3.7.3 Cost Estimate

The construction costs for Alternative-1 and Alternative-2 are shown in the foregoing Table 3.9. The cost for Alternative-3 is shown in Table 3.17. The annual construction costs to be required for each alternative phase are estimated as shown in Table 3.18, based on the construction schedule mentioned above. They are summarized in Table 3.19.

3.7.4 Proposed Implementation Schedule of the Project

(1) General

The decrease in inundation areas by the implementation of the project in the first phase works are estimated by hydraulic analysis as shown in Table 3.20. The results of the study and effects for each phase and whole project in each alternative phase is summarized in Table 3.21. The advantage and disadvantage for each alternative are 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 reagerd to the salinity problem, this scheme has an enough time to study the problem and investigate the countermeasures as described in Appendix VIII, 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.

Alternative-3: The considerable reduction of the flood damage will be expected all through the river course, because the river channel to be improved by the first phase has a capacity to carry the 1973 flood which was the second big flood since 1960 with peak water level of EL. 7.88 m at the Candaba gage station, corresponding to about 10-year return period. Furthermore the salinity conditions of the Pampanga River would not be much changed by the improvement works in the first phase, because the excavation of low-water channel is planned only for the materials of embankment.

Consequently, Alternative-3 is proposed for the implementation of the project from the viewpoint of technical aspect. The construction work plan for the proposed project is as follows:

(2) Engineering Service

The period for the detailed design is planned to be carried out within 12 months, and the construction works will be executed in 108 months. The estimated costs for the engineering services are shown in Table 3.22. They are summarized below:

(Unit: ₱10³)

Item	Foreign Currency	Local Currency	Total
Detailed Design	6,000	5,200	11,200
Construction Stage	15,770	17,800	33,570

The administration expenses on construction stage are estimated at ₱17.8 x 10^6.

(3) Construction Schedule

Workable Days and Working Hours

With regard to workable days and working hours, it was assumed that the construction works would be continued without suspension even in the rainy season. The civil work is affected by rainfall. To estimate workable days within a year for executing civil work, the rain days were checked up based on the rainfall records during the period from 1975 to 1979 at the Apalit station. For this purpose, it was assumed that the rain days are regarded as waiting days for civil work except dredging work as shown in the table below:

Rainfall	Waiting Days
less than 15 mm/day	0.5 day
16 - 30 mm/day	1.0 - 1.5 day
more than 31 mm/day	2.0 - 2.5 day

Table 3.23 shows the rain days at Apalit dividing into the above 3 groups. Using this data, the waiting days are estimated as shown in Table 3.24. Workable days for civil work except dredging work are estimated by use of the following formula.

Workable Days = 365 - waiting days - Sun. & holidays

Table 3.25 shows Sundays and holidays in the recent past 3 years and the estimated workable days.

On the other hand, dredging work is mainly affected by stream velocity of the river. It was assumed that dredger can not be operated under the condition of more than 1.2 m/s of stream velocity which corresponds 1,000 m^3/s of discharge in the Pampanga River. Based on the daily discharge records obtained at the Arayat station, the days which had discharge of more than 1,000 m^3/s were regarded as waiting days for dredging. Workable days for dredger are estimated as 225 days/year considering 65 days for Sundays and holidays.

Working hours were assumed below:

a) One shift with 8 hours plus 2 hours for overtime per day will be adopted for excavation and embankment works.

b) One shift with 8 hours per day will be adopted for civil work except the above works and dredging work.

c) Three shifts with 24 hours per day will be adopted for dredging work in the low-water channel.

Construction Schedule

In view of the large work volume involved, 2 phased implementation of the project is studied. The 2 phases involve 10-year execution in which the 1st phase continues from the 1st year to the 6th year and the 2nd phase overlapping with the 1st phase in the 5th and 6th years, proceeds from the 5th year to the 10th year. The main work quantity of the proposed project is summarized below:

Works	Unit	First Phase	Second Phase	Total
Dredging	10^3m^3	14,073	18,407	32,480
Embankment	10^3m^3	5,275	-	5,275
Heightening	10^3m^3	1,395	-	1,395
Culvert	nos	19	-	19
Intake of fishpond	nos	26	-	26
Revetment	m	-	4,000	4,000
Bridge	place	-	2	2

(4) Preparatory Work

In order to execute the construction work smoothly, in this study, the following preparatory works are considered prior to the execution of the main works.

a. Detailed design

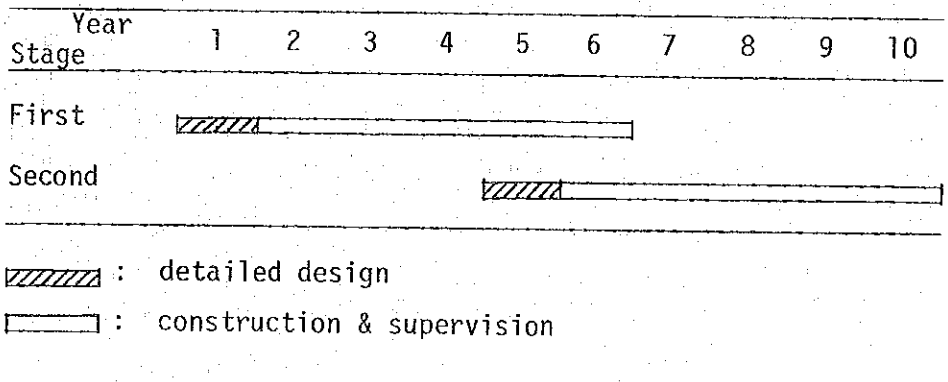
b. Transportation of construction equipment and materials to the job site

c. Construction of temporary construction road including bridge

d. Clearing and other works

For the upper reaches of POK, the existing road will be available to the project as an access road to the work area. Meanwhile, it is required to construct the temporary road including bridge for the downstream area of POK.

The construction schedule is briefly given as follows:



Furthermore, the embankment work is planned to be finalized within a period of the first phase in order to mitigate flood damage due to overtopping on the early stage. The work schedule of the embankment is proposed as shown in the following table, taking into consideration dredging work, operation of construction equipment, flooding and benefit to be expected by the implementation of the project.

River	Embankment Volume ($10^3 m^3$)	Year 1	2	3	4	5	6	7	8	9	10
Labangan	1,470										
Angat	40										
Bagbag	600										
Main Stream P-12K - POK	1,370										
Bebe COC	660										
Main Stream POK - P8K	770										
Maasim	550										
Main Stream P8.4K - P28K	1,210										

(5) Dredging Work

Dredging work is one of the major works in this project and its work volume amounts to 32 x $10^6 m^3$. The proposed channel cross-sections for the first phase works are shown in Fig. 3.12. The dredger with capacity of 800 ps is selected taking into consideration the site conditions. The dredger can be re-assemble at the site.

To determine the required quantity of dredger, the hourly production is estimated at 945 m^3/hr under the following conditions.

Actual construction period:	9 years
Operating hour/day:	17 hours
Annual working days:	225 days
Total volume to be dredged:	32,480 x $10^3 m^3$

The hourly production of the selected dredger is assumed at 255 m^3/hr under the conditions of time efficiency = 0.95 and average transportation distance = 1.2 km. Hence, the dredging work of the project is required 4 dredgers per day within 9 years.

The dredging work is planned to be executed by 2 working teams consists of 2 dredgers each other. One team is to be started at both banks of the river mouth and another team is to be started at both banks of Sec. No. POK. Then, they move toward upstream respectively. Fig. 3.13 shows a method of dredging work.

(6) Embankment Work

Embankment work consists of construction of new levee and heightening of the existing levee. These works are planned below:

a. The extra banking for new levee is considered as 0.5 m.

b. The new levee of the Pampanga River is to be constructed using soil at the site of the base mound. For the heightening of the existing levee, the materials is to be used dredged soil in temporary spoil bank on the high-water channel.

c. The heightening of the existing levee of the Bebe San Esteban Cutoff Channel is planned to be constructed using the dredged soil in the Pampanga River and the soil on the fishpond behind the existing levee.

d. Construction of the levee of the Labangan Floodway is planned to be used the dredged soil in the low-water channel.

e. The levee of the Angat River is planned to be used the soil on the high-water channel.

f. Construction of the levee of the Maasim River is planned by the same method of the Bebe San Estaban Cutoff Channel.

For the above works, the hourly productions of construction equipment are estimated as shown in Table 3.26.

(7) Required Construction Equipment

The required construction equipment for the proposed project is listed in Table 3.27.

Table 2.1 DIRECT CONSTRUCTION COST OF METHOD-1 AND METHOD-2 ON STRETCH BETWEEN BEBE MASANTOL AND MANILA BAY (100-yr Design Flood)

Item	Unit	Unit Cost (₱10^3)	Method-1 Q'ty	Method-1 Amount (₱10^6)	Method-2 Q'ty	Method-2 Amount (₱10^6)
1. Civil Works						
A. Preparation	L.S			20.56		11.33
B. Embankment						
Pampanga R.	10^3m^3	12	-	-	1,330	27.96
Bebe C.O.C.	10^3m^3	12	1,205	14.46	1,460	17.52
Pasag River	10^3m^3	12	265	3.18	-	-
Sub-Total			1,470	17.64	2,790	45.48
C. Excavation						
Pampanga R.	10^3m^3	8	-	-	11,840	94.72
Bebe C.O.C.	10^3m^3	8	9,480	78.64	1,460	11.68
Pasag River	10^3m^3	8	22,630	181.68	-	-
Sub-Total			32,110	259.68	13,300	106.40
D. Outlet Culvert						
Type A	nos	5,500	1	5.50	-	-
Type B	nos	2,200	2	4.40	4	6.00
Type C	nos	1,500	3	4.50	-	-
Intake of fishpond	nos.				26	1.80
Others	L.S.			2.00		4.00
Sub-Total			6	16.40	30	11.80
E. Miscellaneous	L.S.			47.22		25.79
F. TOTAL				361.50		200.80
2. Land & House						
A. Land (Fishpond)	ha	20	825	16.50	1,450	29.00
B. House	nos	15	50	0.75	550	8.25
C. Others	L.S			0.25		0.75
D. Total				17.50		38.00
3. Grand Total				379.00		238.80

Table 2.2 (1) EXISTING LONGITUDINAL PROFILE OF PAMPANGA RIVER, BEBE SAN ESTEBAN CUTOFF CHANNEL, LABANGAN FLOODWAY AND MAASIM RIVER

Station No.	Distance (m)	Elevation (m)				
		Lowest Channel bed	Ground		Levee	
			Left	Right	Left	Right
Pampanga River						
P-14.4 K	0	-5.20	-0.20	-1.12	2.70	1.40
P-14 K	400	-3.90	-0.20	0.10	1.45	1.15
P-12 K	2,400	-5.80	-0.50	-0.40	1.45	1.50
P-10 K	4,450	-5.35	0.18	-0.05	1.20	1.90
P- 8 K	6,400	-3.10	0.20	0.10	1.40	2.20
P- 6 K	8,550	-3.40	0.30	0.25	2.70	1.90
P- 4 K	10,500	-4.30	0.47	0.18	2.00	2.60
P- 2 K	12,250	-5.50	0.48	0.35	2.00	2.00
P 0 K	14,250	-5.40	0.61	0.35	2.80	3.20
P 2 K	16,200	-6.80	1.90	1.88	3.75	5.08
P 4 K	18,480	-6.21	2.00	0.33	3.45	5.35
P 6 K	20,260	-6.76	1.78	1.00	4.25	6.24
P 8 K	22,260	-8.55	3.22	2.06	4.00	8.00
P 10 K	24,230	-9.20	3.00	2.81	4.70	6.80
P 12 K	25,600	-5.80	2.28	2.22	4.35	8.30
P 14 K	27,600	-5.90	4.15	2.36	4.65	8.20
P 16 K	29,250	-9.00	3.90	2.65	5.30	8.70
P 18 K	31,400	-4.70	3.50	3.10	4.70	8.20
P 20 K	32,650	-6.15	3.56	3.00	4.90	8.50
P 22 K	34,680	-8.55	3.50	3.30	5.40	8.80
P 24 K	36,450	-4.90	4.85	3.32	6.05	8.30
P 26 K	38,450	-7.90	3.90	3.97	5.70	9.30
P 28 K	40,220	-5.65	5.88	4.61	6.00	9.30
P 30 K	42,220	-9.55	6.00	4.30	6.80	9.70
P 32 K	44,220	-1.30	5.30	4.70	6.90	10.10
P 34 K	46,220	-2.90	6.70	6.00	8.20	10.10
P 36 K	48,220	-2.25	6.90	5.80	9.00	10.80
P 38 K	50,220	-0.20	9.70	6.60	10.90	10.80
Pasag River - Bebe San Esteban Cutoff Channel						
PA 0 K	0	-3.05	-0.54	0.15	2.45	1.40
PA 2 K	2,000	-4.70	-0.32	0.10	1.55	1.45
PA 4 K	4,000	-5.85	-0.40	0.00	1.58	1.16
PA 6 K	6,000	-6.60	0.00	0.00	1.50	1.00
PA 7.5 K	7,500	-5.00	-0.35	-0.20	1.25	1.02
BC 0 K	9,000	-5.60	0.83	-0.20	2.15	3.15
BC 2 K	11,000	-6.82	0.80	0.50	3.00	2.13
BC 4 K	13,000	-6.82	0.40	0.50	2.80	2.95
BC 6 K	15,000	-6.76	1.73	1.35	3.71	4.05

Table 2.2 (2) EXISTING LONGITUDINAL PROFILE OF PAMPANGA RIVER, BEBE SAN ESTEBAN CUTOFF CHANNEL, LABANGAN FLOODWAY AND MAASIM RIVER

Station No.	Distance (m)	Elevation (m)				
		Lowest Channel bed	Ground		Levee	
			Left	Right	Left	Right
Labangan Floodway - Angat River						
L - 17 K	0	-6.00	0.50	0.50	-	-
L - 15 K	2,000	-5.75	0.50	0.50	-	-
L - 13 K	4,000	-5.25	0.50	0.50	-	-
L - 11 K	6,000	-4.75	0.50	0.50	-	-
L - 9 K	8,000	-4.25	0.90	0.90	-	-
L - 7 K	10,000	-3.75	1.40	1.40	-	-
L - 5 K	12,000	-3.25	1.85	1.85	-	-
L - 4 K	13,000	-3.20	2.50	3.15	3.60	-
L - 3 K	14,000	-2.39	2.80	3.55	5.00	-
L - 2 K	15,000	-4.60	2.80	3.65	5.52	-
L - 1 K	16,000	-3.98	2.70	3.50	5.90	-
L 0 K	17,000	-3.09	3.75	4.00	6.32	-
A 0 K	17,200	-2.70	-	4.60	6.60	-
A 2 K	19,000	-2.58	4.30	5.20	8.35	-
A 4 K	21,000	-2.76	6.10	5.65	8.97	-
Maasim River						
M 0 K	0	-1.70	5.60	6.20	6.00	-
M 1 K	1,000	-0.72	5.70	5.40	5.75	-
M 2 K	2,000	-0.79	5.40	5.30	6.35	-
M 3 K	3,000	1.45	5.65	5.50	6.45	-
M 4 K	4,000	1.37	4.25	5.00	5.45	-
M 5 K	5,000	2.32	4.50	5.00	6.64	-
M 6 K	6,000	2.11	5.20	6.55	7.25	-
M 7 K	7,000	1.86	5.30	6.70	7.45	-
M 8 K	8,000	2.68	6.70	6.50	7.60	-
M 9 K	9,000	2.15	6.85	7.75	8.00	-
M 10 K	10,000	2.33	8.00	8.20	8.35	-

Table 2.3 (1) CONSTRUCTION COST FOR CHANNEL IMPROVEMENT OF PAMPANGA RIVER

Probability : W = 1/100
Stretch : Manila Bay - Sulipan

Item	Unit	Q'ty	Unit Price (₱) F C	Unit Price (₱) L C	Amount ₱ x 10^6 F C	Amount ₱ x 10^6 L C
1. Civil Work						
- Preparation (7%)	L.S					
- Embankment						
Pampanga D-R	10^3m^3	1,120	5,900	5,500	6.61	6.16
Pampanga D-L	10^3m^3	1,210	5,900	5,500	7.14	6.66
Pampanga M-R	10^3m^3	760	5,300	6,500	4.03	4.94
Pampanga M-L	10^3m^3	730	5,900	5,500	4.31	4.02
Bagbag Right	10^3m^3	590	5,900	5,500	3.48	3.25
Bebe R.	10^3m^3	1,460	5,300	6,500	7.74	9.49
Labangan R.	10^3m^3	2,290	5,900	5,500	13.51	12.60
Sub-total					46.82	47.12
- Excavation						
Pampanga $P0^k$ - P8 - 4^k	10^3m^3	10,630	5,900	2,200	62.72	23.39
Pampanga P - 14 - $p0^k$	10^3m^3	11,840	5,900	2,200	69.80	26.05
Sub-total					132.58	49.44
- Revetment	m	1,500	67	760	0.10	1.14
- Outlet						
Type A	nos	1	1,823,000	3,149,000	1.82	3.15
Type B	nos	7	478,000	739,000	3.35	5.17
Type C	nos	2	267,000	399,000	0.53	0.80
Intake of fishpond	nos	26	28,000	42,000	0.72	1.08
Repair of Existing Culverts	L.S				0.40	1.60
Sub-total					6.82	11.80
- Other roads to be replaced	L.S				0.80	3.20
- Miscellaneous (15%)	L.S				29.92	17.81
Total					230.09	138.44
2. Right-of-Way						
- Land						
Paddy field B class	ha	415	-	15,000	-	6.23
Fish pond	ha	1,450	-	20,000	-	29.40
- House B	nos	2,200	-	12,000	-	26.40
- Others						2.67
Total						14.70
3. Contingency (15%)			-	-	34.41	30.31
4. Eng. & Administration (6%)			-	-	15.82	13.95
Grand Total					280.32	247.38
						527.70

Table 2.3 (2) CONSTRUCTION COST FOR CHANNEL IMPROVEMENT OF PAMPANGA RIVER

Probability : W = 1/100
Stretch : Sulipan - Candaba

Item	Unit	Q'ty	Unit Price F.C.	Unit Price L.C.	Amount ₱ x 10^6 F.C.	Amount ₱ x 10^6 L.C.
1. Civil Work						
- Preparation (7%)	L.S				12.52	8.43
- Embankment						
Pampanga Right	10^3m^3	1,850	5,300	6,500	9.81	12.03
Pampanga Left	10^3m^3	1,440	5,900	5,500	8.50	7.92
Maasim R.	10^3m^3	870	6,100	6,500	5.31	5.66
Bagbag R.	10^3m^3	350	5,900	5,500	2.07	1.93
Angat R.	10^3m	140	5,900	5,500	0.83	0.87
Sub-total					26.52	28.51
- Excavation						
Pampanga R.	10^3m^3	21,070	5,900	2,200	124.31	46.35
- Revetment	m	2,500	67	760	0.17	1.90
- Outlet						
Type A	nos	1	1,823,000	3,149,000	1.82	3.15
Type B	nos	7	478,000	739,000	3.35	5.17
Type C	nos	1	267,000	399,000	0.27	0.40
Repairs of existing culverts	L.S.				1.00	4.00
Sub-total					6.44	12.72
- Bridge						
Railroad	m	250	39,900	47,100	9.98	11.77
Highway	m	50	53,200	62,800	2.66	3.14
Provincial Road	m	510	13,300	15,700	6.78	8.01
Sub-total					19.42	22.92
- Other Roads to be replaced	L.S.				2.00	8.00
- Miscellaneous (15%)	L.S.				28.72	19.37
Total					220.10	148.20
2. Right of Way						
- Land						
Paddy field A class	ha	51	-	20,000	-	1.02
Paddy field B class	ha	620	-	15,000	-	9.30
Fish pond	L.S.	-	-	-	-	0.60
- House	nos.	4,510	-	15,000	-	67.65
- Others	L.S.					6.73
Total						85.30
3. Contingency (15%)					33.02	35.03
4. Eng. & Administration (6%)					15.18	16.17
Grand Total					268.30	284.70
					553.00	

Table 2.4 (1) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES
(IMPROVED CHANNEL BY BASIC PLAN)

Swamp/Channel		Code	Unit	Probable Flood (Year) 5	10	20	50	100	100/1
1. San Antonio Swamp									
Inflow	(Pampanga River)	QI1	m^3/sec	2,424	3,070	3,664	4,345	4,895	-
-do-	(Rio Chico River)	QI2	m^3/sec	1,507	2,203	2,849	3,714	4,365	-
at Swamp		HSA	EL.m	10.95	11.80	12.48	13.21	13.72	-
at Arayat		HAY	EL.m	10.09	10.86	11.48	12.14	12.60	-
-do-		QAY	m^3/sec	2,314	2,707	3,049	3,431	3,718	-
Cabiao Candaba Floodway		QCC	m^3/sec	1,304	1,845	2,552	3,480	4,174	-
2. North Candaba Swamp									
Inflow	(Maasim River)	QI3	m^3/sec	551	764	970	1,392	1,728	-
-do-	(from Pampanga River)	QCN1	m^3/sec	0	0	261	1,256	1,937	-
at Swamp		HCN	EL.m	6.25	7.34	7.96	8.75	9.32	-
Outflow	(to Pampanga River)	QCN2	m^3/sec	-1,964	-2,781	-3,162	-4,932	-6,331	-
-do-	(to South Candaba Swamp)	QMD	m^3/sec	0	0	0	0	0	-
3. South Candaba Swamp									
Inflow		QI4	m^3/sec	86	120	147	181	218	-
-do-	(from Pampanga River)	QCS1	m^3/sec	0	0	0	0	0	-
at Swamp		HCS	EL.m	2.87	3.15	3.37	3.65	3.86	-
Outflow	(to Pampanga River)	QCS2	m^3/sec	-439	-614	-498	-684	-688	-
-do-	(-do-)	QCS3	m^3/sec	0	0	0	0	0	-
-do-	(to Angat River)	QCS4	m^3/sec	0	0	0	0	0	-

/1: Improvement of Pasag River and Bebe C.O.C.

