inevitable for effective water management that qualities of ditchtenders be upgraded. For this purpose special education program for ditchtenders will be carried out in one irrigation district, Arayat irrigation district (1,333 ha) where irrigation and drainage facilities will be completed first.

With regard to maintenance of irrigation and drainage facilities, the O & M office will maintain these facilities. Rehabilitation of large scaled structures in these facilities, however, will be executed as a new project.

As far as collection of irrigation fee is concerned, collection service division will collect irrigation fee through the Project Federation of Irrigator's Group in the final stage, however, the collection service division will collect fee from each irrigator's group with joint responsibility at the initial stage. Management of collection fee will be done by the office computer mentioned before which will register name of beneficiaries and other any items necessary for collection of fee.

2.2.2 Coordination Committee

Farm management is one of the most essential factors for success of the Project through extension services and credit supply. It is proposed for the purpose that coordination committee at the field level will be instituted among the Project Manager, representatives from irrigator's group, Region III of Ministry of Agriculture, CBP, PNB, ACA and LBP. The Project Manager will be appointed Chairman of the Coordination Committee.

Through the Coordination Committee irrigation schedule for the land of each irrigator's group and program of Masagana 99 will be planned and decided. Extension services for the beneficiaries will be provided through Region III office of Ministry of Agriculture. Credit services will be supplied through CBP, PNB, ACA and LBP. Water management will be executed under responsibility of the Project Manager.

2.3 Farmer's Organization

2.3.1 Irrigator's Group

For the management, operation and maintenance of the irrigation and drainage systems below terminal irrigation unit of 50 ha, irrigator's group (IG) will be organized by beneficiaries. The IG will be organized by each irrigation unit of 50 ha consisting of about 20 farm households on an average in the irrigation development area. For good coordination and cooperation, irrigation district federations of irrigator's groups will be established through affiliation of irrigator's groups in each irrigation district and the project federations will be organized through affiliation of district irrigation federations. Project federation is composed of 5 irrigation district federations and 220 irrigator's groups in the irrigation development area as follows;

Name of Irrigation District Federation & No.		Command Area of Irrigation District Federation (ha)	No. of Irrigator's Group
	Arayat	1,333	27
	Santa Ana	2,800	56
	San Luis	2,121	43
	Mexico	2,664	53
	San Simon	2,082	41
Total	5	11,000	220

Irrigation district federations are formed taking into account organization of O & M office and the proposed irrigation network as shown in Fig. 2.3. Relation between areas commanded by each irrigation district federation and irrigation canals is summarized as follows;

Name of Irrigation District Federation	Area (ha)	Name of Canals Commanded
Arayat	1,333	Secondary canal-1 Part of main canal
Santa Ana	2,800	Secondary canal-2 Part of main canal
San Luis	2,121	Part of sub-main canal
Mexico	2,664	Secondary canal-3 Secondary canal-4
San Simon	2,082	Secondary canal-5 Secondary canal-6 Part of sub-main canal

For the smooth and efficient operation of the project-wide irrigation water control, the governmental agencies (O & M office) and farmer's organization will be closely interlinked. Such inter-linkage between the governmental agencies (O & M office) and farmer's organization will be carried out through the liaison between a supervisor of each irrigation district and a representative of each irrigation district federation of irrigator's groups and through the liaison between water management technician of each 500 ha - irrigation block and a representative of each irrigator's group in the technical aspect. In the administrative aspect, the inter-linkage will be realized through the participation of the representatives of project federation of irrigator's group and Project Manager in Field Coordination Committee meetings.

2.3.2 Schedule of Irrigator's Group Setup

Schedule of irrigator's group setup is shown in Fig. 2.4.

After the mapping for the irrigation development area, preparation of the parcellary maps necessary for setup of irrigator's group will be made by the field survey during the period of 15 months from April 1984 to June 1985, taking into consideration of the cadastral maps prepared by the Ministry of Agrarian Reform. Based on the parcellary maps, irrigator's groups will be organized for each area commanded by the irrigation districts step by step. The setup of the irrigator's groups will be carried out during the period of two years, starting at July 1985 and finishing at June 1987. Irrigation district federation of the irrigator's groups will be established just after organizing all irrigator's groups in the area commanded by irrigation districts. Project federation will be finally organized at June 1987. From the social aspects, the irrigator's groups will be organized by farmers who live in some administrative unit of Barangay under the help of Project Manager and Barangay captain. In their institutional process, the Project Manager should hold meeting with beneficiaries and inform the beneficiaries that the proposed project will be constructed for their own benefit and on their part and it is their obligation to improve and make the project productivity. And he should stress to them that project investments incurred are their money and in return they should partly pay their obligation and dues for maintenance of the project. In the meeting, the beneficiaries will take part in designing of farm ditches and farm drains. Through the meeting, mutual agreement between the beneficiaries and the Project Manager will reach with regard to right of way of the canal facilities, how to manage irrigation water, collection of irrigation fee, etc.

Table 2.1 PERSONNEL REQUIREMENT FOR OPERATION AND MAINTENANCE IN THE IRRIGATION PROJECT

	No.
Project Manager	1
Irrigation Superintendent	1
<u>Administrative Division</u>	
Cashier	1
Property Custodian	1
Accounting Clerk	1
Clerk	4
Instrumentman	1
Janitor	2
Security Guard	3
Aide	2
Electrician	1
Driver	7
<u>Collection Service Division</u>	
Chief Officer	1
Collector Officer	11
<u>Agricultural Development Division</u>	
Agr. Extension Specialist	1
Agronomist	1
Agr. Liaison Officer	3
<u>Operation Division</u>	
Mechanical/Electric Engineer	1
Computer Engineer	1
Irrigation Superintendent	1
Carpenter	1
Radio Operator	1
<u>5 - Irrigation District</u>	
Division Supervisor	5
Water Management Technician	22
Ditchtender	110
Mechanic	4
Junior Mechanic	4
Total	192

Fig. 1.1 PRESENT ORGANIZATION CHART OF PAMPANGA RIVER CONTROL SYSTEM-PROJECT MANAGEMENT OFFICE (PRCS-PMO)