Table 2.4 (2) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES
(IMPROVED CHANNEL BY BASIC PLAN)

Swamp/Channel	Code	Unit	Probable Flood (Year) 5	10	20	50	100	100/1
4. Pampanga River (Arayat-Sulipan)								
	HAC	EL.m	7.07	7.94	8.49	8.94	9.38	-
	QAC	m^3/sec	2,243	2,651	2,836	2,911	2,956	-
at Candaba	HCD	EL.m	6.36	7.29	7.97	8.72	9.26	-
-do-	QCD	m^3/sec	2,244	2,739	2,782	2,862	2,893	-
	HMR	EL.m	6.23	7.18	7.89	8.68	9.25	-
	QMR	m^3/sec	3,687	4,747	5,707	6,919	7,877	-
	HSP	EL.m	5.64	6.58	7.28	8.07	8.62	-
	QSS	m^3/sec	3,606	4,661	5,615	6,854	7,804	-
	HSS	EL.m	5.24	6.17	6.85	7.62	8.16	-
	QSP	m^3/sec	3,518	4,622	5,605	6,805	7,739	-
	HAP	EL.m	4.68	5.59	6.25	6.99	7.52	-
	QPAU	m^3/sec	3,559	4,692	5,676	6,862	7,812	-
5. Angat River								
	QI5	m^3/sec	737	1,014	1,367	2,048	2,429	-
	HAG	EL.m	3.57	4.38	5.00	5.67	6.16	-
	QAG	m^3/sec	723	1,002	1,353	2,012	2,390	-

/1: Improvement of Pasag River and Bebe C.O.C.

Table 2.4 (3) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES
(IMPROVED CHANNEL BY BASIC PLAN)

Swamp/Channel	Code	Unit	Probable Flood (Year)					
			5	10	20	50	100	100/1
6. Rivers (Downstream Sulipan)								
at Sulipan	HSC	EL.m	3.41	4.23	4.84	5.53	6.02	5.98
Pampanga River	QPAD	m^3/sec	3,133	4,113	5,013	6,013	6,942	6,758
-do-	HBH	EL.m	2.93	3.62	4.20	4.77	5.27	5.24
-do-	QPA2	m^3/sec	3,133	4,113	5,013	6,013	6,942	6,758
at Masantol	HBM	EL.m	2.66	3.30	3.83	4.36	4.82	4.82
Pampanga River	QPA1	m^3/sec	2,292	3,008	3,665	4,394	5,074	0
Bebe-San Esteban Channel	QBS	m^3/sec	841	1,105	1,348	1,619	1,868	6,758
Hagonoy River	HSJ	EL.m	0.53	0.53	0.53	0.53	0.53	0.53
-do-	QHA	m^3/sec	0	0	0	0	0	0
-do-	HHA	EL.m	0.53	0.53	0.53	0.53	0.53	0.53
Labangan Floodway	HLR	EL.m	2.96	3.42	3.97	4.62	5.10	5.06
-do-	QLF	m^3/sec	796	1,058	1,301	1,604	1,844	1,823
-do-	HLF	EL.m	2.10	2.73	3.25	3.89	4.37	4.33

/1: Improvement of Pasag River and Bebe C.O.C.

Table 2.5 (1) INUNDATION AREA DUE TO FLOODS WITHOUT FLOOD CONTROL MEASURES
(EXISTING CONDITION)

Item	Unit	Return Period (year) 1.1	2	5	10	20	50	100
1. North Candaba Swamp								
Maximum Water Level	EL.m	5.0	6.2	7.29	7.85	8.34	8.94	9.39
Inundation Area (Uncultivated)	Km^2	61.2	130.2	160.3	175.7	189.6	207.1	222.3
Ave. Annual Inundation Area	Km^2							125.5
2. South Candaba Swamp								
Maximum Water Level	EL.m	2.7	3.7	5.05	5.88	6.53	7.13	7.54
Inundation Area	Km^2	33.1	59.9	91.2	102.9	112.7	122.3	129.1
Paddy Area (irrigated)	Km^2	-	-	15.4	27.1	36.9	46.5	53.3
Uncultivated Area	Km^2	33.1	59.9	75.8	75.8	75.8	75.8	75.8
Ave. Annual Inundation Area	Km^2							65.9
Paddy Area (irrigated)	Km^2							7.8
Uncultivated Area	Km^2							58.1
3. Lower Reaches of Sulipan								
Inundation Area	Km^2	38.6	74.1	108.9	133.6	133.6	133.6	133.6
Cultivated Area (rainfed)	Km^2	-	16.2	25.5	32.4	32.4	32.4	32.4
Uncultivated Area (To be paddy field)	Km^2	22.9	22.9	22.9	22.9	22.9	22.9	22.9
Fish Pond Area	Km^2	15.7	35.0	60.5	78.3	78.3	78.3	78.3
Ave. Annual Inundation Area	Km^2							79.9
Cultivated Area (rainfed)	Km^2							16.1
Uncultivated Area (To be paddy field)	Km^2							22.9
Fish Pond Area	Km^2							40.9

Table 2.5(2) DECREASE IN INUNDATION AREA WITH FLOOD CONTROL BY RIVER IMPROVEMENT OF PAMPANGA RIVER (Basic Plan with 100-yr Design Flood)

Item	Unit	Return Period (year) 1.1	2	5	10	20	50	100
1. North Candaba Swamp								
Maximum Water Level	EL.m	3.5	5.2	6.25	7.34	7.96	8.75	9.32
Inundation Area (uncultivated)	Km^2	20.0	73.9	131.6	161.7	178.7	201.3	219.8
Decrease in Inundation Area	Km^2	41.2	56.3	28.7	14.0	10.9	5.8	2.5
Ave. Annual Decrease in Inund. Area	Km^2							40.2
2. South Candaba Swamp								
Maximum Water Level	EL.m	1.7	2.3	2.87	3.15	3.37	3.65	3.86
Inundation Area	Km^2	8.3	20.7	36.3	46.0	51.5	57.4	63.9
Paddy Area (irrigated)	Km^2	-	-	-	-	-	-	-
Uncultivated Area	Km^2	8.3	20.7	36.3	46.0	51.5	57.4	63.9
Decrease in Inundation Area	Km^2	24.5	39.2	54.9	56.9	61.2	64.9	65.2
Paddy Area (irrigated)	Km^2	-	-	15.4	27.1	36.9	46.5	53.3
Uncultivated Area	Km^2	24.5	39.2	39.5	29.8	24.3	18.4	11.9
Ave. Annual Decrease in Inund. Area	Km^2							41.1
Paddy Area (irrigated)	Km^2							7.8
Uncultivated Area	Km^2							33.3
3. Downstream Area from Sulipan								
Decrease in Inundation Area	Km^2	38.6	74.1	108.9	133.6	133.6	133.6	133.6
Cultivated Area (rainfed)	Km^2	-	16.2	25.5	32.4	32.4	32.4	32.4
Potential Area (to be Paddy Field)	Km^2	22.9	22.9	22.9	22.9	22.9	22.9	22.9
Fishpond Area	Km^2	15.7	35.0	60.5	78.3	78.3	78.3	78.3
Ave. Annual Decrease in Inund. Area	Km^2							79.9
Cultivated Area (rainfed)	Km^2							16.1
Potential Area (to be Paddy Field)	Km^2							22.9
Fishpond Area	Km^2							40.9

Table 2.6 DECREASE IN FLOOD DAMAGES WITH FLOOD CONTROL BY MEANS OF CHANNEL IMPROVEMENT

(Basic Plan with 100-yr. Design Flood)

Item	Unit	Q'ty	Unit Price (₱)	Amount (₱1,000)
A. Below Sulipan, Calumpit				
- Damage to Paddy and Fish				
Paddy (Rainfed)	ha	1,360	3,890	5,290
Potential to be Paddy Field	ha	1,950	1,550	3,023
Fishpond	ha	4,090	3,889	15,906
Sub-Total				24,219
- Damage to Private Properties	house	1,950	3,000	5,850
- Damage to Public Facilities (300% of Private Properties)				17,550
- Sub-Total				47,619
- Indirect Losses (5% of above)				2,381
- Total				50,000
B. South Candaba Swamp				
- Damage to Paddy				
Irrigated Area	ha	660	8,415	5,554
Potential to be Irrigated Paddy	ha	2,830	5,209	14,742
Sub-Total				20,296
- Damage to Private Properties	house	970	3,000	2,910
- Damage to Public Facilities				8,730
- Sub-Total				31,936
- Indirect Losses (5% of above)				1,597
- Total				33,533
C. North Candaba Swamp				
- Damage to Paddy (Rainfed)	ha	3,420	3,890	13,304
- Other damages (35% of above)				4,656
- Total				17,960
D. Grand Total (Decrease in Average Annual Flood Damage)				101,493

Table 3.1 SUMMARIZED WORK QUANTITIES

(Stepwise Plan with 20-yr. Design Flood)

	Unit	Stretch		Total
		Candaba Sulipan	Below Sulipan	
1. Excavation of Low-Water Channel				
- Length	KM	18.0	22.6	40.2
- Volume				
Pampanga R.	10^3m^3	16,590	15,890	32,480
2. Embankment of New Levee				
- Length	KM	35.3	61.7	97.0
Maasim R.	KM	8.9	-	8.9
Pampanga R.	KM	17.6	31.2	48.8
Old Pampanga R.	KM	-	5.5	5.5
Bagbag R.	KM	3.8	1.3	5.1
Angat R.	KM	5.0	-	5.0
Labangan R.	KM	-	23.7	23.7
- Volume	10^3m^3	1,700	3,620	5,320
Pampanga R.	10^3m^3	850	1,810	
Maasim R.	10^3m^3	550	-	
Bagbag R.	10^3m^3	260	340	
Angat R.	10^3m^3	40	-	
Labangan R.	10^3m^3	-	1,470	
3. Embankment of Heightening				
- Length	KM	12.8	22.8	35.6
Pampanga R.	KM	12.8	7.4	20.2
Bebe C.O.C.	KM	-	15.4	15.4
- Volume	10^3m^3	360	990	1,350
Pampange R.	10^3m^3	360	330	
Bebe C.O.C.	10^3m^3	-	660	
4. Embankment of Base Mound				
- Length	KM	17.6	31.2	48.8
- Volume	10^3m^3	14,830	12,460	27,290
5. Outlet				
- Type A/1	nos	1	1	2
- Type B/2	nos	7	7	14
- Type C/3	nos	1	2	3
- Intake of fishpond	nos	-	26	26
6. Revetment	KM	2.5	1.5	4
7. Bridge	place	2	-	2

Remarks: Dredged material is used for Embankment and Heightening of Pampanga R., Left of Bagbag R.

/1 Size of Culvert: W - 5 m, H - 4.5 m, L - 42 m, 3 cell and w/sluice gate

/2 Size of Culvert: W - 2.5 m, H - 2.5 m, L - 48 m, 2 cell and w/flap & sluice gate

/3 Size of Culvert: W - 2.5 m, H - 2.5 m, L - 48 m, 1 cell and w/flap & sluice gate

Table 3.2 WATER LEVEL HYDROGRAPH OF DESIGN FLOOD WITH 20-YEAR RETURN PERIOD

Time (hr)	Water Level (EL. m)		
	Pampanga River		Labangan Floodway
	Sta. P 20K	Sta. P 0K	Sta. L - 4K
0	1.02	0.00	0.00
6	0.54	0.51	0.51
12	0.53	0.51	0.52
18	0.64	0.57	0.56
24	0.94	0.68	0.65
30	1.56	0.91	0.86
36	2.44	1.33	1.32
42	2.93	1.61	1.61
48	3.37	1.89	1.91
54	3.72	2.10	2.16
60	4.00	2.27	2.37
66	4.20	2.42	2.53
72	4.31	2.41	2.58
78	4.41	2.43	2.60
84	4.55	2.51	2.65
90	4.83	2.62	2.78
96	5.37	2.90	3.04
102	5.88	3.16	3.37
108	6.24	3.41	3.61
114	6.42	3.50	3.76
120	6.54	3.60	3.84
126	6.67	3.62	3.92
132	6.79	3.68	4.03
138	6.90	3.77	4.10
144	6.99	3.85	4.17
150	7.05	3.87	4.22
156	7.09	3.88	4.23
162	7.10	3.87	4.22
168	7.10	3.86	4.19
174	7.10	3.80	4.12
180	7.10	3.78	4.09
186	7.10	3.75	4.07
192	7.06	3.74	4.03
198	7.01	3.67	3.98
204	6.93	3.62	3.91
210	6.83	3.55	3.82
216	6.71	3.48	3.72
222	6.57	3.34	3.61
228	6.39	3.24	3.47
234	6.18	3.10	3.31
240	5.78	2.84	3.04
246	5.18	2.49	2.61
252	4.53	2.13	2.16
258	3.84	1.75	1.78
264	3.56	1.66	1.68
270	3.35	1.60	1.58
276	3.10	1.46	1.42

Table 3.3 SETTLEMENT OF LEVEE BODY DUE TO CONSOLIDATION

Consolidation layer /1	Thickness of consolidation layer H (m)	Stress before loading P_0 (t/m^2)	Stress after loading P_1 (t/m^2)	Void ratio before loading e_0	Void ratio after loading e_1	Settlement di (m)	Total Settlement d (m)
Stretch between P-14^k and P0^k (Initial embankment height, h_2 = 2.6 m)							
Layer No. 1	4.5	4.3	4.6	1.09	1.025	0.14	
Layer No. 2	4.5	8.7	3.8	0.95	0.915	0.08	
Layer No. 3	12.0	15.8	2.2	0.89	0.875	0.10	0.32 ≒ 0.3
Stretch between P0^k and P8^k (Initial embankment height, h_2 = 2.7 m)							
Layer No. 1	6.0	7.9	4.7	1.40	1.26	0.35	
Layer No. 2	15.0	20.2	2.1	0.88	0.86	0.15	0.5
Stretch between P8^k and P28^k (Initial embankment height, h_2 = 3.4 m)							
Layer No. 1	6.0	8.6	5.9	1.03	0.975	0.16	
Layer No. 2	18.0	20.8	2.8	0.86	0.845	0.14	0.3

/1: Consolidation layer is divided into two or three layers depending on the condition of foundation. No. of layer means from the ground surface.

Table 3.4 SETTLEMENT OF BASE MOUND DUE TO CONSOLIDATION

Consolidation layer /1	Thickness of consolidation layer H (m)	Initial stress Po (t/m^2)	Increased stress P (t/m^2)	Void ratio before loading e_0	Void ratio after loading e	Thickness of settlement d (m)	Total thickness d (m)
Stretch between P-14^k and P0^k (Initial embankment height, h_2 = 2.0 m)							
Layer No. 1	4.5	1.6	3.8	1.155	1.07	0.18	
Layer No. 2	4.5	6.0	3.7	0.90	0.94	0.09	
Layer No. 3	12.0	13.1	3.3	0.92	0.89	0.19	0.46 ≒ 0.5
Stretch between P0^k and P8^k (Initial embankment height, h_2 = 3.0 m)							
Layer No. 1	6.0	4.1	5.6	1.59	1.34	0.58	
Layer No. 2	15.0	16.4	5.6	0.91	0.865	0.35	0.93 ≒ 1.0
Stretch between P8^k and P28^k (Initial embankment height, h_2 = 2.9 m)							
Layer No. 1	6.0	4.13	5.62	1.095	1.10	0.24	
Layer No. 2	18.0	16.3	5.62	0.88	0.85	0.24	0.48 ≒ 0.5

/1: Consolidation layer is divided into two or three layers depending on the condition of foundation. No. of layer means from the ground surface.

Table 3.5 LIST OF EXISTING CULVERT

Location	Dimension W x H x Cell	Remarks
I. Pampanga R. Right Side		
1. P 26K + 1.900 m	1.0 x 1.0 x 1	
2. P 24K + 1.400 m	1.5 x 1.5 x 1	
3. P 22K + 300 m	1.5 x 1.5 x 1	
4. P 20K + 1.800 m	1.0 x 1.0 x 1	
5. P 6K + 1.600 m	2.5 x 2.5 x 6	W/ Gate
6. P 2K + 1.000 m	1.5 x 1.5 x 1	
7. P 2K + 600 m	1.5 x 1.5 x 1	
8. P 0K + 700 m	1.0 x 1.0 x 1	
9. P 0K - 200	5.0 x 4.0 x 3	W/ Gate
II. Bebe C.O.C. Right Side		
10. BC 6K - 250 m	1.0 x 1.0 x 1	
11. BC 6K - 1.000 m	1.0 x 1.0 x 1	
12. BC 6K - 1.500 m	1.0 x 1.0 x 1	
13. BC 4K - 300 m	2.5 x 2.5 x 3	W/ Gate
14. BC 2K + 0 m	2.0 x 2.0 x 2	W/ Gate
15. BC 2K - 600 m	1.0 x 1.0 x 1	
16. BC 2K - 1.500 m	2.0 x 2.0 x 2	W/ Gate
17. BC 0K - 700 m	1.0 x 1.0 x 1	
18. BC 0K - 1.300 m	1.5 x 1.5 x 1	
III. Maasim R. Left Side		
19. M 6K + 800 m	0.75 x 1.0 x 1	W/ Gate
20. M 4K + 100 m	2.3 x 2.5 x 1	"
21. M 1K + 600 m	2.3 x 2.5 x 1	"
IV. Pampanga Left Side		
22. P 24K + 1.600 m	2.5 x 2.5 x 1	W/ Gate
23. P 24K + 200 m	1.2 x 1.2 x 2	"
24. P 18K + 1.000 m	2.5 x 2.5 x 3	"
25. P 14K + 1.800 m	2.4 x 2.4 x 3	"
26. P 12K + 1.300 m	2.4 x 2.4 x 3	"
V. Bebe C.O.C. Left Side		
27. BC 6K + 0 m	1.5 x 1.5 x 1	
28. BC 4K - 400 m	2.0 x 2.0 x 2	W/ Gate
29. BC 2K + 0 m	2.0 x 2.0 x 2	W/ Gate
30. BC 2K - 1,300 m	1.5 x 1.5 x 2	
31. BC 0K - 300 m	1.0 x 1.0 x 1	

Table 3.6 QUANTITY OF OUTLET CULVERT TO BE CONSTRUCTED

Stretch	Number of Outlet			
	Type A	Type B	Type C	Total
Maasim R.	-	2	1	3
P 28 k - P 10 k	-	4		4
P 10 k - Angat R.	1	1	-	2
Sub-Total	1	7	1	9
Labangan R.	-	3	1	4
Calumpit Pocket Dike	-	-	1	1
P 6 k - P 0 k	1	-	-	1
P 0 k - P 14 k	-	4	-	4
Sub-Total	1	7	2	10
Total	2	14	3	19

Table 3.7 LOCATIONS OF PROPOSED REVETMENT

Location		Length of Revetment (m)
1. Stretch between Candaba-Sulipan		
P24 k + 1000 m	Left side	400
P22 k	Right side	400
P12 k	Left side	300
P12 k	Right side	300
P10 k	Right side	400
P 8 k + 500 m	Left side	400
P 8 k + 500 m	Right side	300
Sub-Total		2,500
2. Stretch below Sulipan		
P o k + 900 m	Left side	400
P - 2 k	Left side	400
L Ok + 300 m	Right side	400
L 4 k + 500 m	Left side	300
Sub-Total		1,500
3. Total		4,000

Table 3.8(1) UNIT COST FOR PAMPANGA RIVER IMPROVEMENT WORKS

Item	Unit	F.C. (₱)	L.C. (₱)	Total (₱)
- Earth Works				
1. Excavation (Mechanical)	cu.m	2.9	4.3	7.2
2. Excavation (Manual)	cu.m	-	6.2	6.2
3. Dredging	cu.m	5.9	2.2	8.1
4. Embankment (D = 50 m) /1	cu.m	5.9	5.5	11.4
5. Embankment (D = 300 m) /2	cu.m	5.3	6.5	11.8
6. Embankment (D = 1.5 km) /3	cu.m	6.2	7.5	13.7
7. Embankment (D = 3.0 km) /4	cu.m	7.1	8.7	15.8
8. Backfill (Mechanical)	cu.m	3.5	2.9	6.4
9. Backfill (Manual)	cu.m	-	8.6	8.6
- Structural Works				
10. Concrete class AA	cu.m	-	630	630
11. Concrete class A	cu.m	-	514	514
12. Concrete class B	cu.m	-	372	372
13. Concrete class C	cu.m	-	229	229
15. Forming	sq.m	6	51	57
16. Bar	ton	3,140	2,560	5,700
17. Steel sheet pile YSP - I /5	L.M	185	100	285
18. Steel sheet pile YSP - II /6	L.M	229	123	352
19. R.C. pile (□ 30 cm)	L.M	-	228	228
20. R.C. pile (□ 45 cm)	L.M	-	428	428
21. Loose boulder	cu.m	-	62	62
22. Dry Masonry	cu.m	-	66	66
23. Wet Masonry	cu.m	-	195	195
24. Bridge for Expressway	L.M	53,200	62,800	116,000
25. Bridge for Provincial road	L.M	13,300	15,700	29,000
26. Bridge for Highway with Railroad	L.M	39,900	47,100	87,000
- Right of Way				
27. Paddy field class A /7	ha	-	20,000	20,000
28. Paddy field class B	ha	-	15,000	15,000
29. Fishpond	ha	-	20,000	20,000
30. House class A /8	nos.	-	15,000	15,000
31. House class B	nos.	-	12,000	12,000

Remarks:
/1: Including excavation in borrow pit, compacting and hauling, distance 50 m
/2: - do -, Hauling distance 300 m
/3: - do -, " 1.5 km
/4: - do -, " 3.0 km
/5: Including Pile driving, unit weight 38 kgs/m
/6: - do - unit weight 48 kgs/m
/7: Cropped, twice per year for along the Maasim R.
/8: Compensation cost for the large building such as school and church is assumed as about 10% of total compensation for houses.

Table 3.8(2) UNIT COST OF CULVERT AND REVETMENT

Item	Unit	Q'ty	Unit Price(₱) F.C.	Unit Price(₱) L.C.	Amount(₱) F.C.	Amount(₱) L.C.
1. Culvert type A						
- Concrete A	cu.m	1,700	-	514	-	878,940
- Concrete B	cu.m	-	-	372	-	-
- Concrete C	cu.m	124	-	229	-	29,400
- Form	sq.m	4,840	6	51	29,040	246,840
- Bar	ton	111.2	3,140	2,560	349,170	284,670
- Steel sheet pile I (W = 38 kgs/m)	L.M.	-	185	100	-	-
- Steel sheet pile II (W = 48 kgs/m)	L.M.	570	229	123	130,530	70,110
- Concrete sheet pile	L.M.	350	-	228	-	79,800
- Concrete pile 30 cm	L.M.	-	-	228	-	-
- Concrete pile 45 cm	L.M.	1,300	-	428	-	556,400
- Excavation by Equ.	cu.m	9,500	2.9	4.3	27,550	40,950
- Excavation by Manual	cu.m	1,000	-	6.2	-	6,200
- Backfill by Equ.	cu.m	1,000	3.5	2.9	3,500	2,900
- Backfill by Manual	cu.m	680	-	8.6	-	5,850
- Dry Masonry t = 30 cm	sq.m	365	-	20	-	7,300
- Wet Masonry t = 30 cm	sq.m	910	-	60	-	54,600
- Concrete t = 30 cm	sq.m	1,090	-	69	-	75,210
Sub-Total					539,790	2,339,070
- Gate	L.S.				980,000	340,000
- Other (about 20% above)	L.S.				303,210	515,930
Total					1,823,000	3,194,000
2. Culvert type B						
- Concrete A	cu.m	426	-	514	-	218,960
- Concrete B	cu.m	-	-	372	-	-
- Concrete C	cu.m	50	-	229	-	11,450
- Form	sq.m	1,150	6	51	6,900	57,500
- Bar	ton	27.6	3,140	2,560	86,660	70,660
- Steel sheet pile I (W = 38 kgs/m)	L.M.	252	185	100	46,620	25,200
- Steel sheet pile II (W = 48 kgs/m)	L.M.	-	229	123	-	-
- Concrete sheet pile	L.M.	96	-	228	-	21,890
- Concrete pile 30 cm	L.M.	320	-	228	-	72,960

Table 3.8(3) UNIT COST OF CULVERT AND REVETMENT

Item	Unit	Q'ty	Unit Price(₱) F.C.	Unit Price(₱) L.C.	Amount(₱) F.C.	Amount(₱) L.C.
- Concrete pile 45 cm	L.M.	-	-	428	-	-
- Excavation by Equ.	cu.m	2,200	2.9	4.3	6,380	9,460
- Excavation by Manual	cu.m	300	-	6.2	-	1,860
- Backfill by Equ.	cu.m	580	3.5	2.9	2,030	1,680
- Backfill by Manual	cu.m	300	-	8.6	-	2,580
- Dry Masonry t = 30 cm	sq.m	422	-	20	-	8,440
- Wet Masonry t = 30 cm	sq.m	486	-	60	-	29,160
- Concrete t = 30 cm	sq.m	-	-	69	-	-
Sub-Total					148,590	531,800
- Gate	L.S.				350,000	90,000
- Other (about 20% of above)	L.S.				79,410	117,200
Total					478,000	739,000
3. Culvert type C						
- Concrete A	cu.m	235	-	514	-	120,790
- Concrete B	cu.m	-	-	372	-	-
- Concrete C	cu.m	23	-	229	-	5,270
- Form	sq.m	550	6	51	3,300	28,050
- Bar	ton	16.5	3,140	2,560	51,810	42,240
- Steel sheet pile I (W = 38 kgs/m)	L.M.	190	185	100	35,150	19,000
- Steel sheet pile II (W = 48 kgs/m)	L.M.	-	229	123	-	-
- Concrete sheet pile	L.M.	62	-	228	-	14,140
- Concrete pile 30 cm	L.M.	160	-	228	-	36,480
- Concrete pile 45 cm	L.M.	-	-	428	-	-
- Excavation by Equ.	cu.m	500	2.9	4.3	1,450	2,150
- Excavation by Manual	cu.m	70	-	6.2	-	430
- Backfill by Equ.	cu.m	200	3.5	2.9	700	580
- Backfill by Manual	cu.m	150	-	8.6	-	1,290
- Dry Masonry t = 30 cm	sq.m	165	-	20	-	3,300
- Wet Masonry t = 30 cm	sq.m	225	-	60	-	13,500
- Concrete t = 30 cm	sq.m	-	-	69	-	-
Sub-Total					92,410	287,220
- Gate	L.S.				130,000	50,000
- Other (about 20% of above)	L.S.				44,590	61,780
Total					267,000	399,000

Table 3.8(4) UNIT COST OF CULVERT AND REVETMENT

Item	Unit	Q'ty	Unit Price(₱) F.C.	Unit Price(₱) L.C.	Amount(₱) F.C.	Amount(₱) L.C.
4. Revetment						
- Excavation D - 300 M (Mech.)	cu.m	21	2.9	4.3	60.9	90.3
- Excavation (Manual)	cu.m	3	-	6.2	-	18.6
- Wet Masonry	sq.m	6.7	-	59	-	395.3
- Loose Boulder Apron	cu.m	3	-	62	-	186.0
- Other (about 10% of above)					6.1	69.8
Total					67.0	760.0

Table 3.9(1) CONSTRUCTION COST FOR CHANNEL IMPROVEMENT OF PAMPANGA RIVER

Probability: W - 1/20
Stretch : Masantol-Sulipan

Item	Unit	Q'ty	Unit Price F.C.	Unit Price L.C.	Amount ₱ x 10^6 F.C.	Amount ₱ x 10^6 L.C.
1. Civil Work						
- Preparation	L.S.				8.92	5.33
- Embankment						
Pampanga R. (D-R)	10^3m^3	660	5,900	5,500	3.89	3.63
Pampanga R. (D-L)	10^3m^3	710	5,900	5,500	4.19	3.91
Pampanga R. (M-R)	10^3m^3	330	5,300	6,500	1.75	2.15
Pampanga R. (M-L)	10^3m^3	440	5,900	5,500	2.60	2.42
Bagbag R.	10^3m^3	340	5,900	5,500	2.01	1.87
Bebe C.O.C. R.	10^3m^3	300	5,300	6,500	1.59	1.95
Bebe C.O.C. L.	10^3m^3	360	5,300	6,500	1.91	2.34
Labangan R.	10^3m^3	1,470	5,900	5,500	8.67	8.05
Sub-Total					26.61	26.32
- Excavation						
Pampanga (Down)	10^3m^3	7,410	5,900	2,200	43.72	16.30
Pampanga (Middle)	10^3m^3	8,480	5,900	2,200	50.03	18.66
Sub-Total					93.75	34.96
- Outlet						
Type A	nos	1	1,823,000	3,194,000	1.82	3.19
Tyoe B	nos	7	478,000	739,000	3.35	5.17
Type C	nos	2	267,000	399,000	0.53	0.80
Intake of fish pond	nos	26	28,000	42,000	0.72	1.08
Repair of existing culverts	L.S.				0.40	1.40
Sub-Total					6.82	11.64
- Revetment	m	1,500	67	760	0.10	1.14
- Other roads to be replaced	L.S.				0.80	3.20
- Miscellaneous	L.S.				20.42	12.19
Total					157.42	94.78
2. Right of Way (ROW)						
- Land						
Paddy field B class	ha	318	-	15,000	-	4.77
Fishpond	ha	1,339	-	20,000	-	26.78
- House	nos.	2,150	-	12,000	-	25.80
- Other	L.S.					2.65
- Total						60.00
3. Contingency 15%					23.51	23.06
4. Eng. & Administration 5%					10.89	10.64
Grand Total					191.82	188.48
					380.30	

Table 3.9(2) CONSTRUCTION COST FOR CHANNEL IMPROVEMENT OF PAMPANGA RIVER

Probability : W = 1/20
Stretch : Sulipan - Maasim R.

Item	Unit	Q'ty	Unit Price (₱) F.C.	Unit Price (₱) L.C.	Amount (x 10^6) F.C.	Amount (x 10^6) L.C.
1. Civil Work						
- Preparation	L.S.				8.94	5.75
- Embankment						
Pampanga R. (R)	10^3m^3	360	5,300	6,500	1.91	2.34
Pampanga R. (L)	10^3m^3	850	5,900	5,500	5.02	4.68
Maasim R. (L)	10^3m^3	550	6,100	6,500	3.36	3.58
Bagbag R. (L)	10^3m^3	260	5,900	5,500	1.53	1.43
Angat R. (R)	10^3m^3	40	5,900	5,500	0.24	0.22
Sub-total					12.06	12.25
- Excavation						
Pampanga R.	10^3m^3	16,590	5,900	2,200	97.88	36.50
Sub-total						
- Outlet						
Type A	nos	1	1,823,000	3,194,000	1.82	3.19
Type B	nos	7	478,000	739,000	3.35	5.17
Type C	nos	1	267,000	399,000	0.27	0.40
Repair of existing culverts	L.S				1.00	4.00
Sub-total					6.44	12.76
- Revetment	m	2,500	67	760	0.17	1.90
- Bridge						
Railroad	m	40	39,900	47,100	1.60	1.88
Highway	m	30	53,200	62,800	1.60	1.88
Provincial road	m	450	13,300	15,700	5.99	7.06
Sub-total					9.19	10.82
- Other roads to be replaced	L.S.				2.00	8.00
- Miscellaneous (15%)	L.S.				20.50	13.12
Total					157.18	101.10
2. Right of Way						
- Land						
Paddy field A class	ha	46	-	20,000	-	0.92
Paddy field B class	ha	515	-	15,000	-	7.73
Fishpond	ha	30	-	20,000	-	0.60
- House	nos	4,510	-	15,000	-	67.65
- Others	L.S.					6.60
Total						83.50
3. Contingency (15%)					23.58	27.70
4. Eng. & Administration (6%)					10.84	12.70
Grand Total					191.60	225.00 (416.6)

Table 3.10 ESTIMATED MAINTENANCE COST OF DREDGING WORK

Item	Unit	Amount
1. Inflow of Sediment from Upstream		
Bed Load (Q_B) in	$10^3 m^3/yr$	45 /1
Suspended Load (Q_S) in	$10^3 m^3/yr$	713 /2
Total (Q_T) in	$10^3 m^3/yr$	758
2. Sediment in Downstream		
Bed Load (Q_B) dep.	$10^3 m^3/yr$	45 /3
Suspended Load (Q_S) dep.	$10^3 m^3/yr$	285 /4
Total (Q_T) dep.	$10^3 m^3/yr$	330
3. Unit Cost for Dredging Work	₱/m^3	8.1
4. Annual Cost	₱10^6/yr	2.67

Remarks

/1: (Q_B) in

$$= \frac{163\ t/km^2/yr \times 7{,}270\ km^2}{2.65\ t/m^3 \times (1-0.4)} \times 0.06 + \frac{59\ t/km^2/yr \times 356\ km^2}{2.65\ t/m^3 \times (1-0.4)} \times 0.04$$

$$= 45 \times 10^3\ m^3/yr$$

/2: (Q_S) in

$$= \frac{163\ t/km^2/yr \times 7{,}270\ km^2}{2.65\ t/m^3 \times (1-0.4)} \times 0.94 + \frac{59\ t/km^2/yr \times 356\ km^2}{2.65\ t/m^3 \times (1-0.4)} \times 0.96$$

$$= 7.3 \times 10^3 m^3/yr$$

/3: It is assumed all of transported bed load from upstream is sedimented in downstream.

/4: It is assumed 40% of transported suspended load from upstream is sedimented in downstream.

Table 3.11 ECONOMIC CONSTRUCTION COST FOR FLOOD CONTROL PROJECT

(Unit: ₱10^6)

Item	Plan with 20-yr Flood F.C.	L.C.
1. Cost for Civil Works	314.52	195.76
2. Cost to be deducted from Item 1		
A. Embankment of Setback Levee	8.01	12.70
B. Profit of Contractor	6.69	19.48
C. Tax of Contractor	2.01	5.84
D. Sub-Total	16.71	38.02
3. Cost to be added to Item 1		
A. Excavation of Labangan F.	14.90	13.90
B. Compensation, Contingency, Eng. and Administration	68.33	87.12
C. Sub-Total	83.23	101.02
4. Economic Construction Cost	381.04	258.76

Table 3.12(1) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES
(IMPROVED CHANNEL BY STEPWISE PLAN)

Swamp/Channel		Code	Unit	Probable Flood (Year) 5	10	20	50	100
1. San Antonio Swamp								
Inflow	Pampanga River	QI1	m^3/sec	2,424	3,070	3,664	4,345	4,895
-do-	(Rio Chico River)	QI2	m^3/sec	1,507	2,203	2,849	3,714	4,365
at Swamp		HSA	EL.m	10.97	11.81	12.49	13.23	13.73
at Arayat		HAY	EL.m	10.11	10.87	11.49	12.15	12.61
-do-		QAY	m^3/sec	2,323	2,714	3,056	3,441	3,723
Cabiao Candaba Floodway		QCC	m^3/sec	1,285	1,838	2,517	3,447	4,202
2. North Candaba Swamp								
Inflow	(Maasim River)	QI3	m^3/sec	551	764	970	1,392	1,728
-do-	(from Pampanga River)	QCN1	m^3/sec	0	8	448	1,341	1,861
at Swamp		HCN	EL.m	7.05	7.49	8.18	8.77	9.06
Outflow	(to Pampanga River)	QCN2	m^3/sec	-1,412	-2,147	-3,195	-4,394	-4,979
-do-	(to South Candaba Swamp)	QMD	m^3/sec	0	0	0	994	1,860
3. South Candaba Swamp								
Inflow		QI4	m^3/sec	86	120	147	181	218
-do-	(from Pampanga River)	QCS1	m^3/sec	0	0	0	0	0
at Swamp		HCS	EL.m	2.85	3.16	3.38	5.64	7.26
Outflow	(to Pampanga River)	QCS2	m^3/sec	-483	-669	-522	-1,359	-1,506
-do-	(-do-)	QCS3	m^3/sec	0	0	0	0	0
-do-	(to Angat River)	QCS4	m^3/sec	0	0	0	0	0

Table 3.12(2) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES
(IMPROVED CHANNEL BY STEPWISE PLAN)

Swamp/Channel	Code	Unit	Probable Flood (Year)				
			5	10	20	50	100
4. Pampanga River (Arayat-Sulipan)							
	HAC	EL.m	7.21	8.12	8.61	8.96	9.19
	QAC	m^3/sec	2,447	2,615	2,786	2,865	2,907
at Candaba	HCD	EL.m	6.52	7.54	8.20	8.75	9.03
-do-	QCD	m^3/sec	2,493	2,639	2,721	2,808	2,838
	HMR	EL.m	6.39	7.43	8.13	8.71	9.01
	QMR	m^3/sec	3,438	4,603	5,533	6,356	6,813
	HSP	EL.m	5.80	6.83	7.53	8.11	8.40
	QSS	m^3/sec	3,344	4,517	5,447	6,288	6,738
	HSS	EL.m	5.41	6.41	7.10	7.67	7.96
	QSP	m^3/sec	3,258	4,460	5,434	6.221	6.649
	HAP	EL.m	4.85	5.81	6.48	7.05	7.34
	QPAU	m^3/sec	3,192	4,529	5,501	6,283	6,854
5. Angat River							
	QI5	m^3/sec	737	1,014	1,367	2,048	2,429
	HAG	EL.m	3.78	4.62	5.24	5.84	6.14
	QAG	m^3/sec	725	1,002	1,348	2,011	2,390
6. Rivers (Downstream Sulipan)							
at Sulipan	HSC	EL.m	3.64	4.49	5.11	5.68	5.98
Pampanga River	QPAD	m^3/sec	2,841	3,836	4,678	5,450	5,912
-do-	HBH	EL.m	3.03	3.79	4.36	4.84	5.11
-do-	QPA2	m^3/sec	2,841	3,836	4,678	5,450	5,912
at Masantol	HBM	EL.m	2.72	3.41	3.93	4.36	4.61

Table 3.12(3) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES
(IMPROVED CHANNEL BY STEPWISE PLAN)

Swamp/Channel	Code	Unit	Probable Flood (Year)				
			5	10	20	50	100
Pampanga River	QPA1	m^3/sec	1,979	2,684	3,283	3,828	4,156
Bebe-San Esteban Channel	QBS	m^3/sec	863	1,152	1,395	1,622	1,756
Hagonoy River	HSJ	EL.m	0.53	0.53	0.53	0.53	0.53
-do-	QHA	m^3/sec	0	0	0	0	0
-do-	HHA	EL.m	0.53	0.53	0.53	0.53	0.53
Labangan Floodway	HLR	EL.m	2.89	3.64	4.23	4.77	5.06
-do-	QLF	m^3/sec	862	1,158	1,419	1,678	1,823
-do-	HLF	EL.m	2.27	2.95	3.51	4.04	4.33

Table 3.13 DECREASE IN INUNDATION AREA WITH FLOOD CONTROL BY RIVER IMPROVEMENT OF PAMPANGA RIVER (Stepwise Plan with 20-yr. Design Flood)

Item	Unit	Return Period (year) 1.1	2	5	10	20	50	100
1. North Candaba Swamp								
Maximum Water Level	EL.m	3.7	5.4	7.05	7.49	8.18	8.77	9.06
Inundation Area (uncultivated)	km^2	26.0	86.6	153.8	165.8	185.0	201.9	210.6
Decrease in Inundation Area	Km^2	35.2	43.6	6.5	9.9	4.6	5.2	11.7
Ave. Annual Decrease in Inund. Area	Km^2							29.0
2. South Candaba Swamp								
Maximum Water Level	EL.m	1.7	2.3	2.85	3.16	3.38	5.64	7.26
Inundation Area	km^2	8.3	20.7	37.8	46.5	63.8	99.2	124.5
Paddy Area (irrigated)	Km^2	-	-	-	-	-	23.4	48.7
Uncultivated Area	Km^2	8.3	20.7	37.8	46.5	63.8	75.8	75.8
Decrease in Inundation Area	Km^2	24.8	39.2	53.4	56.4	48.9	23.1	4.6
Paddy Area (irrigated)	Km^2	-	-	15.4	27.1	36.9	23.1	4.6
Uncultivated Area	Km^2	24.8	39.2	38.0	29.3	12.0	-	-
Ave. Annual Decrease in Inund. Area	Km^2							39.1
Paddy Area (irrigated)	Km^2							7.1
Uncultivated Area	Km^2							32.0
3. Downstream Area from Sulipan								
Decrease in Inundation Area	Km^2	38.6	74.1	108.9	133.6	133.6	-	-
Cultivated Area (rainfed)	Km^2	-	16.2	25.5	32.4	32.4	-	-
Potential Area (To be Paddy Field)	Km^2	22.9	22.9	22.9	22.9	22.9	-	-
Fish Pond Area	Km^2	15.7	35.0	60.5	78.3	78.3	-	-
Ave. Annual Decrease in Inund. Area	Km^2							76.4
Cultivated Area (rainfed)	Km^2							15.3
Potential Area (To be Paddy Field)	Km^2							22.1
Fishpond Area	Km^2							39.0

Table 3.14 DECREASE IN FLOOD DAMAGES WITH FLOOD CONTROL BY MEANS OF CHANNEL IMPROVEMENT

(Stepwise Plan with 20-yr Design Flood)

Item	Unit	Q'ty	Unit Price (₱)	Amount (₱1,000)
A. Below Sulipan, Calumpit				
- Damage to Paddy and Fish				
Paddy (Rainfed)	ha	1,150	3,890	4,474
Potential to be Paddy Field	ha	1,660	1,550	2,573
Fishpond	ha	3,900	3,889	15,167
Sub-Total				22,214
- Damage to Private Properties	house	1,730	3,000	5,190
- Damage to Public Facilities (300% of Private Properties)				15,570
- Sub-Total				42,974
- Indirect Losses (5% of above)				2,149
- Total				45,123
B. South Candaba Swamp				
- Damage to Paddy				
Irrigated Area	ha	530	8,415	4,460
Potential to be Irrigated Paddy	ha	2,400	5,209	12,502
Sub-Total				16,962
- Damage to Private Properties	house	860	3,000	2,580
- Damage to Public Facilities (300% of Private Properties)				7,740
- Sub-Total				27,282
- Indirect Losses (5% of above)				1,364
- Total				28,646
C. North Candaba Swamp				
- Damage to Paddy (Rainfed)	ha	2,180	3,890	8,480
- Other damages (35% of above)				2,968
- Total				11,448
D. Grand Total (Decrease in Average Annual Flood Damage)				85,217

Table 3.15(1) CONSTRUCTION SCHEDULE FOR ALTERNATIVE 1

(Unit: %)

Item	Unit	Quantity	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	6th yr.	7th yr.	8th yr.	9th yr.	10th yr.
First Phase												
1. Land acquisition and Compensation	L.S	-	5	25	25	20	15	10				
2. Civil work												
Preparatory work	L.S	-		35	20	15	15	15				
Embankment	$10^3 m^3$	2,060		15	25	25	25	10				
Excavation	$10^3 m^3$	16,590		20	25	25	20	10				
Outlet	Place	9		10	30	25	25	10				
Revetment	m	2,500				25	50	25				
Bridge	Place	2		10	30	25	25	10				
Others	L.S	-		20	20	20	20	20				
3. Engineering and Administration	L.S	-	40	12	12	12	12	12				
Second Phase												
1. Land acquisition and Compensation	L.S	-						5	25	25	20	15	10
2. Civil work												
Preparatory work	L.S	-							35	20	15	15	15
Embankment	$10^3 m^3$	4,610							15	25	25	25	10
Excavation	$10^3 m^3$	15,890							20	25	25	20	10
Outlet	Place	10							10	30	25	25	10
Revetment	m	1,500									25	50	25
Bridge	Place	-											
Others	L.S	-							20	20	20	20	20
3. Engineering and Administration	L.S	-						40	12	12	12	12	12

Table 3.15(2) CONSTRUCTION SCHEDULE FOR LATERNATIVE 2

(Unit: %)

Item	Unit	Quantity	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	6th yr.	7th yr.	8th yr.	9th yr.	10th yr.
First Phase												
1. Land acquisition and Compersation	L.S	-	5	25	25	20	15	10				
2. Civil work												
Preparatory work	L.S	-		35	20	15	15	15				
Embankment	$10^3 m^3$	4,610		15	25	25	25	10				
Excavation	$10^3 m^3$	15,890		20	25	25	20	10				
Outlet	Place	10		10	30	25	25	10				
Revetment	m	1,500				25	50	25				
Bridge	Place	-										
Others	L.S	-		20	20	20	20	20				
3. Engineering and Administration	L.S	-	40	12	12	12	12	12				
Second Phase												
1. Land acquisition and Compensation	L.S	-					5	25	25	20	15	10
2. Civil work												
Preparatory work	L.S	-						35	20	15	15	15
Embankment	$10^3 m^3$	2,060						15	25	25	25	10
Excavation	$10^3 m^3$	16,590						20	25	25	20	10
Outlet	Place	9						10	30	25	25	10
Revetment	m	2,500								25	50	25
Bridge	Place	2						10	30	25	25	10
Others	L.S	-						20	20	20	20	20
3. Engineering and Administration	L.S	-					40	12	12	12	12	12

Table 3.15(3) CONSTRUCTION SCHEDULE FOR ALTERNATIVE 3

(Unit: %)