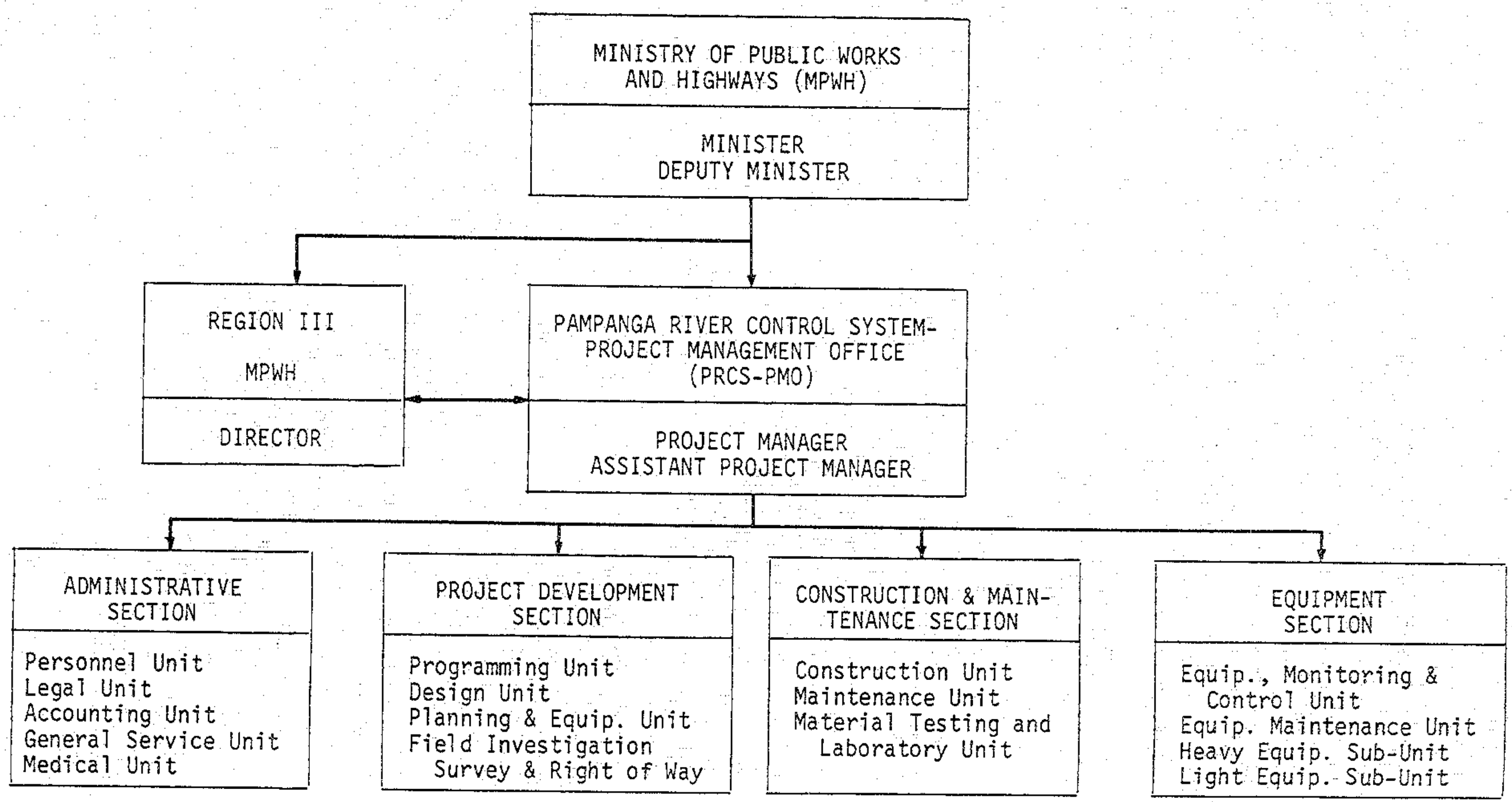


Fig. 1.2 ORGANIZATION CHART AT IMPLEMENTATION FOR THE FLOOD CONTROL PROJECT

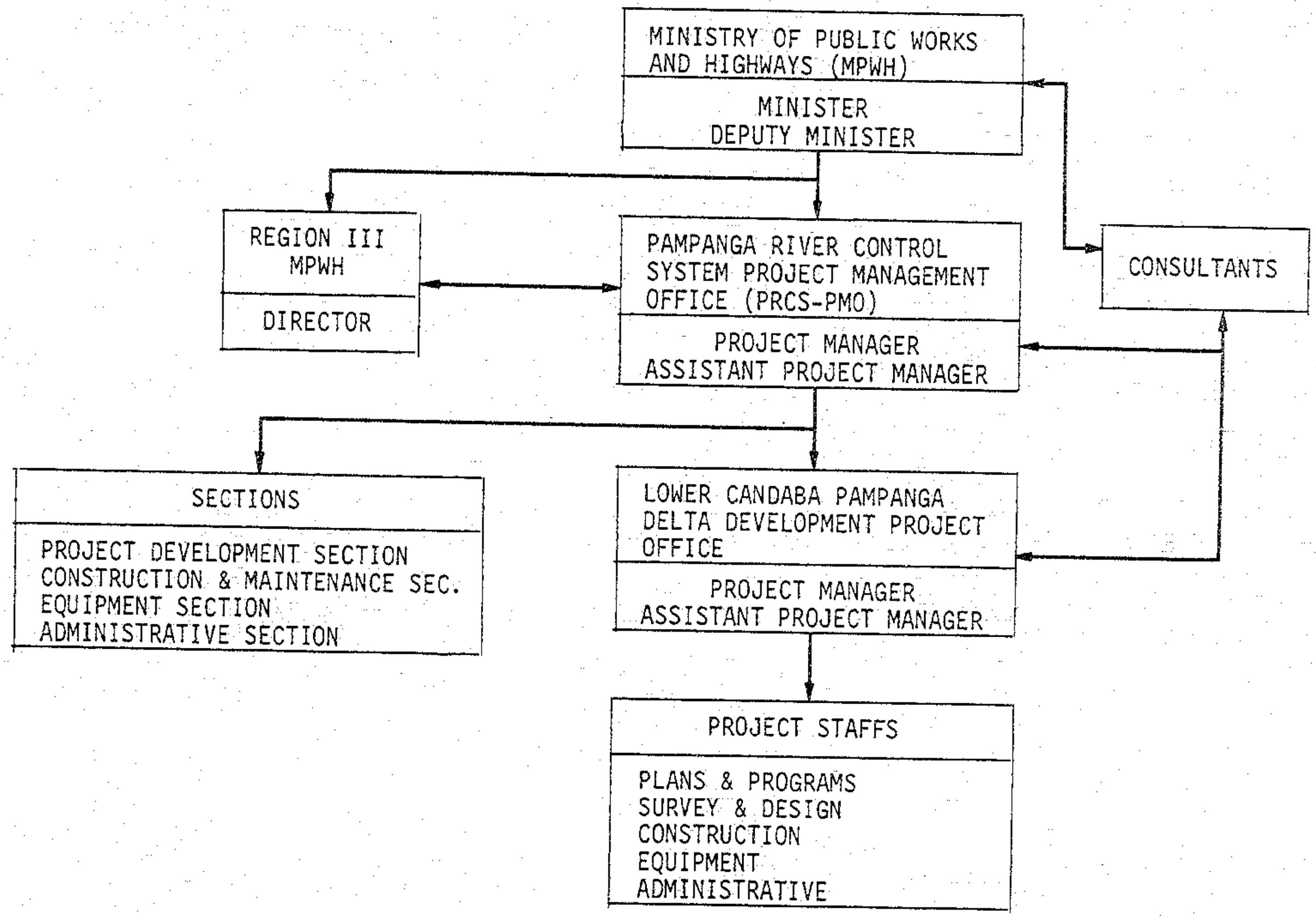
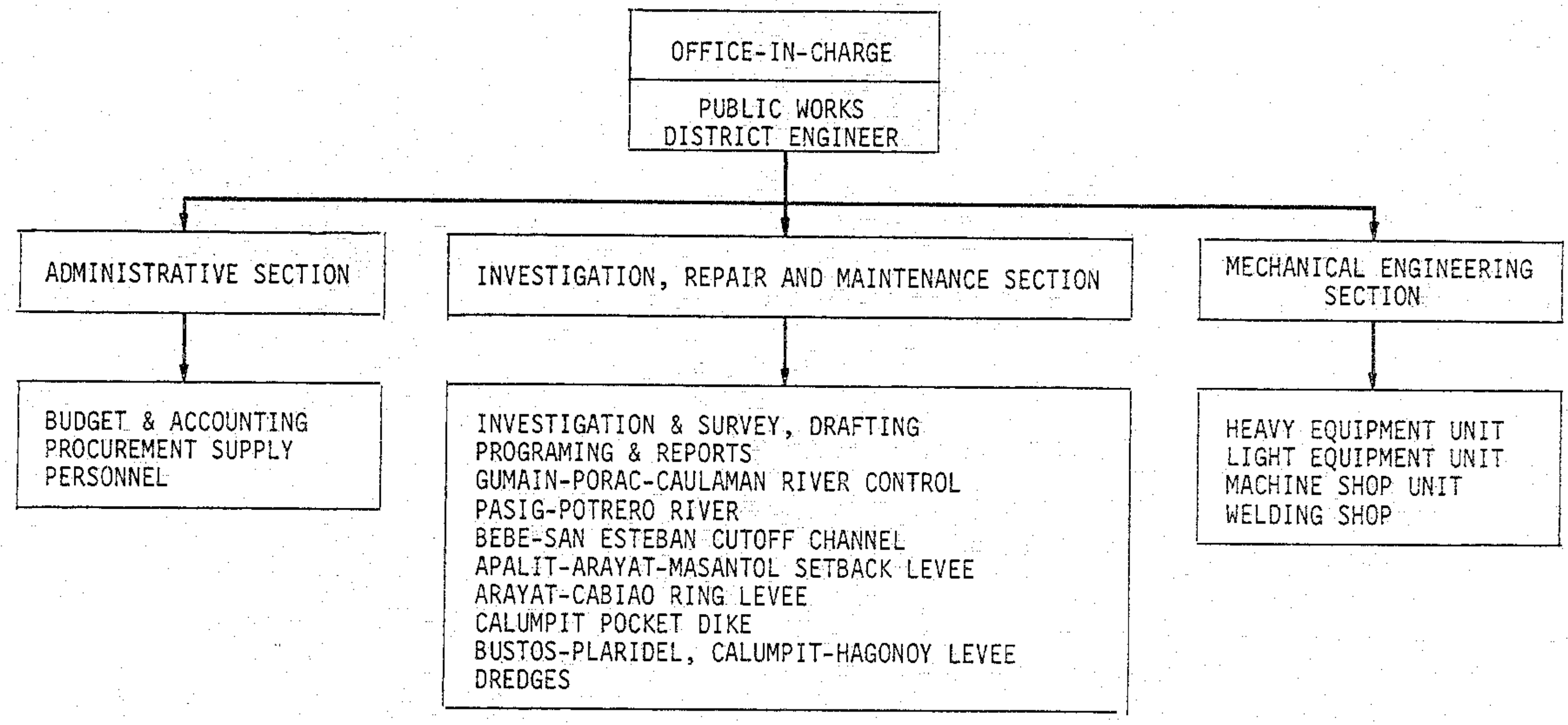


Fig. 1.3 EMERGENCY ORGANIZATION OF PAMPANGA RIVER CONTROL SYSTEM



LEGEND: Flood Stages along Pampange River-Mobilization of Personnel

Stage - I, Bank levee: All heads only will patrol their respective assignment
Stage - II, Bank overflow: All heads and one aide will patrol their respective assignment
Stage - III, Arnedo Dike overflow: All personnel will patrol their respective assignment

Fig. 2.1 PROPOSED ORGANIZATION FOR CONSTRUCTION FOR THE IRRIGATION PROJECT

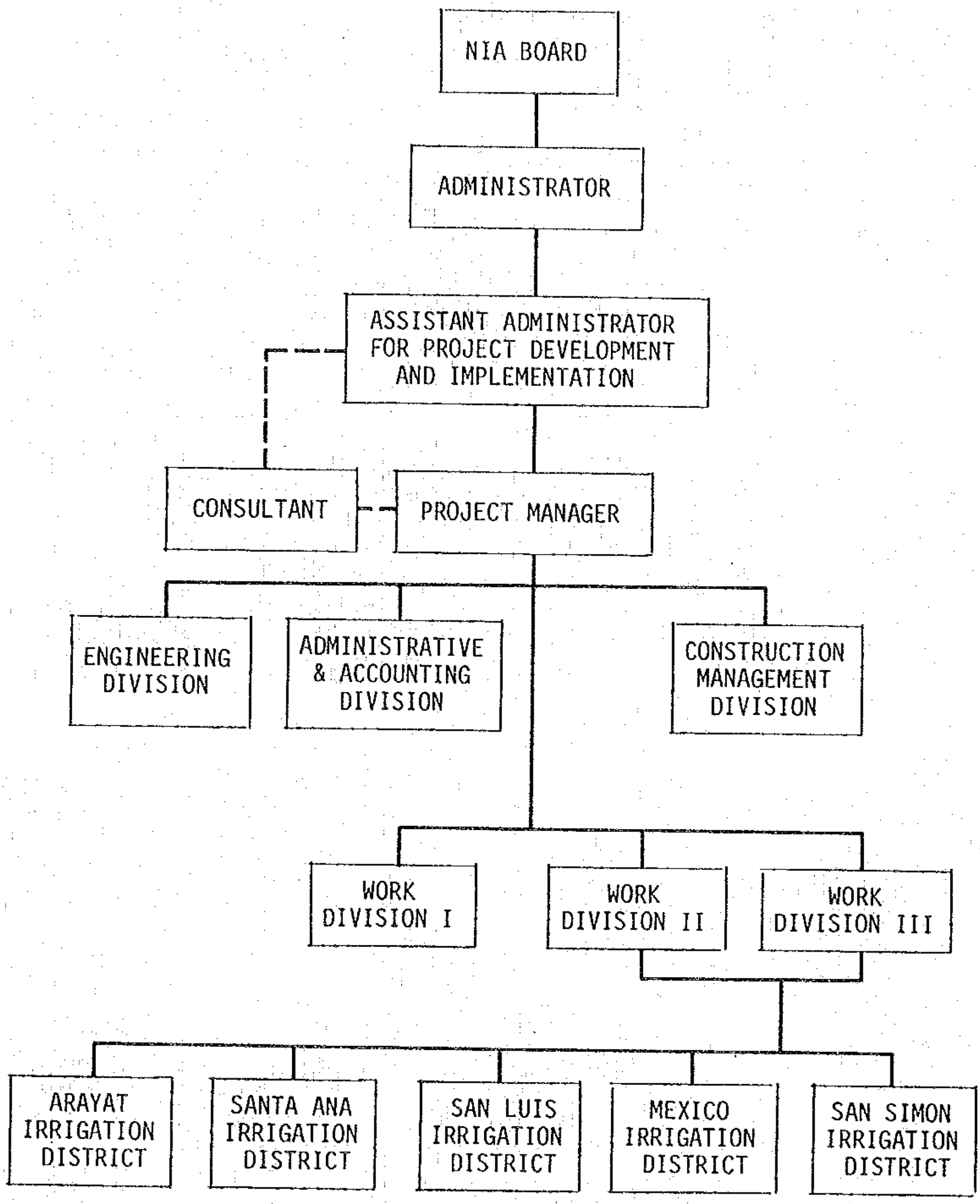


Fig. 2.2 PROPOSED ORGANIZATION FOR OPERATION AND MAINTENANCE OF THE PAMPANGA IRRIGATION PROJECT

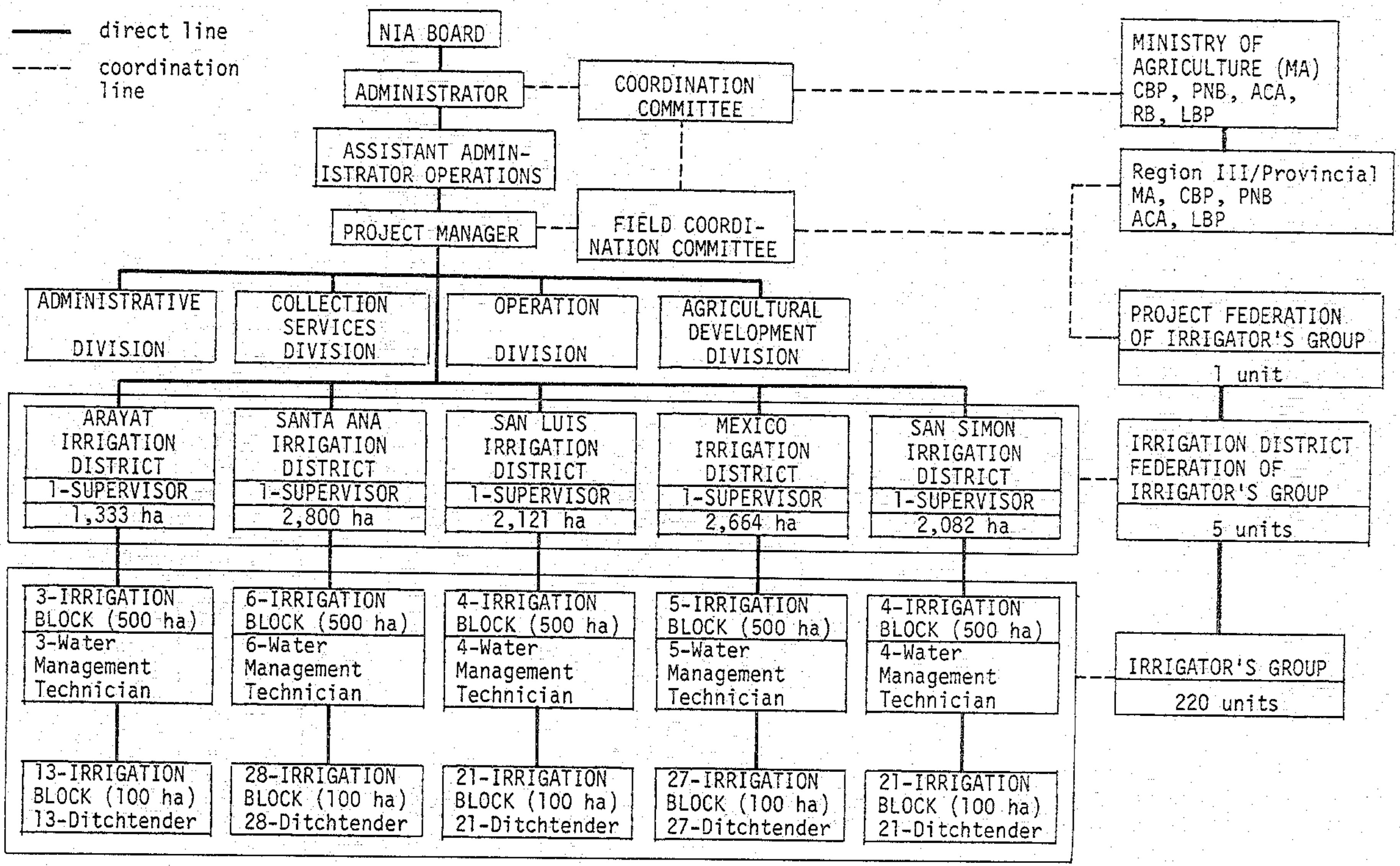


Fig. 2.3 RELATION BETWEEN IRRIGATION NETWORK AND IRRIGATION DISTRICT

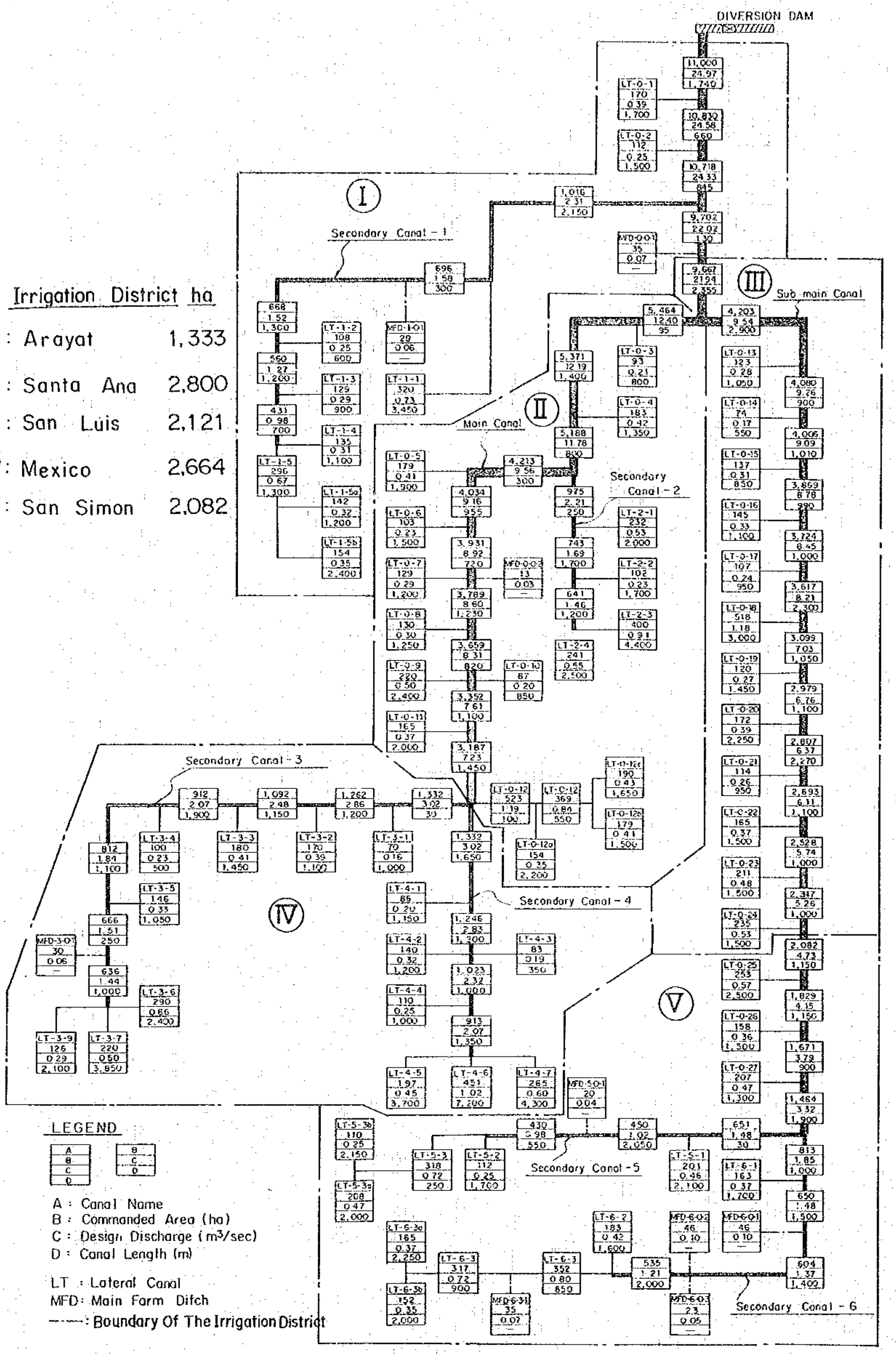
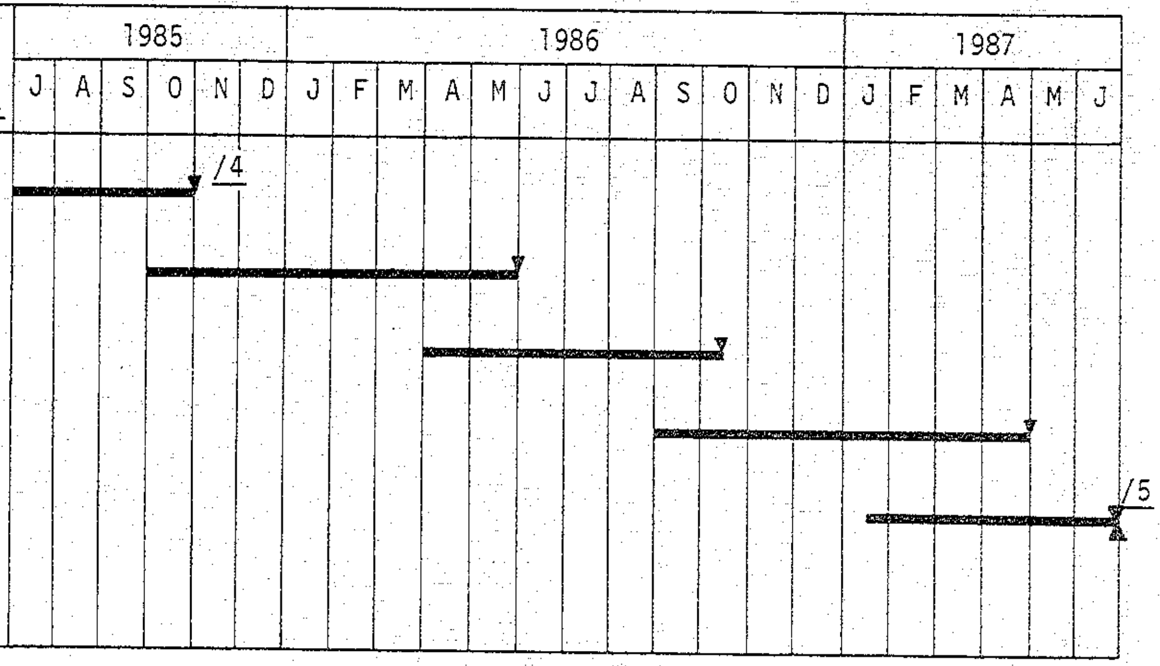


Fig. 2.4 SCHEDULE OF FARMER'S ORGANIZATION SETUP /1

Name of Irrigation District	Command Area (ha)	No. of Farm Households (No.) /2	No. of IG (No.) /3
Arayat	1,333	557	27
Santa Ana	2,800	1,170	56
San Luis	2,121	887	43
Mexico	2,664	1,114	53
San Simon	2,082	872	41
Total	11,000	4,600	220



/1: Parcellary map necessary for setup of irrigator's group will be conducted for the entire irrigation service area (11,000 ha) during period of April, 1984 to June, 1985. Design of farm ditch and farm drain will be done in parallel with irrigator's group setup for each irrigation district

/2: Estimated number of farm households in Irrigation District

/3: Estimated number of irrigator's group in Irrigation District

/4: Establishment of irrigation district federation of irrigator's groups

/5: Establishment of project federation of irrigator's groups

APPENDIX X
EVALUATION

APPENDIX X EVALUATION