Item	Unit	Quantity	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	6th yr.	7th yr.	8th yr.	9th yr.	10th yr.
First Phase												
1. Land acquisition and Compensation	L.S	-	5	25	25	20	15	10				
2. Civil work												
Preparatory work	L.S	-		35	20	15	15	15				
Embankment	$10^3 m^3$	6,670		15	25	25	25	10				
Excavation	$10^3 m^3$	14,073		20	25	25	20	10				
Outlet	Place	19		10	30	25	25	10				
Revetment	m	-										
Bridge	Place	-										
Others	L.S	-		20	20	20	20	20				
3. Engineering and Administration	L.S	-	40	12	12	12	12	12				
Second Phase												
1. Land acquisition and Compensation	L.S	-					20	20	20	20	15	5
2. Civil work												
Preparatory work	L.S	-						35	20	15	15	15
Embankment	$10^3 m^3$	-										
Excavation	$10^3 m^3$	18,407						10	25	25	20	20
Outlet	Place	-										
Revetment	m	4,000								25	50	25
Bridge	Place	2						20	20	20	20	20
Others	L.S	-						20	20	20	20	20
3. Engineering and Administration	L.S	-					40	12	12	12	12	12

Table 3.16(1) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES
(IMPROVED CHANNEL BY FIRST PHASE WORK OF STEPWISE PLAN)

Swamp/Channel		Code	Unit	Probable Flood (Year) Alternative 1 20	Alternative 2 20	Alternative 3 10
1. San Antonio Swamp						
Inflow	(Pampanga River)	QI1	m^3/sec	3,664	3,664	3,070
-do-	(Rio Chico River)	QI2	m^3/sec	2,849	2,849	2,203
at Swamp		HSA	EL.m	12.51	12.51	11.84
at Arayat		HAY	EL.m	11.50	11.51	10.90
-do-		QAY	m^3/sec	3,064	3,067	2,728
Cabiao Candaba Floodway		QCC	m^3/sec	2,486	2,492	1,792
2. North Candaba Swamp						
Inflow	(Maasim River)	QI3	m^3/sec	970	970	764
-do-	(from Pampanga River)	QCN1	m^3/sec	684	656	210
at Swamp		HCN	EL.m	8.41	8.31	7.98
Outflow	(to Pampanga River)	QCN2	m^3/sec	-3,328	-2,130	-2,099
-do-	(to South Candaba Swamp)	QMD	m^3/sec	0	1,456	0
3. South Candaba Swamp						
Inflow		QI4	m^3/sec	147	147	120
-do-	(from Pampanga River)	QCS1	m^3/sec	0	2,150	0
at Swamp		HCS	EL.m	3.39	5.84	3.17
Outflow	(to Pampanga River)	QCS2	m^3/sec	-261	-964	-516
-do-	(-do-)	QCS3	m^3/sec	0	-3,464	0
-do-	(to Angat River)	QCS4	m^3/sec	0	0	0

Table 3.16(2) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES
(IMPROVED CHANNEL BY FIRST PHASE WORK OF STEPWISE PLAN)

Swamp/Channel	Code	Unit	Probable Flood (Year) Alternative 1 20	Alternative 2 20	Alternative 3 10
4. Pampanga River (Arayat-Sulipan)					
	HAC	EL.m	8.72	8.71	8.45
	QAC	m^3/sec	2,746	2,670	2,570
at Candaba	HCD	EL.m	8.42	8.39	8.05
-do-	QCD	m^3/sec	2,689	2,619	2,502
	HMR	EL.m	8.37	8.29	7.95
	QMR	m^3/sec	5,427	4,258	4,351
	HSP	EL.m	7.86	6.67	7.32
	QSS	m^3/sec	5,334	2,445	4,262
	HSS	EL.m	7.51	6.27	6.87
	QSP	m^3/sec	5,348	2,398	4,185
	HAP	EL.m	7.05	5.83	6.16
	QPAU	m^3/sec	5,396	2,202	4,218
5. Angat River					
	QI5	m^3/sec	1,367	1,367	1,014
	HAG	EL.m	6.19	5.21	4.86
	QAG	m^3/sec	1,331	1,350	1,002
6. Rivers (Downstream Sulipan)					
at Sulipan	HSC	EL.m	6.12	5.13	4.77
Pampanga River	QPAD	m^3/sec	4,319	4,732	3,419
-do-	HBH	EL.m	4.29	4.40	3.97
-do-	QPA2	m^3/sec	4,201	4,732	3,419

Table 3.16(3) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES
(IMPROVED CHANNEL BY FIRST PHASE WORK OF STEPWISE PLAN)

Swamp/Channel	Code	Unit	Probable Flood (Year)		
			Alternative 1	Alternative 2	Alternative 3
			20	20	10
at Masantol	HBM	EL.m	3.93	3.96	3.48
Pampanga River	QPA1	m^3/sec	2,807	3,322	2,234
Bebe-San Esteban Channel	QBS	m^3/sec	1,395	1,410	1,185
Hagonoy River	HSJ	EL.m	3.17	0.53	0.53
-do-	QHA	m^3/sec	118	0	0
-do-	HHA	EL.m	2.59	0.53	0.53
Labangan Floodway	HLR	EL.m	5.76	4.24	3.90
-do-	QLF	m^3/sec	1,634	1,425	1,274
-do-	HLF	EL.m	5.07	3.52	3.20

Remarks:

Alternative 1: Improvement of upstream of the Pampanga River (Sulipan-Candaba)

Alternative 2: Improvement of Labangan River and downstream of the Pampanga River (Manila Bay-Sulipan)

Alternative 3: Improvement of the whole range of the Pampanga River (Manila Bay-Candaba)

Table 3.17(1) CONSTRUCTION COST FOR CHANNEL IMPROVEMENT OF PAMPANGA RIVER FIRST PHASE - ALTERNATIVE-3

Item	Unit	Q'ty	Unit Price (₱) F.C.	Unit Price (₱) L.C.	Amount (₱10⁶) F.C.	Amount (₱10⁶) L.C.
1. Civil Work						
-Preparation	L.S.				8.87	6.71
-Embankment						
Pampanga R.(R P-14k-P0k)	10^3m^3	660	5,900	5,500	3.89	3.63
Pampanga R.(L P-14k-P0k)	10^3m^3	710	5,900	5,500	4.19	3.90
Pampanga R.(R P0k-P8k)	10^3m^3	330	5,300	6,500	1.75	2.14
Pampanga R.(L P0k-P8k)	10^3m^3	440	5,900	5,500	2.60	2.42
Pampanga R.(R P8k-P28k)	10^3m^3	360	5,300	6,500	1.91	2.34
Pampanga R.(L P8k-P28k)	10^3m^3	850	5,900	5,500	5.02	4.67
Bagbag R.	10^3m^3	600	5,900	5,500	3.54	3.30
Bebe C.O.C.(R)	10^3m^3	300	5,300	6,500	1.59	1.95
Bebe C.O.C.(L)	10^3m^3	360	5,300	6,500	1.91	2.34
Maasim R.	10^3m^3	550	6,100	6,500	3.36	3.57
Angat R.	10^3m^3	40	5,900	5,500	0.24	0.22
Labangan R.	10^3m^3	1,470	5,900	5,500	8.67	8.09
Sub-total					38.67	38.57
-Excavation						
Pampanga R.(P -14k-P00k)	10^3m^3	5,053	5,900	2,200	29.81	11.12
Pampanga R.(P 0k-P8k)	10^3m^3	3,385	5,900	2,200	19.97	7.45
Pampanga R.(P8k-P28k)	10^3m^3	4,095	5,900	2,200	24.16	9.01
Sub-total					73.94	27.58
-Outlet						
Type A	nos	2	1,823,000	3,194,000	3.65	6.38
Type B	nos	14	478,000	739,000	6.69	10.34
Type C	nos	3	267,000	399,000	0.80	1.20
Intake of fishpond	nos	26	28,000	42,000	0.72	1.08
Repair of existing culverts	L.S.				1.40	5.60
Sub-total					12.54	23.44
-Other roads to be replaced	L.S.				1.54	6.16
-Miscellaneous 15%					20.33	15.38
Total					156.61	118.80
2. Right of Way						
-Land						
Paddy field A class	ha	25	-	20,000	-	0.50
" " B class	ha	458	-	15,000	-	6.87
Fishpond	ha	753	-	20,000	-	15.06
-House A	nos.	2,481	-	15,000	-	37.21
B	nos.	1,183	-	12,000	-	14.20
-Others	L.S.					5.16
Total						79.00
3. Contingency (15%)					23.38	29.53
4. Eng. & Administration (6%)					10.63	13.49
Grand Total					190.62	240.82
					431.44	

Table 3.17(2) CONSTRUCTION COST FOR CHANNEL IMPROVEMENT OF PAMPANGA RIVER

Second Phase
Alternative - 3

Item	Unit	Q'ty	Unit Price F.C.	Unit Price L.C.	Amount ₱ x 10^6 F.C.	Amount ₱ x 10^6 L.C.
1. Civil Work						
- Preparatory L.C.					8.99	4.37
- Excavation						
Pampanga R. (D)	10 m	3,427	5,900	2,200	20.22	7.54
Pampanga R. (M)	10 m	4,025	5,900	2,200	23.75	8.85
Pampanga R. (U)	10 m	12,495	5,900	2,200	73.72	27.49
Sub-Total		19,947			117.69	43.88
- Revetment	m	4,000	67	760	0.27	3.04
- Bridge						
Railroad	m	40	39,900	47,100	1.60	1.88
Highway	m	30	53,200	62,800	1.60	1.88
Provincial road	m	450	13,300	15,700	5.99	7.06
Sub-Total					9.19	10.82
- Road to be replaced	L.S.				1.26	5.04
- Miscellaneous (15%)	L.S.				20.59	9.93
Total					157.99	77.08
2. Right of Way						
- Paddy field A class	ha	21	-	20,000	-	0.42
Paddy field B class	ha	375	-	15,000	-	5.63
Fishpond	ha	616	-	20,000	-	12.32
- House	nos.	2,029	-	15,000	-	30.44
House	nos.	967	-	12,000	-	11.60
- Other						4.09
Total						64.50
3. Contingency (15%)					23.71	21.23
4. Eng. & Administration (6%)					11.10	9.85
Grand Total					192.80	172.66
					365.46	

Table 3.18(1) ANNUAL CONSTRUCTION COST FOR ALTERNATIVE-1

(Unit: ₱10^6)

Item	1		2		3		4		5		6		7		8		9		10		Total		
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	Total
First Phase																							
1. Land acquisition and Compensation		4.18		20.88		20.88		16.70		12.52		8.35										83.50	83.50
2. Civil Work			30.58	17.75	38.46	24.63	37.28	23.63	32.42	22.29	18.44	12.80									157.18	101.10	258.28
-Preparation			3.13	2.01	1.79	1.15	1.34	0.86	1.34	0.86	1.34	0.86									8.94	5.75	14.69
-Embankment			1.81	1.84	3.01	3.06	3.02	3.06	3.02	3.06	1.21	1.22									12.06	12.25	24.31
-Excavation			19.58	7.30	24.47	9.12	24.47	9.12	19.58	7.30	9.79	3.65									97.88	36.50	134.38
-Outlet			0.64	1.28	1.93	3.82	1.61	3.19	1.61	3.19	0.64	1.28									6.44	12.76	19.20
-Revetment							0.04	0.48	0.08	0.95	0.04	0.48									0.17	1.90	2.07
-Bridge			0.92	1.08	2.76	3.25	2.30	2.70	2.30	2.70	0.92	1.08									9.19	10.82	20.01
-Other			0.40	1.60	0.40	1.60	0.40	1.60	0.40	1.60	0.40	1.60									2.00	8.00	10.00
-Miscellaneous			4.10	2.64	4.10	2.62	4.10	2.62	4.10	2.62	4.10	2.62									20.50	13.12	33.62
3. Contingency (15%)		0.63	4.59	5.79	5.77	6.83	5.59	6.05	4.86	5.22	2.77	3.17									23.58	27.70	51.28
4. Engineering and Administration (6%)	4.34	5.08	1.30	1.52	1.30	1.52	1.30	1.52	1.30	1.52	1.30	1.52									10.84	12.70	23.54
Sub total	4.34	9.89	36.46	45.93	45.53	53.86	44.17	47.92	38.59	41.56	22.51	25.84									191.60	224.99	416.60
Second Phase																							
1. Land acquisition and Compensation										3.00		15.00		15.00		12.00		9.00		6.00		60.00	60.00
2. Civil Work											30.79	17.07	38.17	22.97	37.40	22.41	32.74	20.95	18.32	11.38	157.42	94.78	252.20
-Preparation											3.12	1.87	1.78	1.07	1.34	0.80	1.34	0.80	1.34	0.80	8.92	5.33	14.25
-Embankment											3.99	3.95	6.66	6.58	6.65	6.58	6.65	6.58	2.66	2.63	26.61	26.32	52.93
-Excavation											18.75	6.99	23.44	8.74	18.75	8.74	18.75	6.99	9.38	3.50	93.75	34.96	128.71
-Outlet											0.68	1.17	2.05	3.49	1.70	2.91	1.70	2.91	0.68	1.17	6.81	11.65	18.46
-Revetment															0.02	0.28	0.05	0.57	0.02	0.28	0.10	1.14	1.24
-Bridge																							
-Other											0.16	0.64	0.16	0.64	0.16	0.64	0.16	0.64	0.16	0.64	0.80	3.20	4.00
-Miscellaneous											4.08	2.46	4.08	2.46	4.08	2.46	4.08	2.46	4.08	2.36	20.42	12.19	32.71
3. Contingency (15%)										0.45	4.61	4.79	5.69	5.65	5.58	5.12	4.88	4.45	2.74	2.60	23.51	23.06	46.57
4. Engineering and Administration (6%)									4.35	4.25	1.31	1.28	1.31	1.28	1.31	1.28	1.30	1.27	1.31	1.28	10.89	10.64	21.53
Sub total									4.35	7.70	36.71	38.14	45.17	44.90	44.30	40.81	38.92	35.67	22.37	21.26	191.82	188.48	380.30
Grand total	4.34	9.89	36.46	45.93	45.53	53.86	44.17	47.92	42.94	49.26	59.22	63.98	45.17	44.90	44.30	40.81	38.92	35.67	22.37	21.26	383.42	413.48	796.90

Table 3.18(2) Annual Construction Cost for Alternative-2

(Unit: ₱10^6)

Item	1		2		3		4		5		6		7		8		9		10		Total		
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	Total
First Phase																							
1. Land acquisition and Compensation		3.00		15.00		15.00		12.00		9.00		6.00										60.00	60.00
2. Civil Work			30.79	17.07	38.17	22.97	37.40	22.41	32.74	20.95	18.32	11.38									157.42	94.78	252.20
-Preparation			3.12	1.87	1.78	1.07	1.34	0.80	1.34	0.80	1.34	0.80									8.92	5.33	14.25
-Embankment			3.99	3.95	6.66	6.58	6.65	6.58	6.65	6.58	2.66	2.63									26.61	26.32	52.93
-Excavation			18.75	6.99	23.44	8.74	18.75	8.74	18.75	6.99	9.38	3.50									93.75	34.96	128.71
-Outlet			0.68	1.17	2.05	3.49	1.70	2.91	1.70	2.91	0.68	1.17									6.81	11.65	18.46
-Revetment							0.02	0.28	0.05	0.57	0.02	0.28									0.10	1.14	1.24
-Bridge																							
-Other			0.16	0.64	0.16	0.64	0.16	0.64	0.16	0.64	0.16	0.64									0.80	3.20	4.00
-Miscellaneous			4.08	2.46	4.08	2.46	4.08	2.46	4.08	2.46	4.08	2.36									20.42	12.19	32.71
3. Contingency (15%)		0.45	4.61	4.79	5.69	5.65	5.58	5.12	4.88	4.45	2.74	2.60									23.51	23.06	46.57
4. Engineering and Administration (6%)	4.35	4.25	1.31	1.28	1.31	1.28	1.31	1.28	1.30	1.27	1.31	1.28									10.89	10.64	21.53
Sub total	4.35	7.70	36.71	38.14	45.17	44.90	44.30	40.81	38.92	35.67	22.37	21.26									191.82	188.48	380.30
Second Phase																							
1. Land acquisition and Compensation										4.18		20.88		20.88		16.70		12.52		8.35		83.50	83.50
2. Civil Work											30.58	17.75	38.46	24.63	37.28	23.63	32.42	22.29	18.44	12.80	157.18	101.10	258.28
-Preparation											3.13	2.01	1.79	1.15	1.34	0.86	1.34	0.86	1.34	0.86	8.94	5.75	14.69
-Embankment											1.81	1.84	3.01	3.06	3.02	3.06	3.02	3.06	1.21	1.22	12.06	12.25	24.31
-Excavation											19.58	7.30	24.47	9.12	24.47	9.12	19.58	7.30	9.79	3.65	97.88	36.50	134.38
-Outlet											0.64	1.28	1.93	3.82	1.61	3.19	1.61	3.19	0.64	1.28	6.44	12.76	19.20
-Revetment															0.04	0.48	0.80	0.95	0.04	0.48	0.17	1.90	2.07
-Bridge											0.92	1.08	2.76	3.25	2.30	2.70	2.30	2.70	0.92	1.08	9.19	10.82	20.01
-Other											0.40	1.60	0.40	1.60	0.40	1.60	0.40	1.60	0.40	1.60	2.00	8.00	10.00
-Miscellaneous											4.10	2.64	4.10	2.62	4.10	2.62	4.10	2.62	4.10	2.62	20.50	13.12	33.62
3. Contingency (15%)										0.63	4.59	5.79	5.77	6.83	5.59	6.05	4.86	5.22	2.77	3.17	23.58	27.70	51.28
4. Engineering and Administration (6%)									4.34	5.08	1.30	1.52	1.30	1.52	1.30	1.52	1.30	1.52	1.30	1.52	10.84	12.70	23.54
Sub total									4.34	9.89	36.46	45.93	45.53	53.86	44.17	47.92	38.59	41.56	22.51	25.84	191.60	224.99	416.60
Grand total	4.35	7.70	36.71	38.14	45.17	44.90	44.30	40.81	43.26	45.56	58.83	67.19	45.53	53.86	44.17	47.92	38.59	41.56	22.51	25.84	383.42	413.48	796.90

Table 3.18(3) ANNUAL CONSTRUCTION COST FOR ALTERNATIVE-3

(Unit: ₱10^6)

Item	1		2		3		4		5		6		7		8		9		10		Total		
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	Total
First Phase																							
1. Land acquisition and Compensation		3.95		19.75		19.75		15.80		11.85		7.90										79.00	79.00
2. Civil Work			29.38	20.41	38.30	29.50	37.19	27.95	33.48	26.57	18.26	14.37									156.61	118.80	275.41
-Preparation			3.10	2.34	1.78	1.34	1.33	1.01	1.33	1.01	1.33	1.01									8.87	6.71	15.58
-Embankment			5.80	5.79	9.67	9.64	9.67	9.64	9.67	9.64	3.86	3.86									38.67	38.57	77.24
-Excavation			14.79	5.52	18.49	6.89	18.49	6.89	14.79	5.52	7.38	2.76									73.94	27.58	101.52
-Outlet			1.32	2.44	3.98	7.32	3.32	6.10	3.32	6.10	1.32	2.44									13.26	24.40	37.66
-Revetment																							
-Bridge																							
-Other			0.30	1.24	0.31	1.23	0.31	1.23	0.31	1.23	0.31	1.23									1.54	6.16	7.70
-Miscellaneous			4.07	3.08	4.07	3.08	4.07	3.08	4.06	3.07	4.06	3.07									20.33	15.38	35.71
3. Contingency (15%)		0.59	4.40	6.01	5.71	7.35	5.51	6.53	4.99	5.73	2.77	3.32									23.38	29.53	52.91
4. Engineering and Administration (6%)	4.25	5.40	1.28	1.62	1.27	1.62	1.27	1.62	1.28	1.62	1.28	1.61									10.63	13.49	24.12
Sub total	4.25	9.94	35.06	47.79	45.28	58.22	43.97	51.90	39.75	45.77	22.31	27.20									190.62	240.82	431.44
Second Phase																							
1. Land acquisition and Compensation										12.90		12.90		12.90		12.90		9.67		3.23		64.50	64.50
2. Civil Work											19.30	8.92	40.19	20.25	39.80	20.80	29.39	13.95	29.31	13.16	157.99	77.08	235.07
-Preparation											3.15	1.53	1.80	0.87	1.35	0.66	1.35	0.66	1.34	0.65	8.99	4.37	13.36
-Embankment																							
-Excavation											11.77	4.39	29.42	10.97	29.42	10.97	23.54	8.78	23.54	8.77	117.69	43.88	161.57
-Outlet																							
-Revetment															0.07	0.76	0.13	1.52	0.07	0.76	0.27	3.04	3.31
-Bridge													4.60	5.41	4.59	5.41					9.19	10.82	20.01
-Other											0.26	1.01	0.25	1.01	0.25	1.01	0.25	1.01	0.25	1.00	1.26	5.04	6.30
-Miscellaneous											4.12	1.99	4.12	1.99	4.12	1.99	4.12	1.98	4.11	1.98	20.59	9.93	30.52
3. Contingency (15%)										2.05	2.91	3.25	6.04	4.95	5.98	5.04	4.43	3.53	4.35	2.41	23.71	21.23	44.94
4. Engineering and Administration (6%)									4.44	3.81	1.34	1.21	1.33	1.21	1.33	1.21	1.33	1.21	1.33	1.20	11.10	9.85	20.95
Sub total									4.44	18.76	23.55	26.28	47.56	39.31	47.11	39.95	35.15	28.36	34.99	20.00	192.80	172.66	365.46
Grand total	4.25	9.94	35.06	47.79	45.28	58.22	43.97	51.90	44.19	64.53	45.86	53.48	47.56	39.31	47.11	39.95	35.15	28.36	34.99	20.00	383.42	413.48	796.90

Table 3.19 ANNUAL CONSTRUCTION COST
FOR FLOOD CONTROL PROJECT

(Unit: ₱10^6)

	1st Phase		2nd Phase		Whole Phase		
	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
1. Alternative - 1							
1st yr.	9.9	4.3			9.9	4.3	14.2
2nd yr.	45.9	36.5			45.9	36.5	82.4
3rd yr.	53.9	45.5			53.9	45.5	99.4
4th yr.	47.9	44.2			47.9	44.2	92.1
5th yr.	41.6	38.6	7.7	4.4	49.3	43.0	92.3
6th yr.	25.8	22.5	38.1	36.7	63.9	59.2	123.1
7th yr.			44.9	45.2	44.9	45.2	90.1
8th yr.			40.8	44.3	40.8	44.3	85.1
9th yr.			35.7	38.9	35.7	38.9	74.6
10th yr.			21.3	22.3	21.3	22.3	43.6
Total	225.0	191.6	188.5	191.8	413.5	383.4	796.7
2. Alternative - 2							
1st yr.	7.7	4.4			7.7	4.4	12.1
2nd yr.	38.1	36.7			38.1	36.7	74.8
3rd yr.	44.9	45.2			44.9	45.2	90.1
4th yr.	40.8	44.3			40.8	44.3	85.1
5th yr.	35.7	38.9	9.9	4.3	45.6	43.2	126.0
6th yr.	21.3	22.3	45.9	36.5	67.2	58.8	126.0
7th yr.			53.9	45.5	53.9	45.5	99.4
8th yr.			47.9	44.2	47.9	44.2	92.1
9th yr.			41.6	38.6	41.6	38.6	80.2
10th yr.			25.8	22.5	25.8	22.5	48.3
Total	188.5	191.8	225.0	191.6	413.5	383.4	796.9
3. Alternative - 3							
1st yr.	9.9	4.3			9.9	4.3	14.2
2nd yr.	47.8	35.0			47.8	35.0	82.8
3rd yr.	58.2	45.3			58.2	45.3	103.5
4th yr.	51.9	44.0			51.9	44.0	95.9
5th yr.	45.8	39.8	18.8	4.4	64.6	44.1	108.7
6th yr.	27.2	22.3	26.3	23.6	53.5	45.9	99.4
7th yr.			39.3	47.6	39.3	47.6	86.9
8th yr.			39.9	47.1	39.9	47.1	87.0
9th yr.			28.4	35.1	28.4	35.1	63.5
10th yr.			20.0	35.0	20.0	35.0	55.0
Total	240.8	190.6	172.7	192.8	413.5	383.4	796.9

Table 3.20(1) DECREASE IN INUNDATION AREA WITH FLOOD CONTROL BY RIVER IMPROVEMENT OF PAMPANGA RIVER (Stepwise Plan, Alternative - 1, 1st Phase)

Item	Unit	Return Period (year)						
		1.1	2	5	10	20	50	100
1. North Candaba Swamp								
Maximum Water Level	El.m	3.7	5.4	7.11	7.70	8.41	8.94	9.39
Inundation Area (uncultivated)	km^2	26.0	86.6	155.4	171.6	191.6	207.1	222.3
Decrease in Inundation Area	km^2	35.2	43.6	4.9	4.1	-2.0	-	-
Ave. Annual Decrease in Inund. Area	km^2							27.5
2. South Candaba Swamp								
Maximum Water Level	El.m	1.7	2.3	2.87	3.17	3.39	5.64	7.26
Inundation Area	km^2	8.3	20.7	37.8	46.5	63.8	99.2	124.5
Paddy Area (irrigated)	km^2	-	-	-	-	-	23.4	48.7
Uncultivated Area	km^2	8.3	20.7	37.8	46.5	63.8	75.8	75.8
Decrease in Inundation Area	km^2	24.8	39.2	53.4	56.4	48.9	23.1	4.6
Paddy Area (irrigated)	km^2	-	-	15.4	27.1	36.9	23.1	4.6
Uncultivated Area	km^2	24.8	39.2	38.0	29.3	12.0	-	-
Ave. Annual Decrease in Inund. Area	km^2							39.1
Paddy Area (irrigated)	km^2							7.1
Uncultivated Area	km^2							32.0
3. Downstream Area from Sulipan								
Decrease in Inundation Area	km^2							
Cultivated Area (rainfed)	km^2							
Potential Area (to be Paddy Field)	km^2							
Fishpond Area	km^2							
Ave. Annual Decrease in Inund. Area	km^2							
Cultivated Area (rainfed)	km^2							
Potential Area (to be Paddy Field)	km^2							
Fishpond Area	km^2							

Table 3.20(2) DECREASE IN INUNDATION AREA WITH FLOOD CONTROL BY RIVER IMPROVEMENT OF PAMPANGA RIVER (Stepwise Plan, Alternative - 2, 1st Phase)

Item	Unit	Return Period (year) 1.1	2	5	10	20	50	100
1. North Candaba Swamp								
Maximum Water Level	El.m							
Inundation Area (uncultivated)	km^2							
Decrease in Inundation Area	km^2							
Ave. Annual Decrease in Inund. Area	km^2							
2. South Candaba Swamp								
Maximum Water Level	El.m	2.7	3.2	4.2	5.2	5.84	6.90	7.54
Inundation Area	km^2	33.1	47.5	72.0	93.1	101.9	118.5	129.1
Paddy Area (irrigated)	km^2	-	-	-	17.3	26.1	42.7	53.3
Uncultivated Area	km^2	33.1	47.5	72.0	75.8	75.8	75.8	75.8
Decrease in Inundation Area	km^2	-	12.4	19.2	9.8	10.8	3.8	-
Paddy Area (irrigated)	km^2	-	-	-	9.8	10.8	3.8	-
Uncultivated Area	km^2	-	12.4	19.2	-	-	-	-
Ave. Annual Decrease in Inund. Area	km^2							14.7
Paddy Area (irrigated)	km^2							1.2
Uncultivated Area	km^2							13.5
3. Downstream Area from Sulipan								
Decrease in Inundation Area	km^2	38.6	74.1	108.9	133.6	133.6	-	-
Cultivated Area (rainfed)	km^2	-	16.2	25.5	32.4	32.4	-	-
Potential Area (to be paddy Field)	km^2	22.9	22.9	22.9	22.9	22.9	-	-
Fishpond Area	km^2	15.7	35.0	60.5	78.3	78.3	-	-
Ave. Annual Decrease in Inund. Area	km^2							76.4
Cultivated Area (rainfed)	km^2							15.3
Potential Area (to be Paddy Field)	km^2							22.1
Fishpond Area	km^2							39.0

Table 3.20(3) DECREASE IN INUNDATION AREA WITH FLOOD CONTROL BY RIVER IMPROVEMENT OF PAMPANGA RIVER (Stepwise Plan, Alternative - 3, 1st Phase)

Item	Unit	Return Period (year)						
		1.1	2	5	10	20	50	100
1. North Candaba Swamp								
Maximum Water Level	El.m	4.4	5.8	7.2	7.98	8.34	8.94	9.39
Inundation Area (uncultivated)	km^2	45.5	119.2	157.9	179.3	189.6	207.1	222.3
Decrease in Inundation Area	km^2	15.7	11.0	2.4	-3.6	-	-	-
Ave. Annual Decrease in Inund. Area	km^2							8.6
2. South Candaba Swamp								
Maximum Water Level	El.m	1.7	2.3	2:85	3.16	4.6	6.35	7.54
Inundation Area	km^2	8.3	20.7	37.8	46.5	81.2	109.7	129.1
Paddy Area (irrigated)	km^2	-	-	-	-	-	33.9	53.3
Uncultivated Area	km^2	8.3	20.7	37.8	46.5	81.2	75.8	75.8
Decrease in Inundation Area	km^2	24.8	39.2	53.4	56.4	31.5	12.6	-
Paddy Area (irrigated)	km^2	-	-	15.4	27.1	26.1	12.6	-
Uncultivated Area	km^2	24.8	39.2	38.4	29.3	5.4	-	-
Ave. Annual Decrease in Inund. Area	km^2							35.4
Paddy Area (irrigated)	km^2							4.4
Uncultivated Area	km^2							31.0
3. Downstream Area from Sulipan								
Decrease in Inundation Area	km^2	38.6	74.1	108.9	133.6			
Cultivated Area (rainfed)	km^2	-	16.2	25.5	32.4			
Potential Area (to be paddy Field)	km^2	22.9	22.9	22.9	22.9			
Fishpond Area	km^2	15.7	35.0	60.5	78.3			
Ave. Annual Decrease in Inund. Area	km^2							70.8
Cultivated Area (rainfed)	km^2							13.7
Potential Area (to be Paddy Field)	km^2							21.2
Fishpond Area	km^2							35.9

Table 3.21 SUMMARY OF EVALUATION AND EFFECTS ON FLOOD CONTROL PROJECT (STEPWISE PLAN WITH 20 YEAR DESIGN FLOOD)

Alternative	Construction Cost			Stretch to be Improved		Effect		
	Local Currency (₱10^6)	Foreign Currency (₱10^6)	Total (₱10^6)	Stretch	Length (km)	Decrease in Inund. Area (10^3ha)	Increase of Paddy Prod. (10^3t)	Decrease in Inund. House (nos)
Alternative-1								
First Phase	225.0	191.6	416.6	Candaba-Sulipan	18	4.7	5.0	4,500
Second Phase	188.5	191.8	380.3	Sulipan-Manila Bay	22	14.0	2.9	8,900
Whole	413.5	383.4	796.9	Candaba-Manila Bay	40	18.7	7.9	13,400
Alternative-2								
First Phase	188.5	191.8	380.3	Sulipan-Manila Bay	22	14.4	3.9	8,900
Second Phase	225.0	191.6	416.6	Candaba-Sulipan	18	4.3	4.0	4,500
Whole	413.5	383.4	796.9	Candaba-Manila Bay	40	18.7	7.9	13,400
Alternative-3								
First Phase	240.8	190.6	431.4	Candaba-Manila Bay	40	18.2	5.0	10,400
Second Phase	172.7	192.8	365.5	-do-	40	0.5	2.9	3,000
Whole	413.5	383.4	796.9	-do-	40	18.7	7.9	13,400

Table 3.22 BREAKDOWN OF ENGINEERING COST FOR FLOOD CONTROL PROJECT

(Unit: ₱10³)

Item	Foreign Currency	Local Currency	Total
1. Topographic Survey	-	2,000	2,000
2. Geological Survey	-	500	500
3. Hydraulic Model Test	-	500	500
4. Engineering Consultants	21,770	5,450	27,220
5. Engineering & Administration Expenses	-	14,550	14,550
Total	21,770	23,000	44,770

Table 3.23 RAINFALL DAYS AT APALIT (1975 - 1979)

Year	Month / r^{mm}/day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1975	1-9	5	1	1	3	2	6	8	11	10	9	1	7	
	10-15	-	1	-	-	1	7	-	2	3	-	2	1	
	16-30	-	-	-	-	2	4	2	5	3	5	1	2	
	31-	-	-	1	-	-	1	-	3	1	1	-	2	
	Total	5	2	2	3	5	18	10	21	17	15	4	12	114
1976	1-9	2	1	5	-	9	6	1	8	4	2	2	4	
	10-15	-	-	1	1	2	4	1	4	4	2	1	1	
	16-30	-	-	-	-	1	1	1	1	1	-	-	-	
	31-	-	-	1	-	7	3	3	3	4	-	-	-	
	Total	2	1	7	1	19	14	6	16	17	4	3	5	95
1977	1-9	3	1	1	1	6	7	22	13	18	7	12	1	
	10-15	-	-	-	-	2	2	2	1	5	-	1	-	
	16-30	2	-	-	-	-	1	3	-	3	-	2	-	
	31-	-	-	-	-	-	2	2	6	3	-	1	-	
	Total	5	1	1	1	8	12	29	20	29	7	16	1	130
1978	1-9	1	1	1	1	1	14	17	7	11	7	4	2	
	10-15	-	-	-	-	-	2	3	1	4	3	1	-	
	16-30	-	-	-	-	-	-	3	2	1	2	-	-	
	31-	-	-	-	-	3	-	1	13	2	7	-	-	
	Total	1	1	1	1	4	16	24	23	18	19	5	2	115
1979	1-9	-	1	1	2	15	24	12	9	11	16	2	3	
	10-15	-	-	1	-	3	1	6	1	-	2	-	1	
	16-30	-	-	-	-	1	5	2	2	3	1	-	-	
	31-	-	-	-	-	2	-	1	7	3	2	-	-	
	Total	0	1	2	2	20	30	21	19	17	21	2	3	138

Table 3.24 MONTHLY WAITING DAYS FOR CIVIL WORKS

Year	Month / r mm/day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1975	1-15	2.5	1.0	0.5	1.5	1.5	5.5	4.0	6.5	6.5	4.0	1.5	4.0	
	16-30	-	-	-	-	3.0	6.0	3.0	7.5	4	7.5	1.5	3.0	
	31-	-	-	2.5	-	-	2.5	-	7.5	2.5	2.5	-	5.0	
	Total	2	1	3	2	4	14	7	21	13	14	3	12	96
1976	1-15	1.0	0.5	3.0	0.5	5.5	5	1	6	4	2	1.5	2.5	
	16-30	-	-	-	-	1.5	1.5	1.5	1.5	1.5	-	-	-	
	31-	-	-	2.5	-	17.5	7.5	7.5	7.5	10.0	-	-	-	
	Total	1	1	5	1	24	14	10	15	15	2	1	3	92
1977	1-15	1.5	0.5	0.5	0.5	4.0	4.5	14.0	17.0	11.0	3.5	6.5	0.5	
	16-30	1.5	-	-	-	-	1.5	4.5	-	4.5	-	3.0	-	
	31-	-	-	-	-	-	5.0	5.0	15.0	7.5	-	2.5	-	
	Total	3	0	1	0	4	11	29	22	23	4	12	1	110
1978	1-15	0.5	0.5	0.5	0.5	0.5	8.0	10.0	1.5	5.5	5.5	2.5	1.0	
	16-30	-	-	-	-	1.5	-	4.5	4.0	1.5	3.0	-	-	
	31-	-	-	-	-	7.5	-	2.5	26.0	5.0	17.5	-	-	
	Total	1	0	1	0	9	8	17	30	12	25	3	1	107
1979	1-15	4.0	0.5	1.0	1.0	9.0	12.0	9.0	5.0	5.5	4.0	1.0	2.0	
	16-30	-	-	-	-	1.5	7.5	3.0	3.0	4.5	1.5	-	-	
	31-	-	-	-	-	5.0	-	2.5	17.5	7.5	5.0	-	-	
	Total	4	1	1	1	16	19	15	25	17	11	1	2	113

Table 3.25 SUNDAY AND HOLIDAYS IN PAST 3 YEARS AND ESTIMATED WORKABLE DAYS

Sundays & Holidays

(Unit: day)

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
1979	5	4	4	7	5	5	6	4	5	4	5	7	61
1980	5	4	5	7	5	6	5	5	4	4	5	7	62
1981	5	4	5	6	7	5	5	5	6	4	7	7	66

Estimated Workable Days

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
Waiting days	1	1	2	1	11	13	16	23	16	11	4	4	103
Sunday and Holidays	5	4	5	7	6	6	5	5	5	4	6	7	65
Non-work days	6	5	7	8	17	19	21	28	21	15	10	11	168
Workable days	25	23	24	22	14	11	10	3	9	16	20	20	197

Table 3.26 HOURLY PRODUCTION OF CONSTRUCTION EQUIPMENT

Equipment			Hourly Production
Bulldozer	20 t class	D = 20 m	45 m^3
Bulldozer	20 t class	D = 50 m	40 m^3
Bulldozer	11 t class	D = 50 m	28 m^3
Bulldozer	7 t class	D = 20 m	24 m^3
Backhoe	0.6 m^3		24 m^3
Dragline	0.6 m^3		24 m^3
Dumptruck	6 t class	D = 500 m	18 m^3
		D = 1.0 km	12 m^3
		D = 3.0 km	8 m^3
Dumptruck	8 t class	D = 500 m	24 m^3
		D = 1.0 km	18 m^3
		D = 3.0 km	12 m^3
Vibration Roller	1 t		10 m^3
Vibration Roller	2.5 t		30 m^3
Vibration Plate Compactor			2.5 m^3
Concrete Mixer		(0.4 m^3)	14 m^3

Table 3.27 REQUIRED CONSTRUCTION EQUIPMENT

Equipment	Capacity	Required Nos.
Dredger	PS 800 with discharge pipe 8 km	4
Anchor Barge	-	2
Tag Boat	-	4
Bulldozer, swamp	20 t class	22
-do-	15 t class	5
-do-	7 t class	10
Backhoe (with attachment)	0.6 m^3	12
Amphibious Excavator	0.4 m^3	4
Dumptruck	8 t	28
Vibration Roller	2.5 t	10
-do-	1 t	30
Vibration Plate Compactor	80 kg	20
Concrete Mixer	0.4 m^3	4
Ordinary Truck	4 t	4
Truck Crane	20 t	1
Service Car		6
Submergible Pump	ø150 mm	20
Diesel Generator	100 kVA	4

Fig. 2.1 LOCATION MAP OF RIVER CROSS-SECTION FOR SURVEY

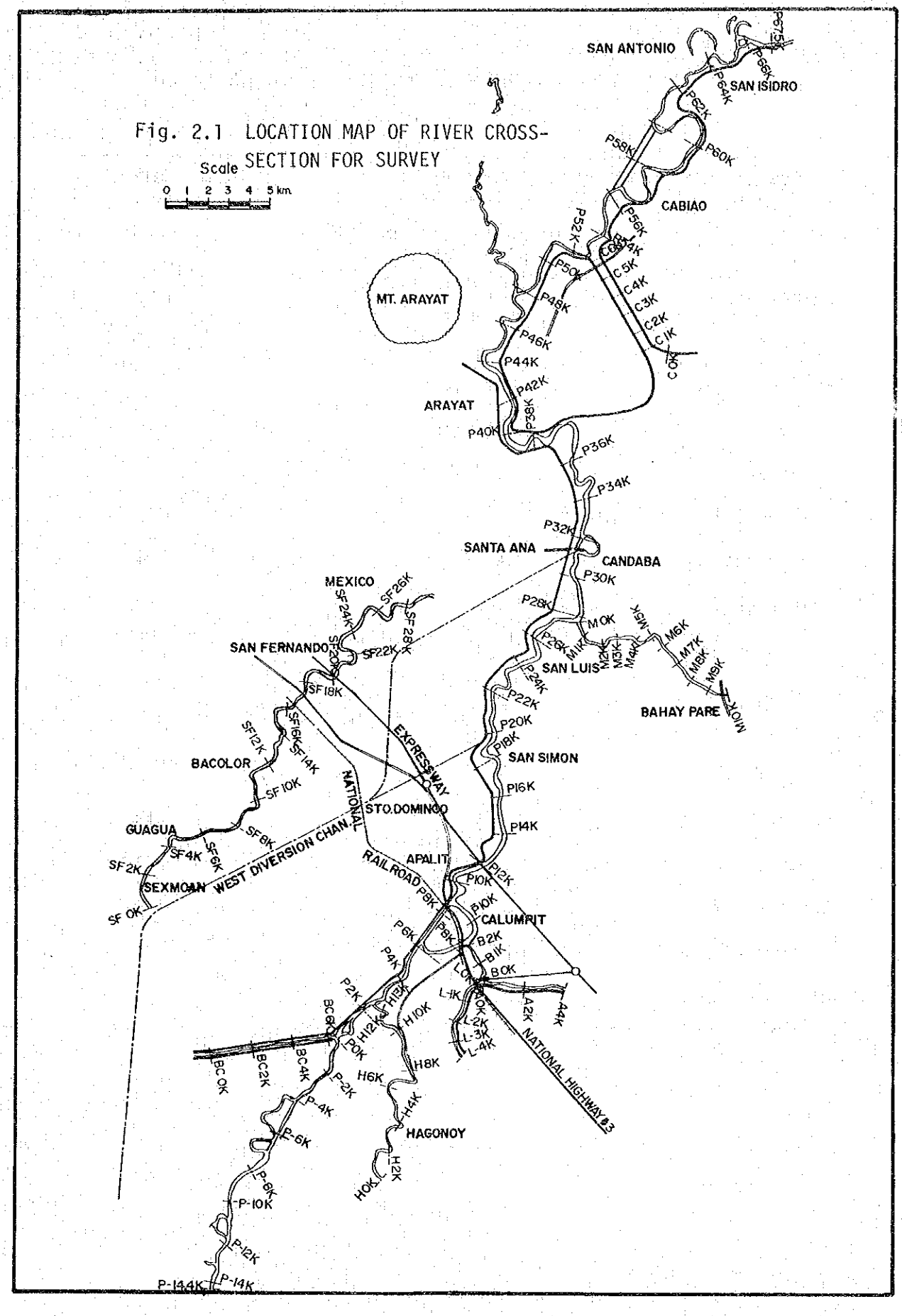
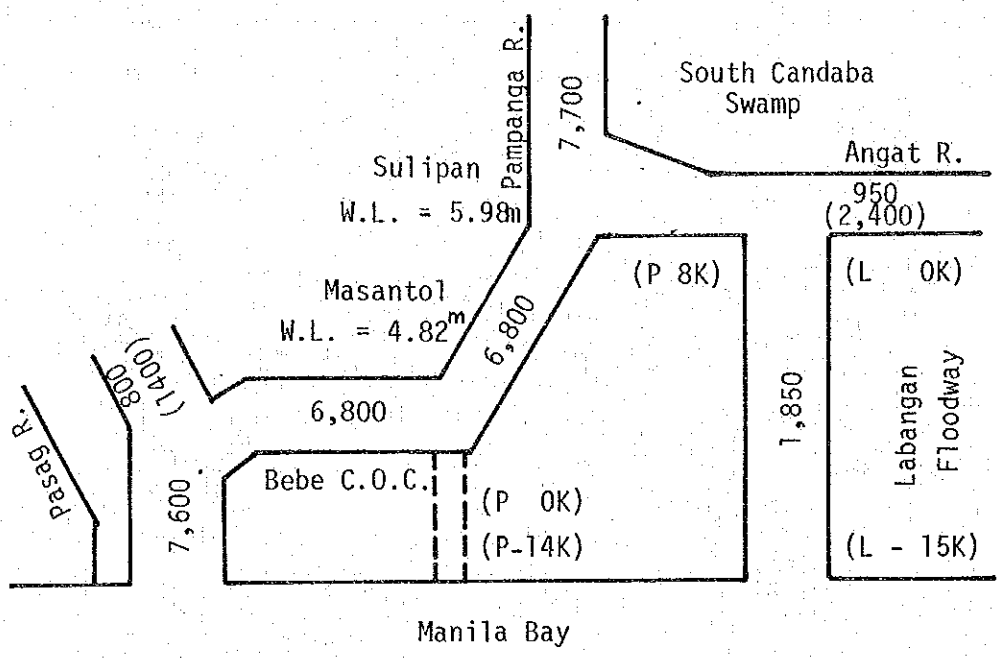


Fig. 2.2 DESIGN FLOOD DISCHARGE DISTRIBUTION ON DOWNSTREAM
(Plan with 100-yr. Flood Discharge)

(Unit: m^3/sec)

Method-1 : Pampanga R. (P-14K - P 0K) ------ Closing at Diversion
: Bebe C.O.C. ---------- Widening and Excavating



Method-2 : Pampanga R. (P-14K - P 0K) -------- Widening and Excavation
: Bebe C.O.C. ---------- Heightening