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

APPENDIX X EVALUATION

CHAPTER 1 GENERAL

The project formulation both flood control and irrigation projects has been based on the development goal containing i) improvement of flood conditions in the South Candaba and lower coastal area, ii) rice production increase both for self sufficiency in the project area and rice supply to Metro Manila, iii) improving income and living standards of the rural population and iv) promoting employment.

In flood control sector, plan with 20-year design flood was studied. The irrigation project was studied two alternative plans in accordance with irrigation water intake method, pumps or diversion dam.

The evaluation of these projects is synthetically carried out in view of economic, financial and socio-economic aspects as described in the following chapters.

CHAPTER 2 ECONOMIC EVALUATION

2.1 Flood Control and Irrigation Benefits

Flood control benefits are the expected reduction of flood damages for farm crops, fisheries, private properties, public facilities and so on, and the expected development effect for the land having not been utilized during the wet season. Irrigation benefits are expected to be the increment of farm income of crops between future with and without project condition. The flood control and irrigation benefits to be expected from the projects are summarized as follows;

Flood Control Project	(₱10^3)
Flood Control Project with 20-year design flood	91,900
Irrigation Project	
Diversion Dam Scheme	98,449
Pump Scheme	76,138

Benefits accrued from the flood control project and the irrigation projects during the project life are shown in Tables 2.1, 2.2 and 2.3. Details of irrigation benefit and flood control benefit are shown in Table 3.11 in Appendix V and Table 3.14 in Appendix IV, respectively.

2.2 Economic Cost

Economic construction cost for the projects is estimated taking into consideration deducting tax and contractor's profit for the construction cost. With respect to compensation cost for the paddy field where river improvement facilities, irrigation and drainage facilities are installed, land compensation cost is evaluated in terms of negative benefit.

The economic construction cost for flood control and irrigation projects is summarized below;

Flood Control Project	(₱10^6)
Flood Control Plan with 20-year design flood	639.8
Irrigation Project	
Diversion Dam Scheme	356.2
Pump Scheme	246.4

Negative benefit is estimated as follows;

Irrigation Project

Pump Scheme

		(ha)	(₱/ha)	(₱10^6)
Single cropping area	Rainfed(wet)/1	200	1,598	0.32
	Irrigated(wet)	400	1,991	0.80
	do (dry)/2	200	2,365	0.47
Double cropping area	Irrigated(wet)	200	1,991	0.40
	do (dry)	200	2,365	0.47
	Total			2.46

Diversion Dam Scheme

		(ha)	(₱/ha)	(₱10^6)
Single cropping area	Rainfed(wet)	300	1,598	0.48
	Irrigated(wet)	400	1,991	0.80
	do (dry)	200	2,365	0.47
Double cropping area	Irrigated(wet)	200	1,991	0.40
	do (dry)	200	2,365	0.47
	Total			2.62

Flood Control Project

1989 - 1992	(ha)	(₱/ha)	(₱10^6)
Double cropping area	21	5,209	0.1
Single cropping area	329	1,550	0.5
Fishpond area	562	2,417	1.4
Total			2.0

1993 - 2032	(ha)	(₱/ha)	(₱10^6)
Double cropping area	46	5,209	0.3
Single cropping area	730	1,550	1.1
Fishpond area	1,250	2,417	3.0
Total			4.4

Tables 2.4, 2.5 and 2.6 show disbursement schedule of economic costs for the flood control project and the irrigation projects, respectively.