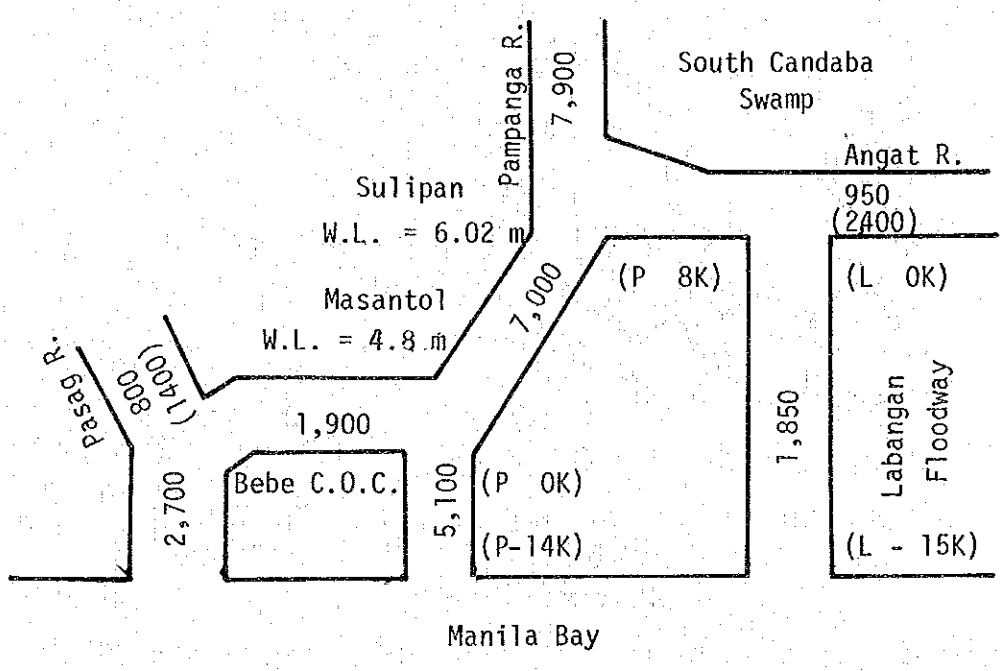


Fig. 2.3 PLANNED RIVER CHANNEL ALIGNMENT OF METHOD 1 AND METHOD 2

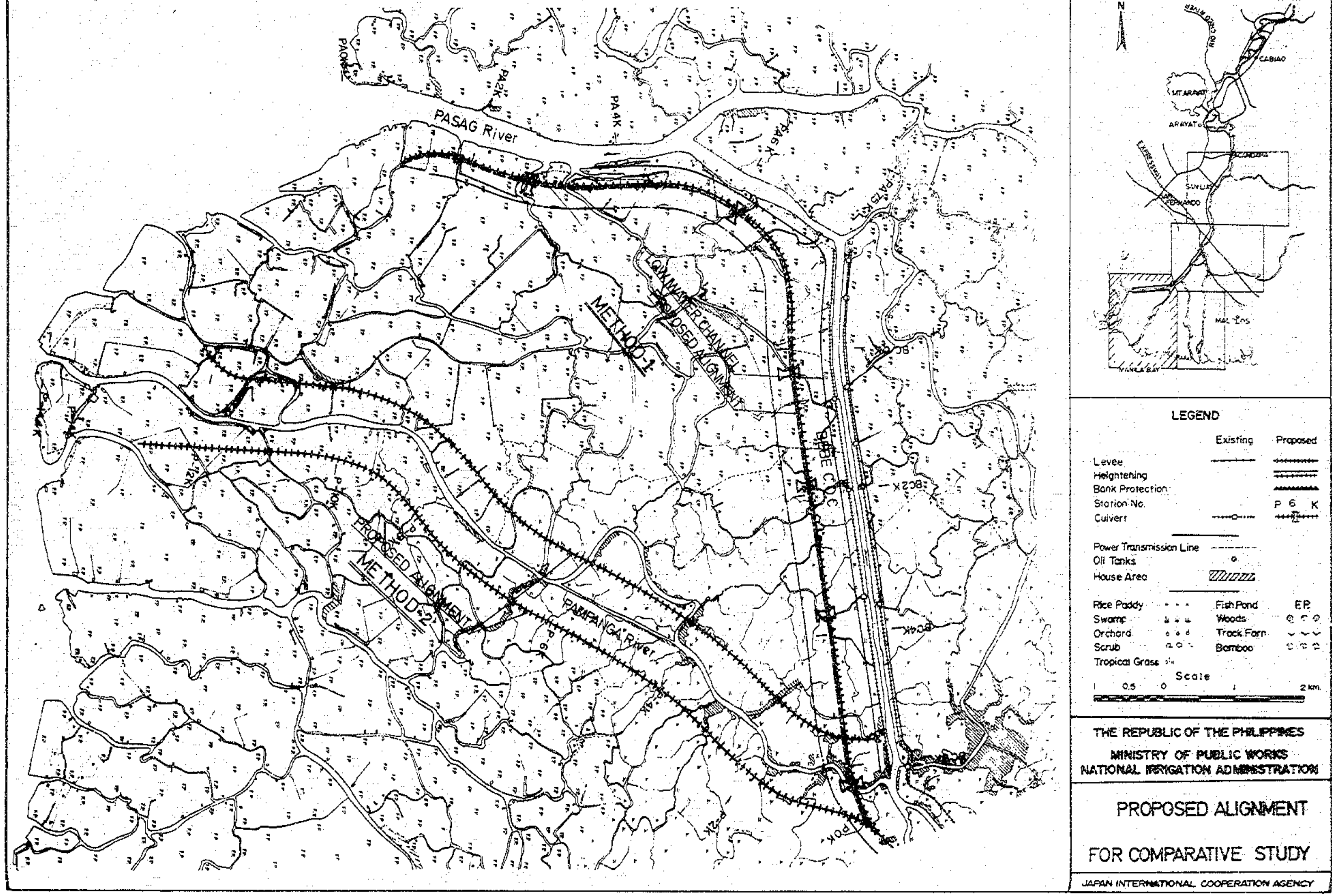
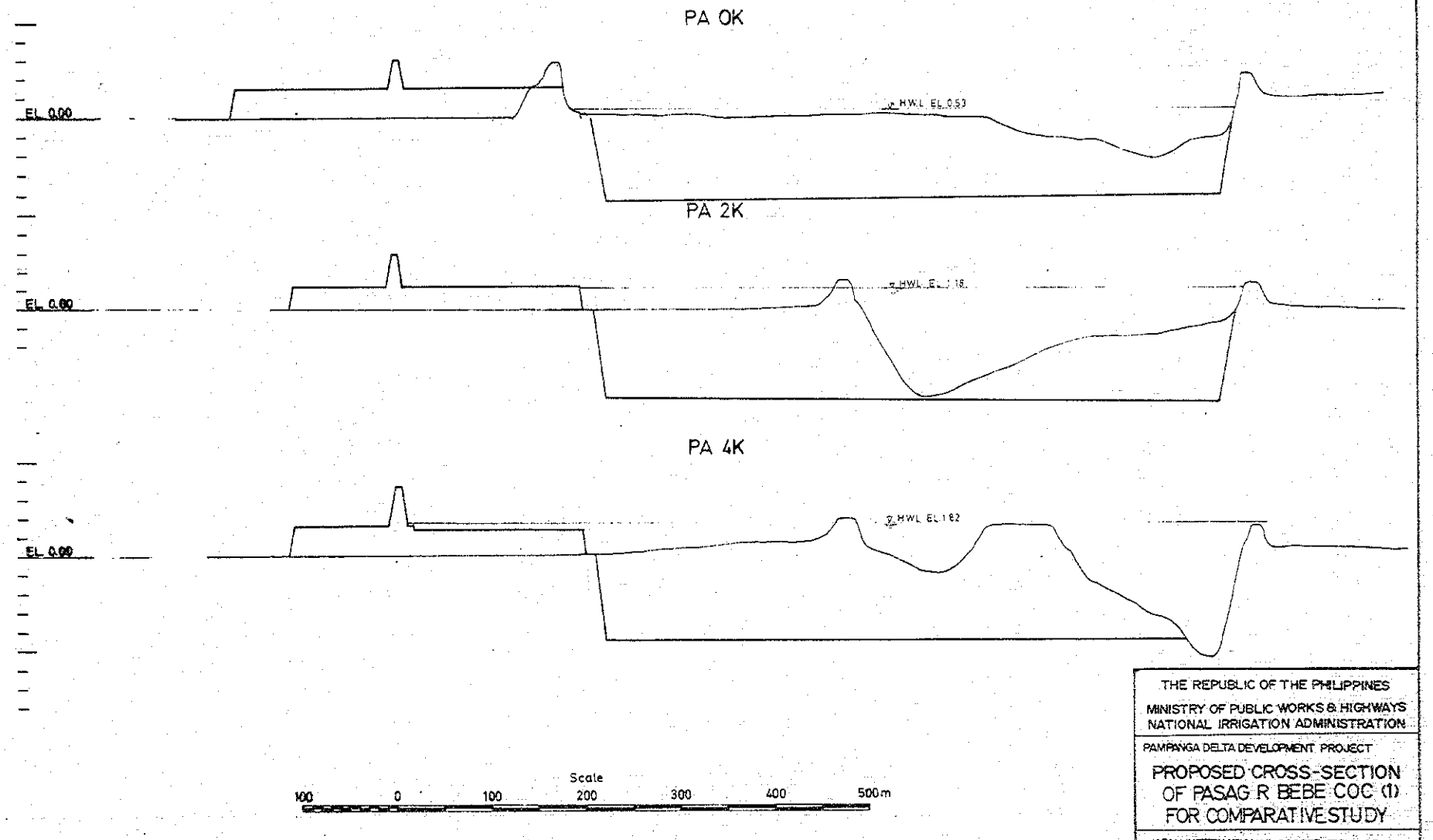


Fig. 2.4(1) PLANNED CROSS-SECTION OF METHOD-I



THE REPUBLIC OF THE PHILIPPINES
MINISTRY OF PUBLIC WORKS & HIGHWAYS
NATIONAL IRRIGATION ADMINISTRATION
PAMPANGA DELTA DEVELOPMENT PROJECT
PROPOSED CROSS-SECTION OF PASAG R BEBE COC (1) FOR COMPARATIVE STUDY
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 2.4(2) PLANNED CROSS-SECTION OF METHOD-I

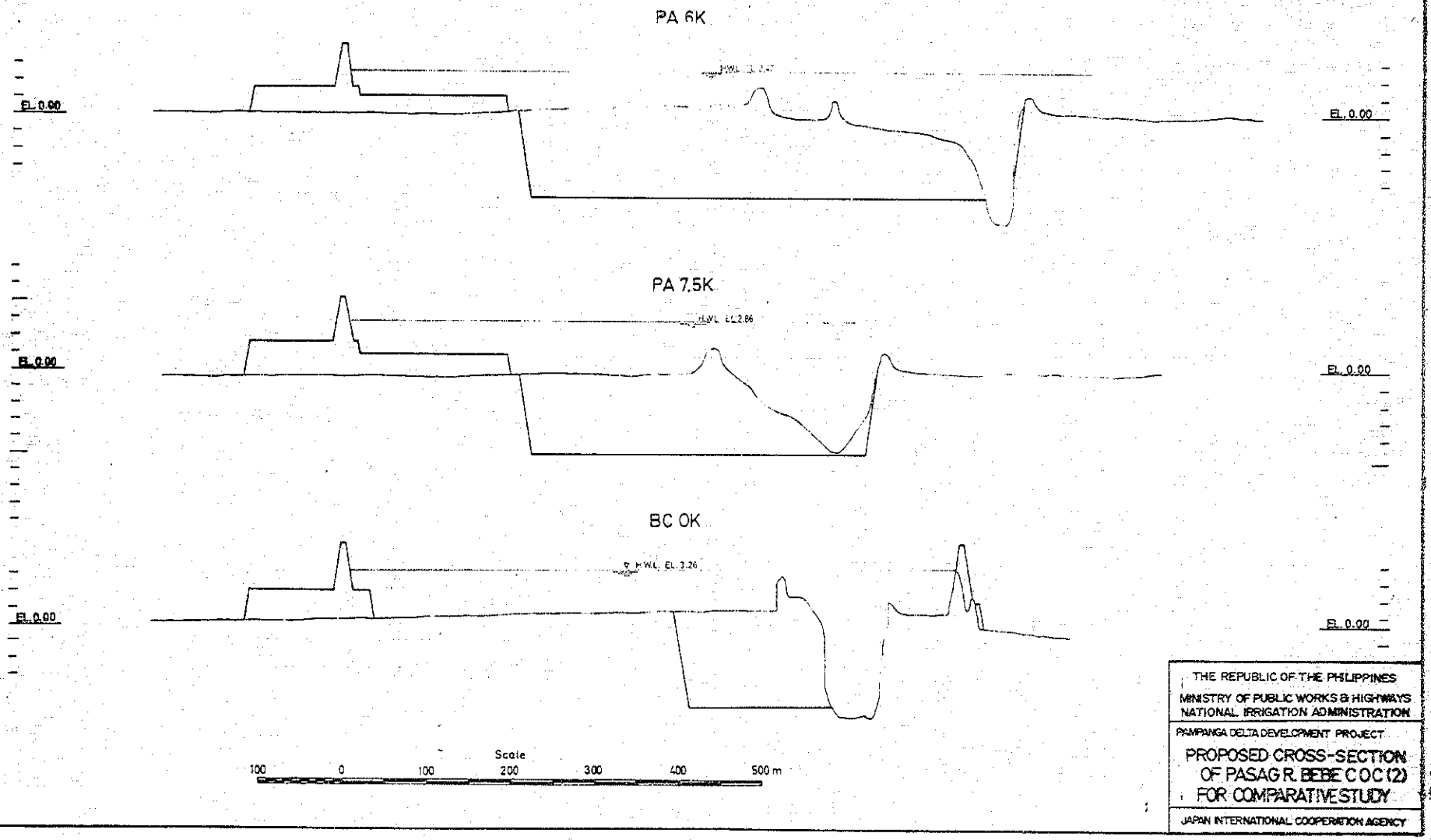


Fig. 2.4(3) PLANNED CROSS-SECTION OF METHOD-I

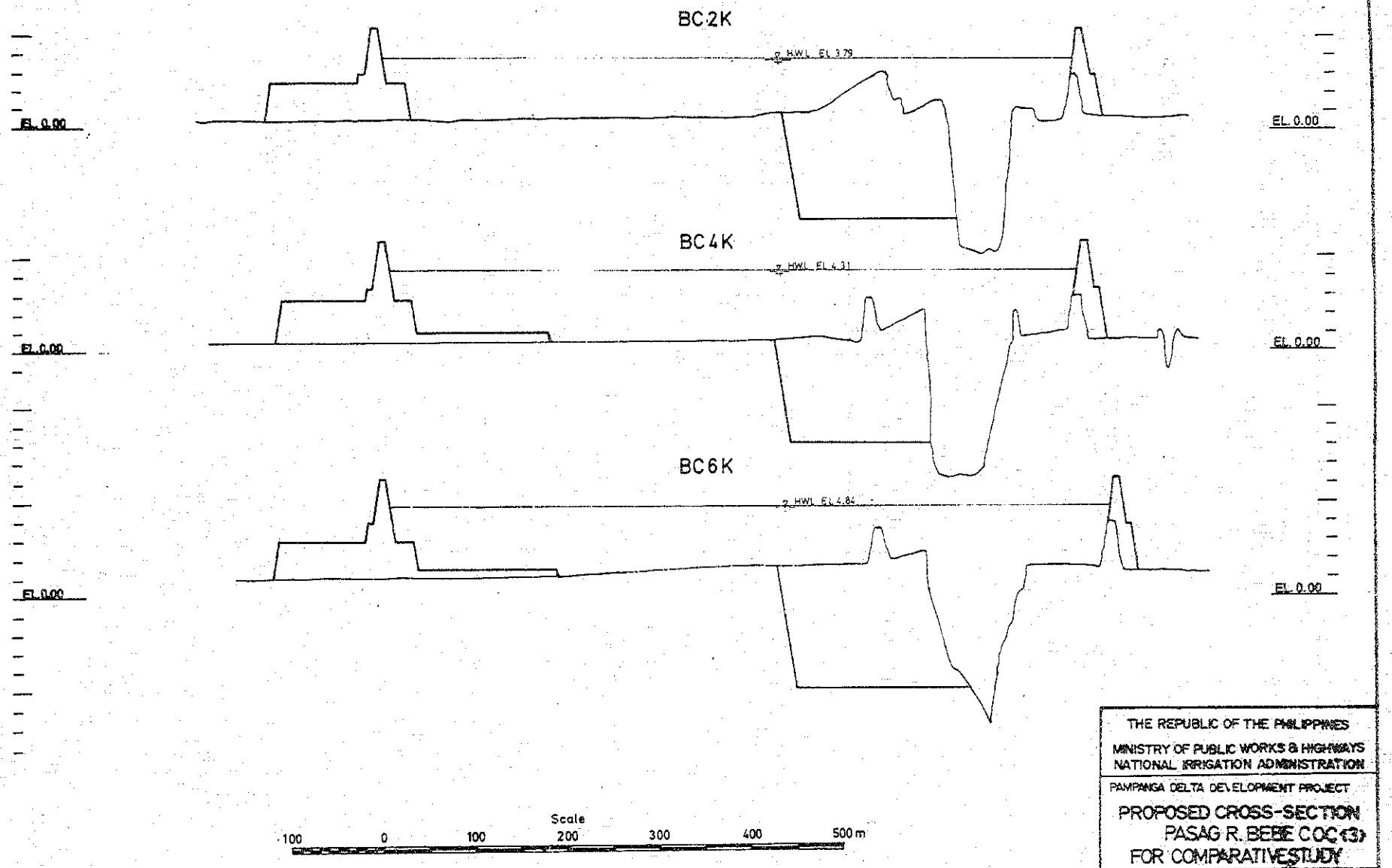


Fig. 2.5 FLOOD DISCHARGE DISTRIBUTION UNDER PRESENT CONDITION
(100 year RETURN PERIOD)

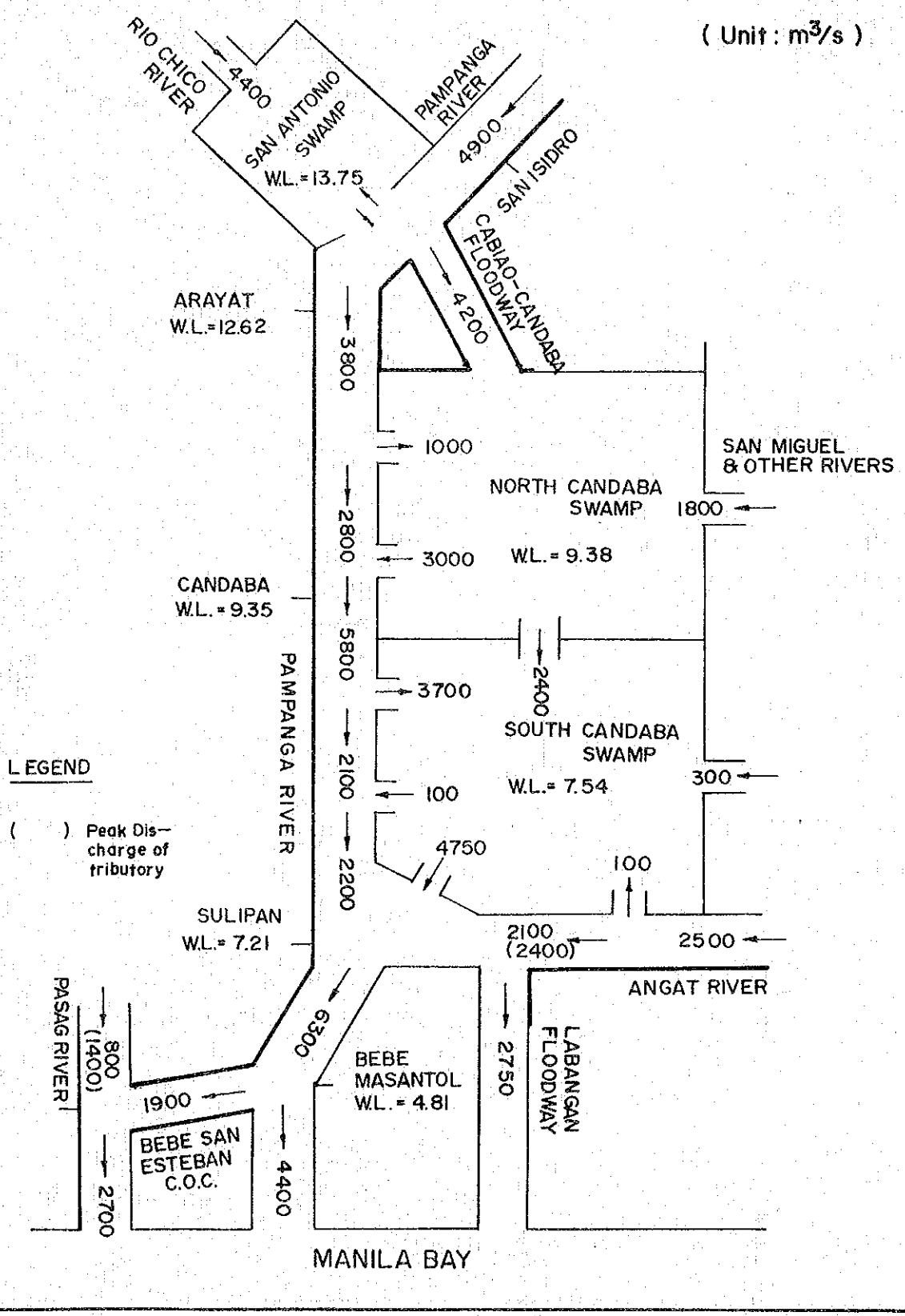


Fig. 2.6 FLOOD DISCHARGE DISTRIBUTION FOR BASIC PLAN
(Plan with 100-yr. Design Flood)

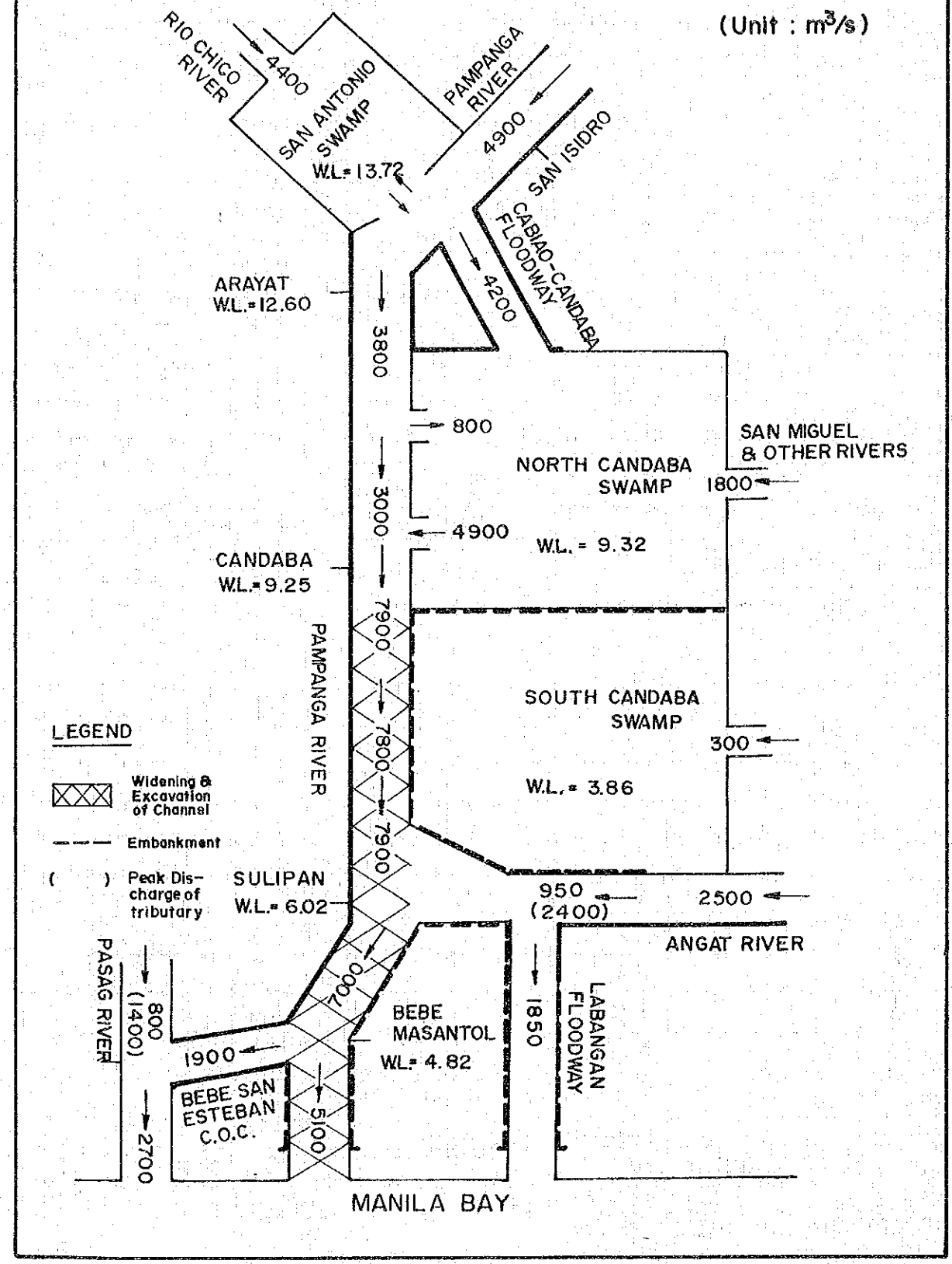


Fig. 2.7(1) PROPOSED LONGITUDINAL PROFILE FOR BASIC PLAN

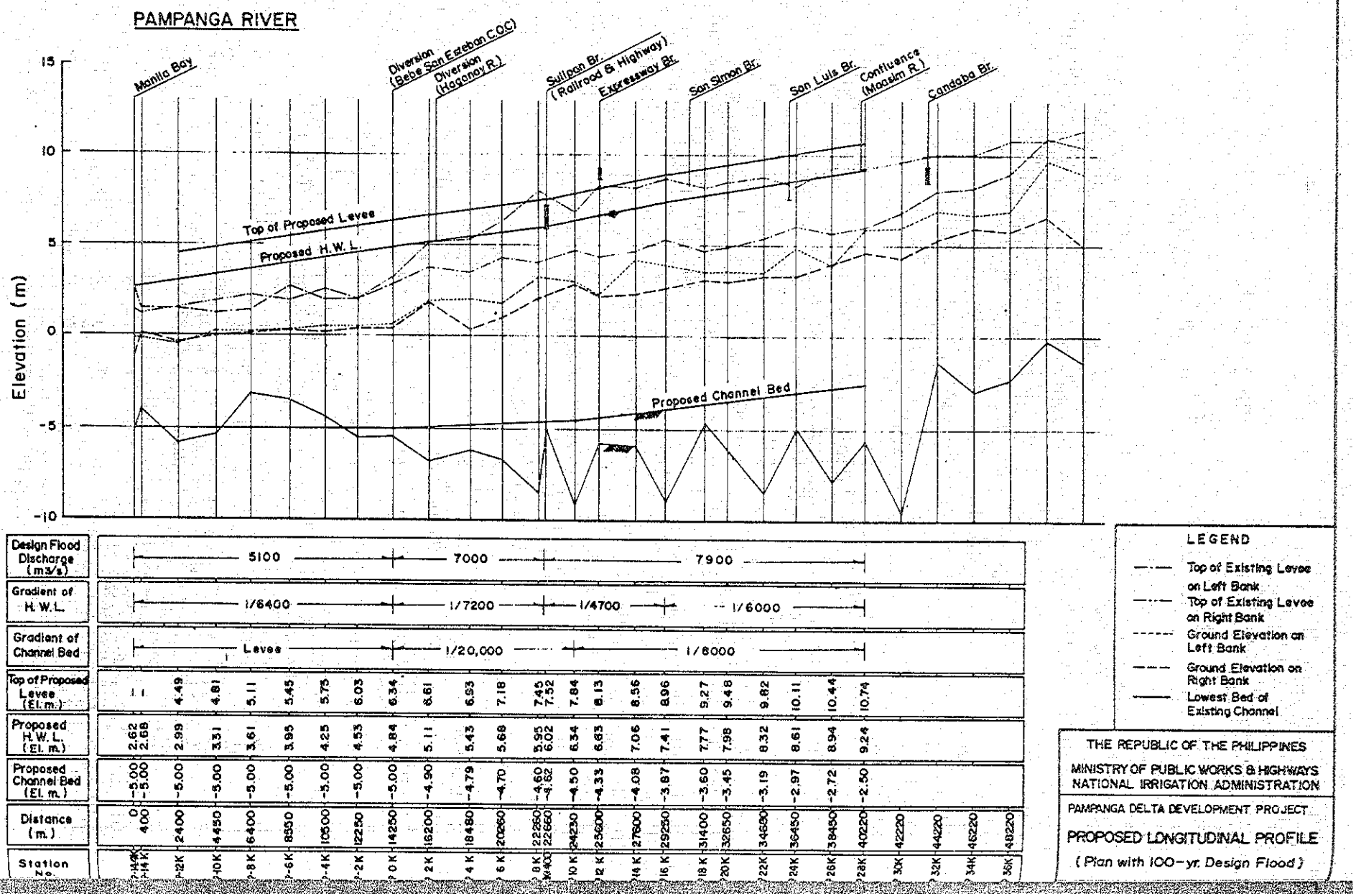


Fig. 2.7(2) PROPOSED LONGITUDINAL PROFILE FOR BASIC PLAN

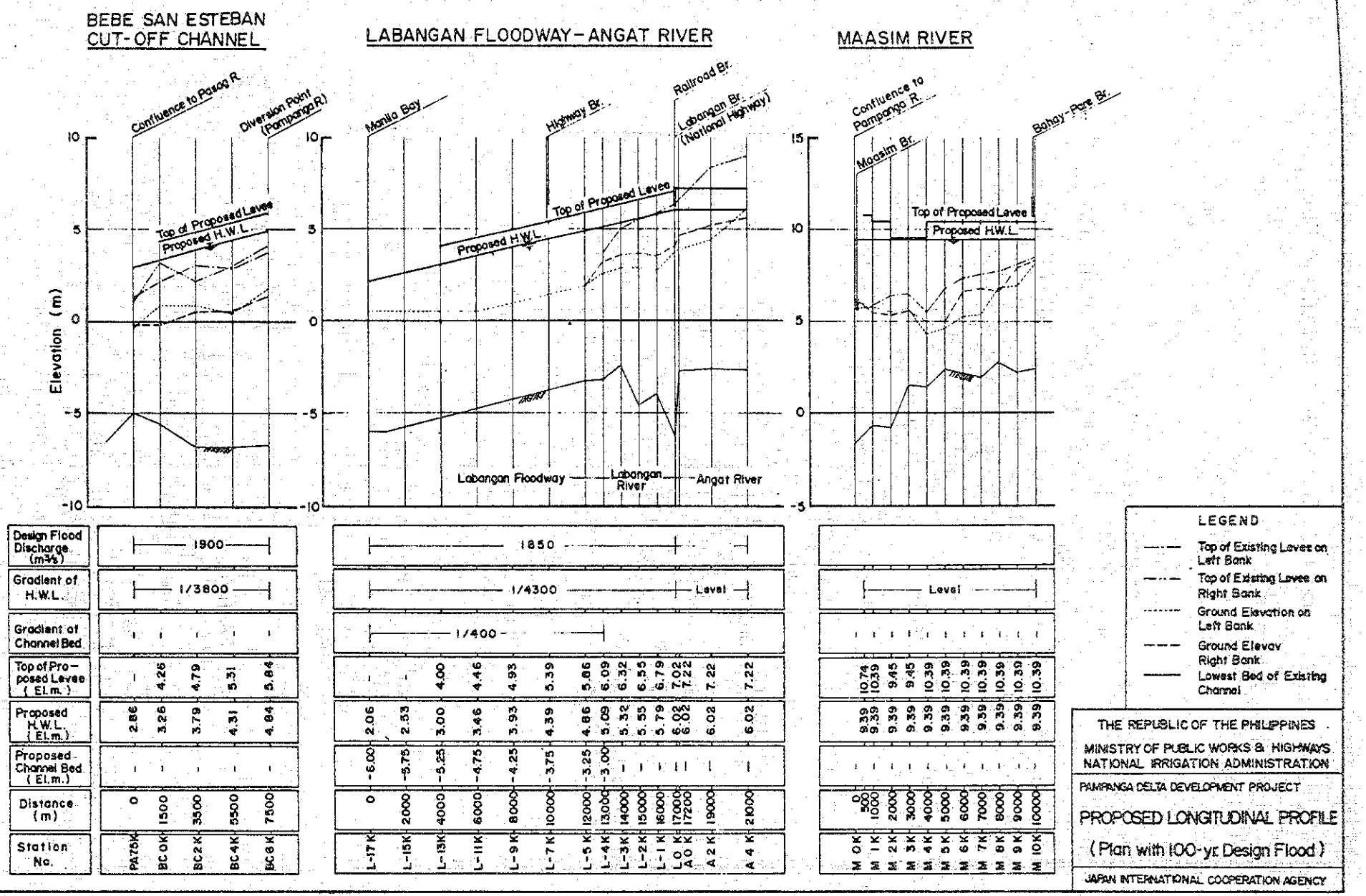


Fig. 2.8 NET WORK OF HYDRAULIC SIMULATION MODEL

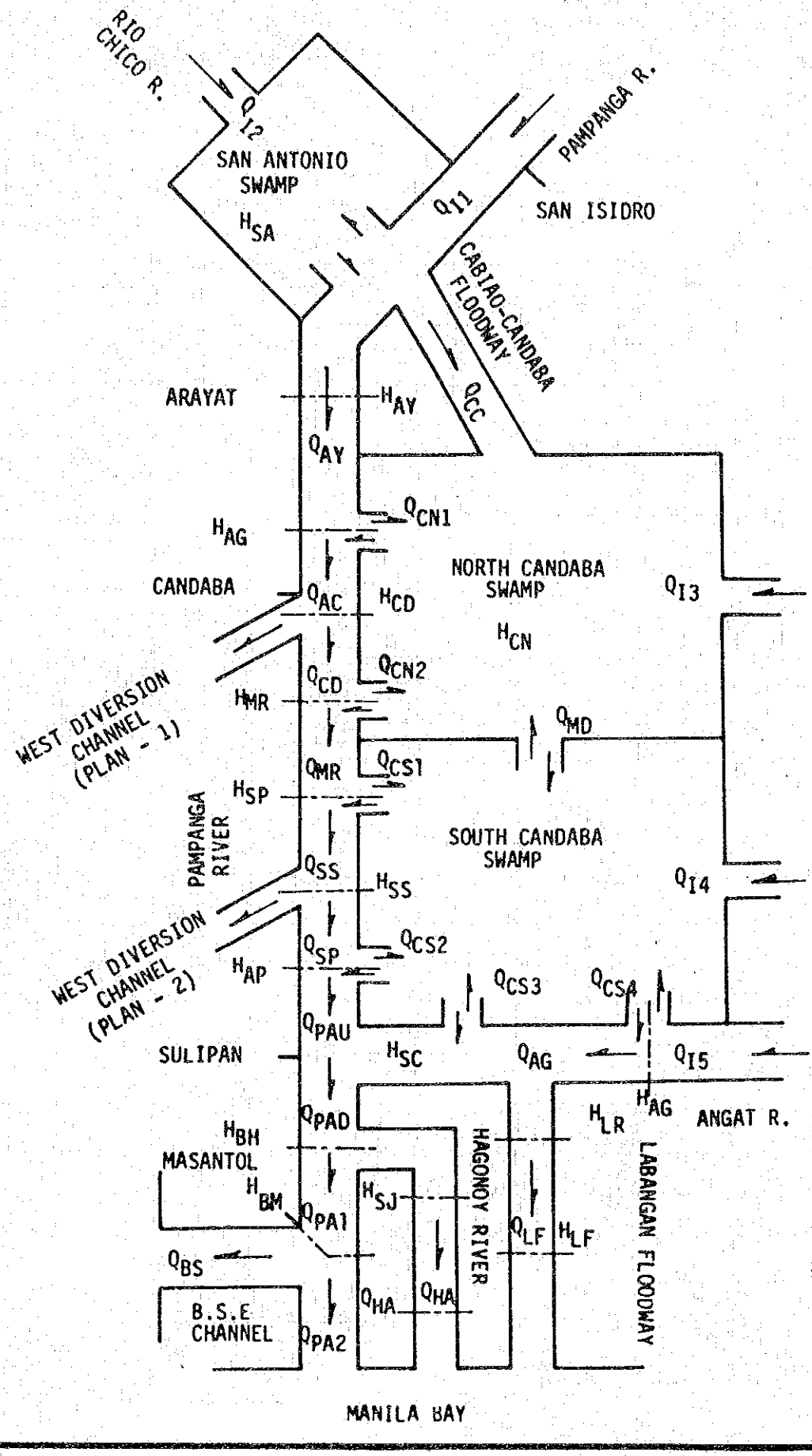


Fig. 3.1 FLOOD DISCHARGE DISTRIBUTION UNDER PRESENT CONDITION
(20 year RETURN PERIOD)

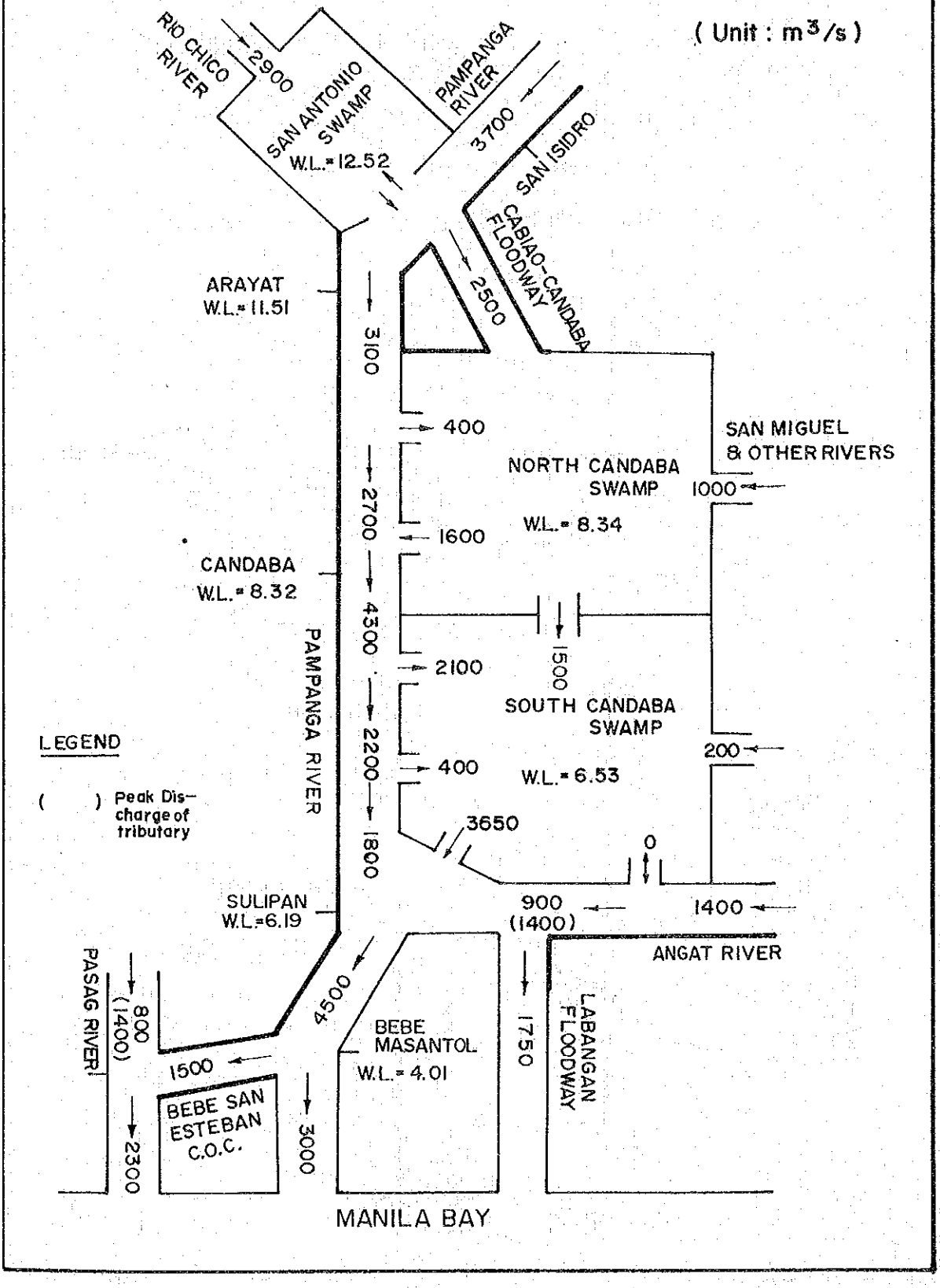


Fig. 3.2 FLOOD DISCHARGE DISTRIBUTION FOR STEPWISE PLAN
(Plan with 20-yr. Design Flood)

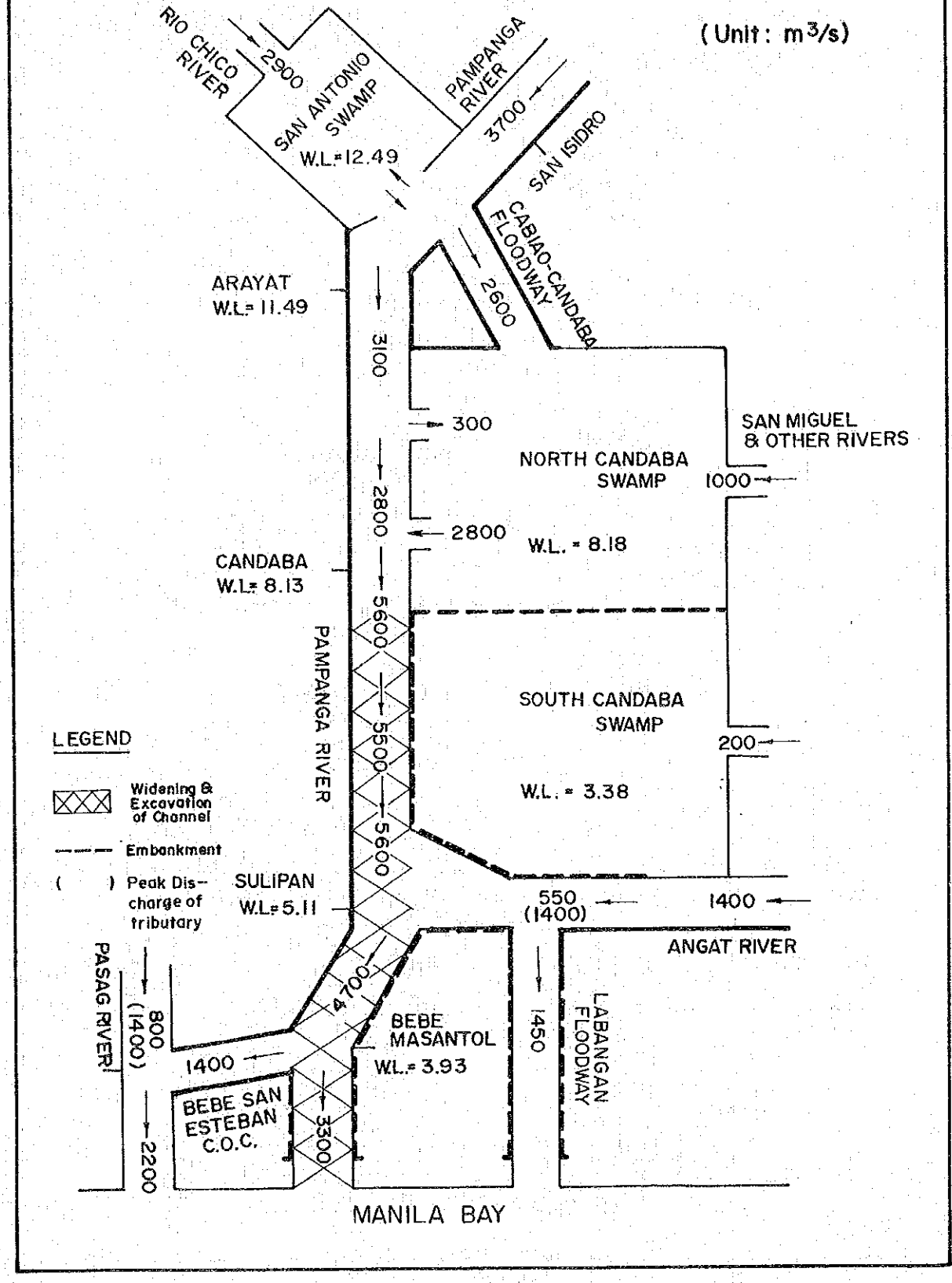


Fig. 3.3 TYPICAL CROSS-SECTION FOR PROPOSED LEVEE

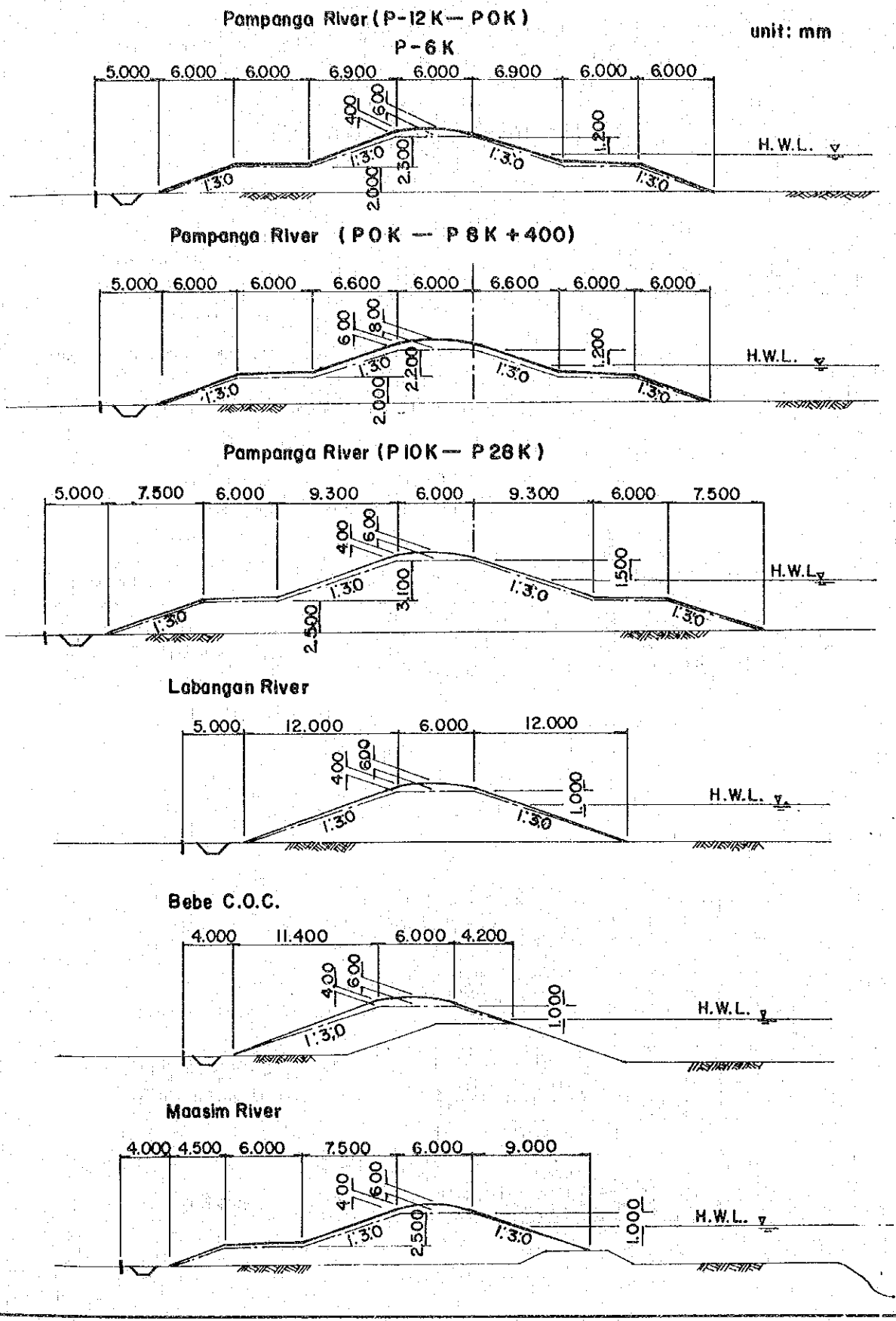
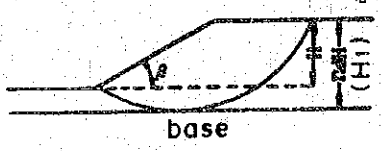