/1: wet season paddy
/2: dry season paddy

2.3 Internal Rate of Return

Internal rate of return on the investment, the rate of interest which equates the present values of the outlays and return at zero point, was graphically calculated under the following conditions and formulas.

a) Condition of evaluation

	Flood Control Project	Irrigation Project
-Construction period (year)	10	Pump Scheme : 6 Diversion Dam Scheme : 7
-Useful life of the project (year)	50 years including construction period	50 years including construction period
-Zero point	1983	1983

b) Formulas for calculation

Total present worth of outlays at zero point is calculated as follows;

Flood Control Project:

$$\text{Total present worth of outlays} = \sum_{n=1}^{10} IF_n(1+i)^{-n} + \sum_{n=11}^{50} OMF(1+i)^{-n} + RF\,(1+i)^{-25}$$

$$\text{Total present worth of return} = BF_1 \sum_{n=1}^{10} (1+i)^{-n} + BF_2 \sum_{n=11}^{50} (1+i)^{-n} - NBF_1 \sum_{n=1}^{10} (1+i)^{-n} + NBF_2 \sum_{n=11}^{50} (1+i)^{-n}$$

Irrigation Project:

(a) Pump Scheme

$$\text{Total present worth of outlays} = \sum_{n=1}^{6} IP_n(1+i)^{-n} + \sum_{n=5}^{50} OM_p(1+i)^{-n} + RP_1[(1+i)^{-14} + (1+i)^{-24} + (1+i)^{-34} + (1+i)^{-44}] + RP_2(1+i)^{-29}$$

Total present worth of return = $\frac{BP}{5}[(1+i)^{-5}$

$+ 2(1+i)^{-6} + 3(1+i)^{-7} + 4(1+i)^{-8}] + BP\sum_{n=9}^{50}(1+i)^{-n}$

$- NBP\sum_{n=5}^{50}(1+i)^{-n}$

(b) Diversion Dam Scheme

Total present worth of outlays = $\sum_{n=1}^{7} IDn(1+i)^{-n} +$

$\sum_{n-6}^{50} OMd(1+i)^{-n} + RD[(1+i)^{-15} + (1+i)^{-25} + (1+i)^{-35}$

$+ (1+i)^{-45}]$

Total present worth of return = $\frac{BD}{5}[(1+i)^{-6} + (1+i)^{-7}$

$+ (1+i)^{-8} + (1+i)^{-9}] + \sum_{n=10}^{50} BD(1+i)^{-n} - NBD\sum_{n=6}^{50}(1+i)^{-n}$

where;

IPn: Cosntruction cost of Pump Scheme at n-th construction year.

OMp: Annual O & M cost for Pump Scheme (₱11.0 x 10^6)

RP_1: Replacement cost for Pump Scheme at the year of 1998, 2008, 2017 and 2027.

RP_2: Replacement cost for Pump Scheme at the year of 2011.

BP : Irrigation benefit for Pump Scheme (₱76.14 x 10^6)

NBP_1: Negative benefit for Pump Scheme during the year of 1987 to 1990

NBP_2: Negative benefit for Pump Scheme during the year of 1991 to 2032.

IDn: Construction cost of Diversion Dam Scheme at the n-th construction year.

OMd: Annual O & M cost for Diversion Dam Scheme (₱4.0 x 10^6).

RD: Replacement cost for Diversion Dam Scheme at the year of 1997, 2007, 2017 and 2027.

IFn: Construction cost of Flood Control Project at the n-th construction year.

OMF: Annual O & M cost for Flood Control Project.

RF: Replacement cost for Flood Control Project.

BF_1: Flood control benefit at the year of 1989 to 1992.

BF_2: Flood control benefit at the year of 1993 to 2032

NBF_1: Negative benefit for flood control project at the year of 1989 to 1992.

NBF_2: Negative benefit for flood control project at the year of 1993 to 2037.

The projects are expected to yield internal rate of return of 10.8% for the flood control project, and 15.4% for the diversion dam scheme and 15.5% for the pump scheme in the irrigation project. These value of the internal rate of return indicate that both the flood control project and the irrigation projects are economically feasible.

2.4 Benefit Cost Ratio

In addition to the internal rate of return, economic evaluation by using benefit/cost ratio is conducted as a comparative study. Estimated benefit/cost ratio ranges for various discount rates as follows;

Discount Rate	Benefit/Cost Ratio: Flood Control Project	Irrigation Project: Pump Scheme	Irrigation Project: Diversion Dam Scheme
3	2.7	3.06	4.53
4	2.3	2.77	3.87
5	2.0	2.51	3.32
6	1.8	2.27	2.87
7	1.5	2.06	2.51
8	1.4	1.87	2.20
9	1.2	1.70	1.94
10	1.1	1.56	1.73
11	1.0	1.42	1.55
12	0.9	1.31	1.39
13	0.8	1.21	1.26
14	0.7	1.12	1.14
15	-	1.03	1.04
16	-	0.96	0.95
17	-	0.89	0.87

2.5 Sensitivity Test

Project sensitivity is analyzed with respect to change in flood control and irrigation benefits, construction cost, delay of production and power rate.

The results of sensitivity test are summarized in Table 2.7.

CHAPTER 3 FINANCIAL EVALUATION

3.1 General

Financial evaluation of the both flood control and irrigation projects is made by the analysis of the typical farm budgets and the assessment for repayment of the project construction cost.

Farm budget analysis is conducted to assess whether the project will have sufficient incentive to the farmers in the irrigation area and will bring enough income increase in the farmer's economy. Assessment of the water charge to be introduced in the irrigated area is also made briefly.

In succession, construction fund requirement is estimated for the implementation of the project, taking into account the cost escalation to be expected during the construction period. Repayment analysis is made on the basis of the expected direct revenue and the estimated fund requirement with the assumed terms of the finance.

3.2 Irrigation Project

3.2.1 Farm Budget Analysis and Irrigation Fee

In order to assess the irrigation project from farmers' economy view point, analysis of farm budget for typical farmer are examined under both the future without project and the future with project conditions.

After the implementation of the irrigation project, year round irrigation will permit double cropping of paddy per annum for the most of the project area and increasing unit yield of paddy to 5 tons per ha for dry season paddy and 4.5 tons per ha for wet season paddy, respectively. As a result, drastic increase on farm income in the future with project condition can be expected in the typical farmer. On the other hand, substantial increase on farm income will be expected in the future without project condition. The typical farm budgets in both future without and with conditions are outlined below. Details are explained in Chapter 3, Appendix V.

a) Without Project Condition

(Unit: Pesos)

Item	Single Crop of Paddy (Rainfed)	Single Crop of Paddy (Irrigated)	Double Crop of Paddy (Irrigated)
I) Gross Income	14,780	14,792	19,434
(1) Farm income	5,287	5,913	11,355
(2) Off-farm income	8,993	8,879	8,079
II) Gross Outgo	14,024	14,551	18,934
(3) Production cost	3,654	4,181	8,564
(4) Living expenses	10,370	10,370	10,370
III) Net Reserve (Capacity to pay)	256	241	500
IV) Net Farm Income (1-3)	1,633	1,732	2,791

b) With Project Condition

(Unit: Pesos)

Item	Diversion Dam Scheme	Pump Scheme
I) Gross Income	29,870	26,508
(1) Farm income	21,220	17k858
(2) Off-farm income	8,650	8,650
II) Gross Outgo	26,501	24,358
(3) Production cost	13,021	10,878
(4) Living expenses	13,480	13,480
III) Net Reserve (Capacity to pay)	3,369	2,150
IV) Net Farm Income (1-3)	8,199	6,980

Farm incomes with project on the typical farm under single cropping of paddy will be expected to become about 3 and 4 times of that of without project condition for the Pump and the Diversion Dam Schemes, respectively and about 2 times on the typical farm under double cropping of paddy.

Net farm incomes with project on the typical farm on single cropping of paddy will be expected to increase 4 to 5 times and about 3 times on the typical farm under double cropping of paddy. Annual net reserve or capacity to pay will be about ₱250 on single cropping farm and ₱500 on double cropping of paddy farm in without project condition and become ₱3,369 in the Diversion Dam Scheme and ₱2,150 in the Pump Scheme.

On the other hand study of irrigation fee was made by the following assumptions.

Case-1 Existing irrigation fee applied to National Irrigation System

Case-2 Irrigation fee is composed of operation and maintenance cost for the project

Case-3 Irrigation fee consists of operation and maintenance cost for the project and loan repayment for the construction cost

Existing irrigation fee per ha in the NIA national irrigation project is set depending on the irrigation systems. For the gravity irrigation system irrigation fee is 2 cavans of paddy for wet season paddy and 3 cavans of paddy for dry season paddy. For the pump irrigation system irrigation fee is 3 cavans of paddy for wet season paddy and 5 cavans of paddy for dry season paddy. In case 2, irrigation fee for the both season paddies per ha is calculated at ₱1,000/1 for the Pump Scheme and ₱364/2 for the Diversion Dam Scheme. In case 3, irrigation fee for the both season paddies per ha is calculated at ₱1,937/3 for the Pump Scheme and ₱1,786/4 for the Diversion Dam Scheme. The irrigation fee for the typical farm and balance between the irrigation fee and capacity to pay are shown below;

(1) Diversion Dam Scheme

(Unit: Pesos)

	Capacity to pay of the farm	Irrigation fee	Balance
Case 1	3,369	545/1	2,824
Case 2	3,369	545	2,824
Case 3	3,369	2,679	690

/1: Total O & M cost/11,000 ha = 11,000,000 Pesos/11,000 ha

/2: Total O & M cost/11,000 ha = 4,000,000 Pesos/11,000 ha

/3: Total O & M cost + Average loan repayment/annum

/4: Total O & M cost + Average loan repayment/annum

(2) Pump Scheme

(Unit: Pesos)

	Capacity to pay of the farm	Irrigation fee	Balance
Case 1	2,150	873/2	1,277
Case 2	2,150	1,500	650
Case 3	2,150	2,906	-756

Irrigation fee to be charged to the beneficiaries should be within the reasonable range that can still give to the farmer's sufficient incentives for agricultural production increase in the irrigation development area.

It is, therefore, considered that less than 30% of the increased net reserve or capacity to pay would be the expected irrigation fee at the maximum. In this sense the pump scheme is not realistic from the farmer's view point. It seems realistic and plausible that the diversion dam scheme is operated by applying irrigation fee consisting of only operation and maintenance cost or existing irrigation fee rate.

3.2.2 Repayment

Fund requirement for the project construction is estimated on the basis of the disbursement schedule of the project cost and expected cost escalation. The rates of cost escalation are estimated at 6.5% per annum for foreign currency portion and 10% per annum for local currency portion during the construction period.

Estimated fund requirements are ₱628.1 million for the diversion dam scheme and ₱411.5 million for the pump scheme as shown in Tables 3.1 and 3.2.

On the basis of the estimated fund requirement, cash flow statements are prepared under assumption of the following financial conditions for some cases as shown in Tables 3.3, 3.4, 3.5, 3.6 and 3.7.

Foreign currency portion:

Financed by bilateral or international organization with interest rate of 3.5% per annum and repayment period of 25 years including grace period of 5 years.

/1: 5 cavans of paddy x ₱1,455/ton of paddy x 1.5 ha

/2: 8 cavans of paddy x ₱1,455/ton of paddy x 1.5 ha

Local currency portion:

Financed by the budget allocation of the Government with no interest or no repayment.

In the cash flow statement it is indicated that the expected direct revenue of irrigation fee will cover the operation and maintenance cost but will not cover loan repayment. Required amount for the repayment should be provided by the Government subsidy.

3.3 Flood Control Project

Fund requirement for the project construction is estimated as the same manner in the irrigation project. Estimated fund requirement is ₱1,372 million as shown in Table 3.8. On the basis of the estimated fund requirement, cash flow statement is prepared in the same manner as the irrigation project as shown in Table 3.9. The operation and maintenance cost and loan repayment will be subsidized by the Government.

CHAPTER 4 PROJECT ASSESSMENT

4.1 Project Effect and Social Impacts

4.1.1 Flood Control Project

4.1.1.1 Stabilization of Peoples Livelihood

At present, the flood damage occurs every year. Many houses and farms lands in the project area suffer large damage from floods. After the proposed project completed, about 19,000 ha of land and 13,400 houses in the protected area will be relieved from floods. The other unquantified benefit is reduction in casuality for human life. The casuality by flood in the Pampanga River has occured almost every year. The casuality will be largely reduced by the implementation of the project.

4.1.1.2 Incremental Rice Production

The increase in the rice production by the project is expected from the reduction in flood damage and improved land conditions. The production increase will be expected to be 14,800 tons of rice.

4.1.1.3 Employment Opportunity

The implementation of the project will provide employment opportunities to landless workers and farmers in and around the project area. The unskilled labor requirement for the project is estimated to be 1.5 million man-days during the construction period.

4.1.1.4 Fisheries

Even after the proposed levee completed along the South Candaba Swamp, its lower area of about 2,000 ha will remain as the same swampy condition. It is recommended that the lowest part of 20 ha will be digged at the depth of 1.5 m for the area of fish sanctuary during dry season. The remained adult fishes will breed enough eggs to increase the fish production of the said area of 2,000 ha during rainy season.

By dredging the lowest reaches of the Pampanga River, seawater intrusion will be increased in the lower reaches. Accordingly, the productivity of the upper fishpond area will be increased at 30 - 40% from the present level, owing to supply of the high salined water to the said fishpond.

4.1.1.5 Relocation of Houses

There exist about 6,700 houses in the proposed route of levee. It is requisite to create new replacement place in the highland and to shift inhabitants there to the place.

The base mound area allocated to the two municipalities of Apalit and San Simon is planned to be 260 ha. The existing area of Apalit and San Simon amounts to 180 ha. Accordingly the area for relocation of two municipalities is sufficient.

4.1.2 Irrigation Project

4.1.2.1 Incremental Rice Production

The project will provide a basis on increasing unit yield and expansion of irrigated field through provision of irrigation and drainage facilities. The project will produce incremental rice production of 47,000 tons in the diversion dam scheme and 36,000 tons in the pump scheme, which plays an important role in self sufficiency of rice in the project area or rice supply to Metro Manila.

4.1.2.2 Employment Opportunity

It is estimated that the project will generate employment opportunities totalling about 1.9 million man-days for the diversion dam scheme and 1.4 million man-days for the pump scheme during the construction period. Most of the manpower will be supplied from landless workers and farmers in and around the irrigation development area. In addition the project will create a demand for farm labor requirement accrued from increased farm activities due to intensive use of the land and high productivity. The incremental farm labor requirement is estimated at 1.5 million man-days per annum for the diversion dam scheme and 1.1 million man-days per annum for the pump scheme as shown in Table 4.1 and on Fig. 4.1.

4.1.2.3 Farmer's Income

The farmer's income will be expected to improve considerably as a direct result of the increase of rice production. The net farm income on the typical farmer both in present and with project conditions represents in the following table.

Typical Farmer with 1.5 ha	Present	With Project: Diversion Dam Scheme	With Project: Pump Scheme
	(₱)	(₱)	(₱)
i. Rainfed land	1,377	8,199	6,980
ii. Irrigated land with single cropping of rice	1,491	8,199	6,980
iii. Irrigated land with double cropping of rice	2,291	8,199	6,980

The net farm income of the typical farmers on rainfed land and irrigated land with single cropping of rice will increase 5 and 6 times of the present farm income. For the typical farmer on irrigated land with double cropping of rice, the project will bring about 4 times of the present net farm income for diversion scheme and 3 times for pump scheme respectively. Accordingly, net reserve for the farmers will be expected to be improved from present subsistence level to ₱3,400 for the diversion dam scheme and ₱2,150 for the pump scheme, respectively.

4.1.2.4 Fisheries

The proposed diversion dam scheme will form a year round water body of about 1,800 to 2,600 ha located in the lowest part of the San Antonio Swamp. This reservoir will engage in an influencial function of the Pampanga River eco-system. At the same time it is expected that potentiality of the fisheries resources will be highly increased by the following management of the reservoir:

i) Setting a year round fish sanctuary of about 1,000 ha as shown in Fig. 4.2.

ii) Setting regulation on the minimum limit of gill net mesh and bamboo fence mesh, and prohibition of dynamite fishing in the reservoir, and

iii) Establishment of a permanent research station to collect basic data on the eco-system of the Pampanga River System.

4.1.2.5 Social Impacts

Traditionally harvesting and threshing of paddy have been carried out by community activities so called "hunusan". Any villagers can take part in such farmings, from which a harvester gains one sixth of output that seems equivalent to the marginal product of labor at a market wage rate at present low productivity condition. After implementation of the irrigation project, introduction of improved irrigation farming in the project area will be expected to provide increasing land productivity, which will result in increasing unit yield of paddy to 4.5 ton/ha for wet season paddy and 5 tons/ha for dry season paddy. In such circumstances the one sixth of output for harvesting and threshing will become substantially larger than the prevailing market wage rate. Consequently farmer employers could increase their incomes by reducing harvester's share to lower than one sixth or replacing "hunusan system" by hired labor at the market wage rates.

It is, however, predicted that the "gama system",/1 a contractual arrangement wherein those who want to participate in harvesting agree to do weeding in the paddy field in exchange as a harvesters and receive one sixth of output, will be developed under a patron-client relation between farmer employers and landless workers in the project area without destruction of traditional system.

4.1.3 Salinity Intrusion

The implementation of the projects for both flood control and irrigation will promote seawater intrusion to the Pampanga River. As a result, the production from fishpond will increase owing to supply of high salined water to fishpond, on the other hand, it will give some adverse effect to water intake on the downstream reaches and to ground water. The adverse effect varies depending on the volume of excavation of low-water channel by flood control project and intake water volume by irrigation project.

To know the extent of adverse effect, the seawater intrusion distance and its affected period are estimated without and with project as shown in Table 4.2. The affection is summarized as follows:

a. The salinity condition near the water surface would not be much changed by the implementation of the projects for both flood control and irrigation.

b. Due to excavation of the channel, the seawater intrusion near the bottom of the channel will be extended to about 7 km in the basic plan and about 4 km in the stepwise plan.

c. Due to diverting water in the upstream by the irrigation project, the seawater intrusion near the bottom of the channel will be extended to about 5 km in the pump scheme and about 6 km in the diversion dam scheme.

d. In the case of the condition after completion of the projects for both flood control and irrigation, the seawater intrusion near the channel bottom will be extended as follows:

Flood Control Plan	Irrigation Project	
	Diversion Dam Scheme	Pump Scheme
Basic Plan	10 km	9 km
Stepwise Plan	8 km	8 km

/1: Rapid diffusion of "gama system" is recognized in the irrigation projects around the Laguna de Bay.

The new intrusion of seawater at the bottom of the river has a possibility to raise the salinity pollution to the ground water in the vicinity of river course where the saltwater will intrude. The behavior of polluted ground water is usually defined by many factors such as location and depth of intake well, intake water volume from a well, elevation of ground water surface, geological condition, permeability of ground and so on. Those factors can be only studied by the field survey in the vast area including boring test, hydraulic well test, long term field observation of ground water and others.

One of the solution of salinity pollution problems is construction of salinity control gates in the downstream of the Pampanga River and the Labangan Floodway. By the salinity control gates, the seawater intrusion to the upstream can be stopped perfectly, however much fund will be required to construct the gates. One of the economical counter-measure for the problem is to construct the facility of small water supply system for the area to be polluted by salinity.

On the other hand, the future development projects in the Pampanga River Basin and in the vicinity area such as the Balog-Balog Irrigation Project, the UPRIIS project and so on have a great effect to increase the discharge of the Pampanga River by newly created return flow. Accordingly, the practical solution will be found after the detailed investigation on the above mentioned various measures in the future.

4.2 Assessment of the Project

4.2.1 Flood Control Project

As mentioned in Appendix IV, three alternative plans in implementation of the project area were studied adopting two phased execution within 10 years. The results of study and effects for each phase and whole project in each alternative phase is summarized in Table 4.3. The advantage and disadvantage for each alternative area as follows:

Alternative-1: Although flooding in the South Candaba Swamp will be prevented by the levee to be constructed along the swamp at an early stage, the duration of flooding in the downstream area from Sulipan will be slightly extended. This means the enlargement of regional unbalance of flooding menace in the project area. With regard to the salinity problem, this scheme has an enough time to study the problem and investigate the countermeasures because the excavation of low-water channel will be executed at the later stage.

Alternative-2: The flood control effects will be expected not only in the downstream area from Sulipan but also in the South Candaba Swamp. On the other hand, it is necessary to solve the salinity problem at an early stage, because the excavation of low-water channel in the downstream from Sulipan is planned in the first phase.