Fig. 3.4 STABILITY OF SLOPE

Explanation



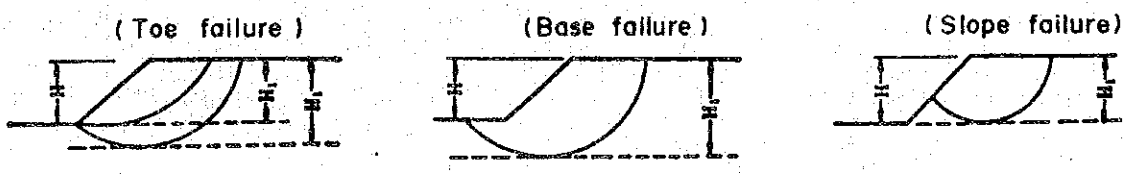
β : Angle of slope

H : Height of banking

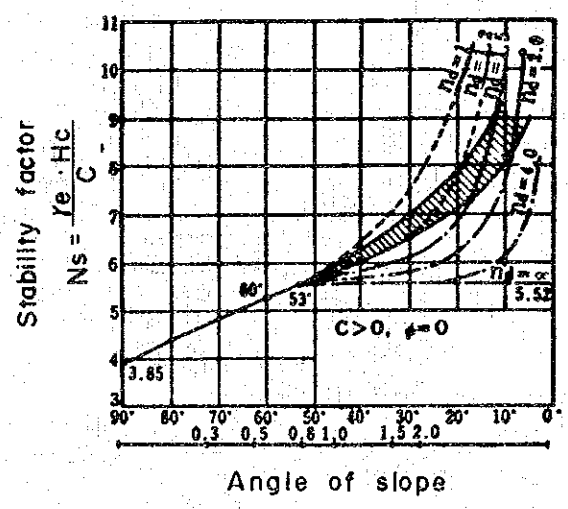
H_1 : Height from top of banking to base

nd : Depth factor (H_1/H)

Type of slope Failure



Taylor's Diagram



Logend

Ns : Safety factor

γe : Effective unit weight of bank material

Hc : Critical height

C : Cohesion

Fig. 3.5 SEEPAGE LINE THROUGH LEVEE

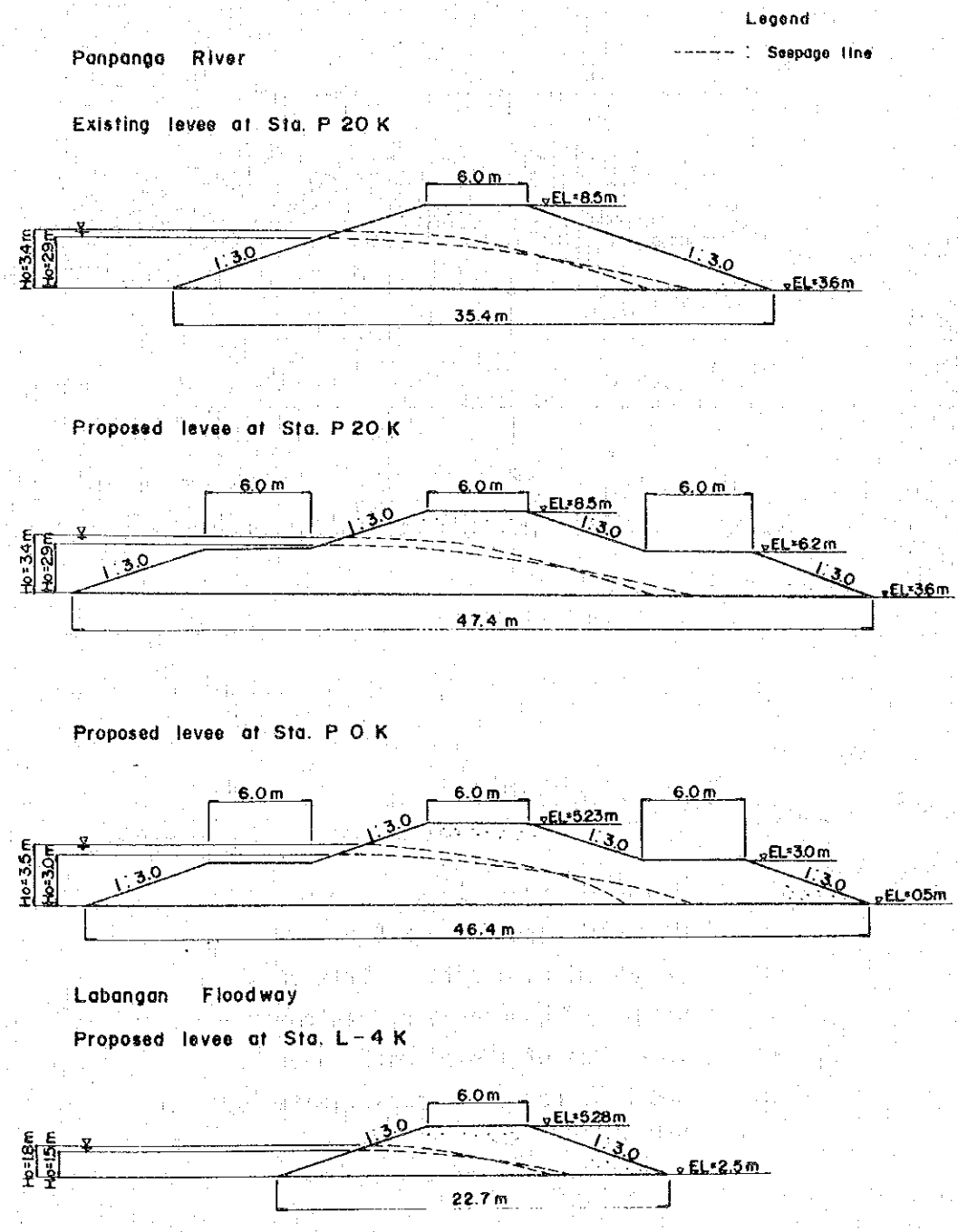
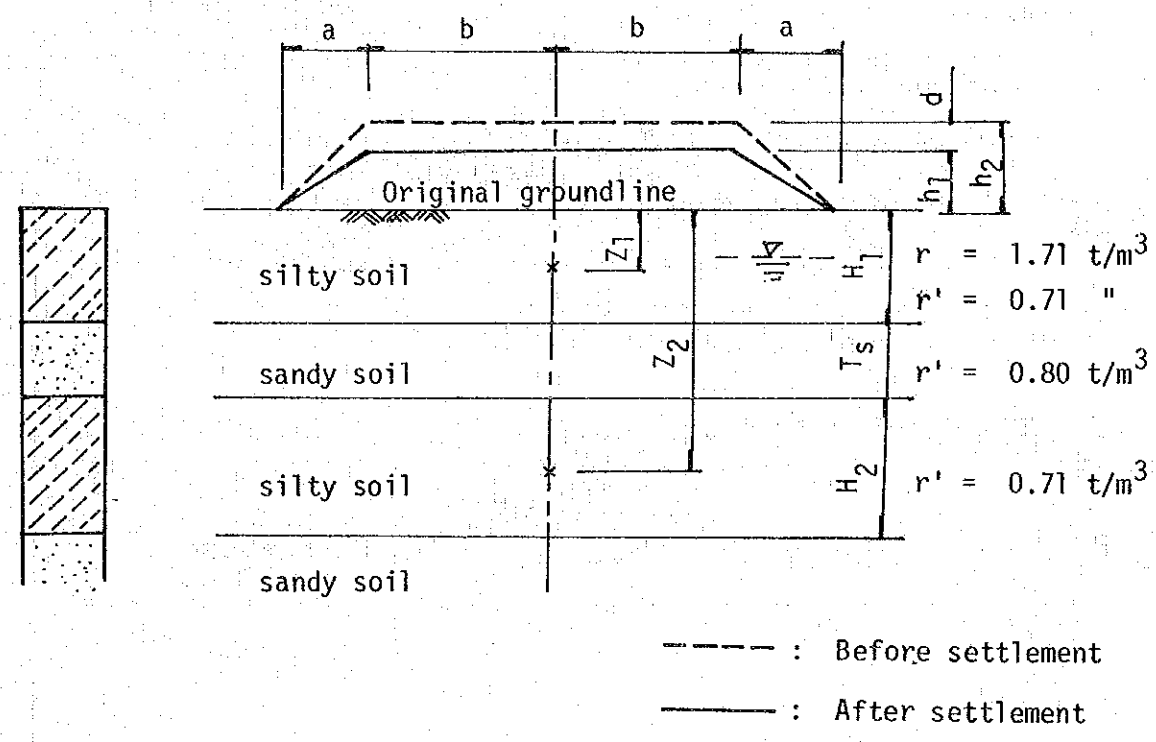


Fig. 3.6 TYPICAL FOUNDATION LAYER



where

a : Width of Levee slope

b : Width of Base Mound x 0.5

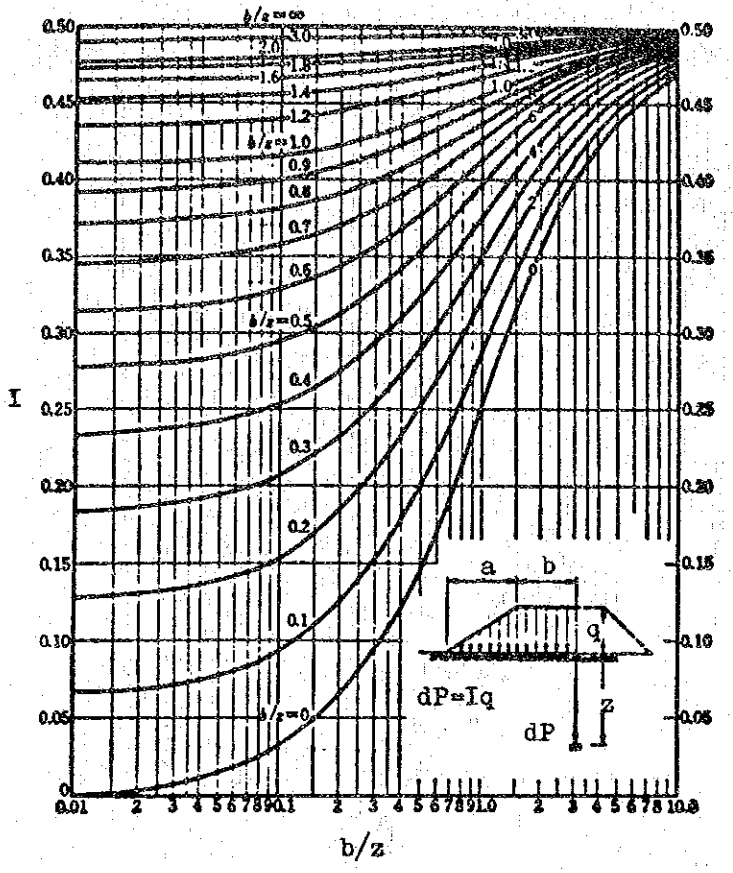
h_1 : Height of Bank after settlement

h_2 : Height of Bank before settlement

H_1, H_2 : Thickness of consolidate layer

Z_1, Z_2 : Depth of center of consolidate layer from groundline

Fig. 3.7 Influence Value by Osterberg



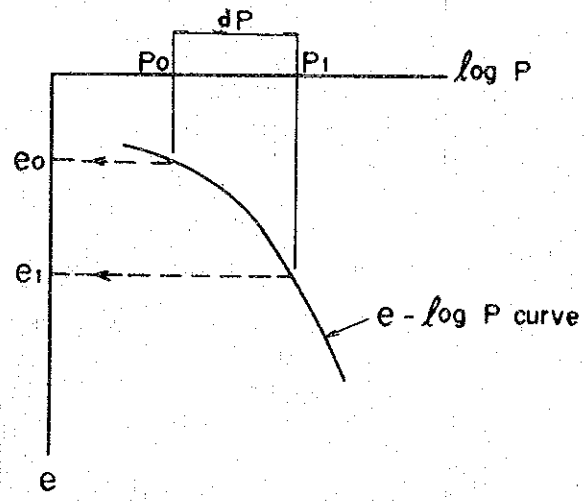
Notes

Po : Stress before loading
($P_o = \Sigma \gamma_s \cdot h$)

P1 : Stress after loading

$$\left(\begin{array}{l} P_1 = P_o + dP \\ dP = I \cdot q \\ q = h \cdot \gamma_s \end{array} \right)$$

e - log P Curve



eo : Void ratio before loading

e1 : Void ratio after loading

Fig 3.8 CROSS- SECTION of REVETMENT

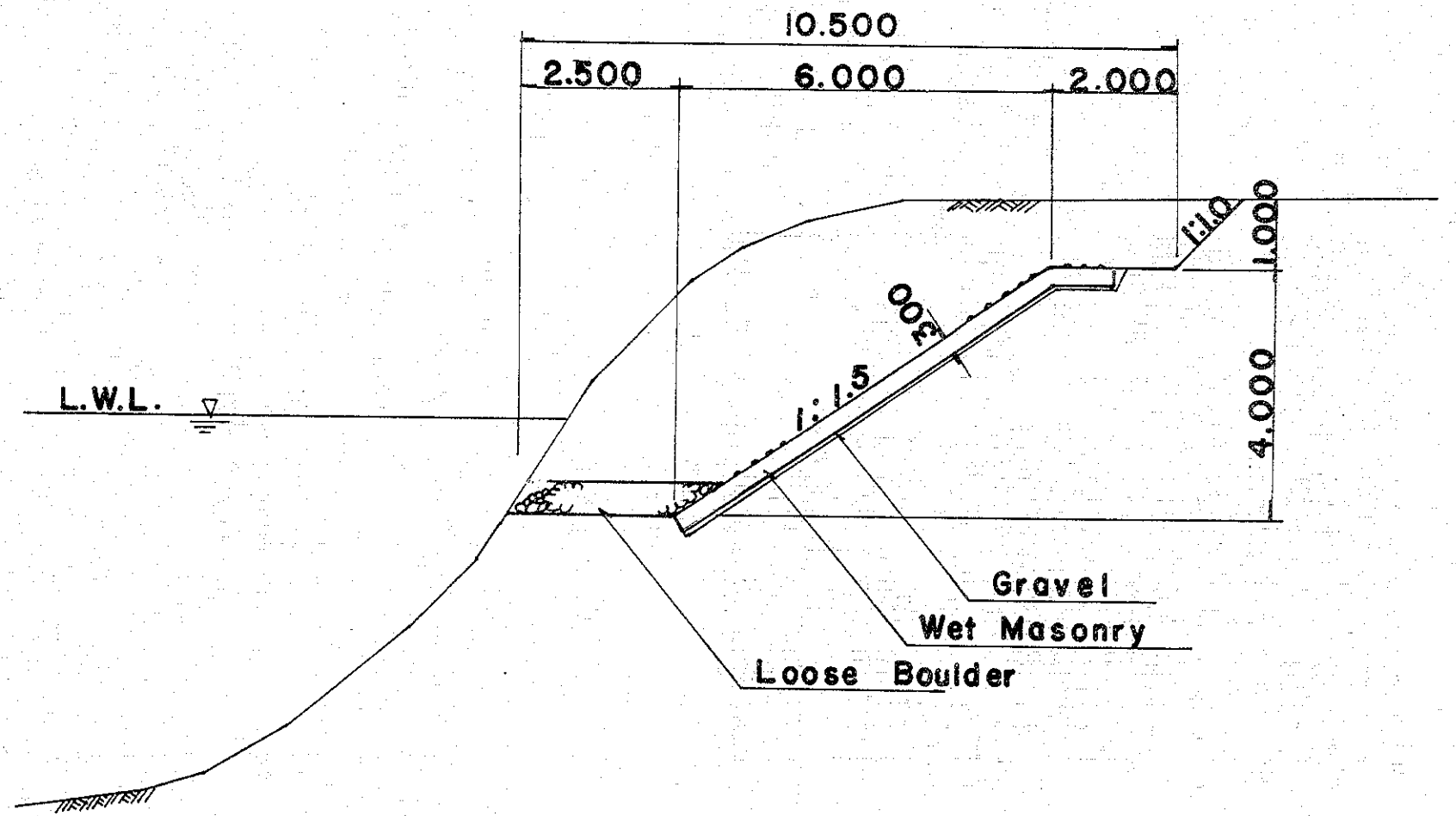
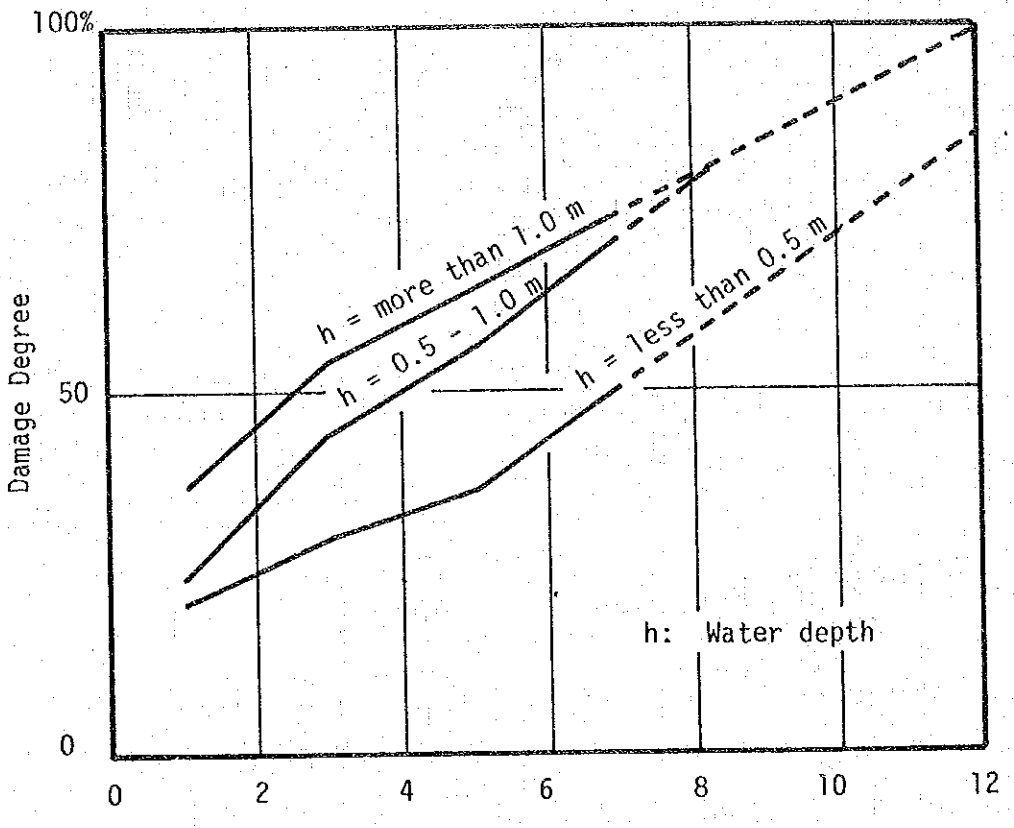


Fig. 3.9 RATE OF DECREASE IN YIELD OF PADDY DUE TO SUBMERGENCE



(Unit:%)

Submerged duration (day)	Water depth		
	less than 0.5 m	0.5 - 0.9 m	more than 1.0 m
1 - 2	21	24	37
3 - 4	30	44	54
5 - 6	36	56	64
more than 7	50	71	74

Data Source: Appendix: Investigation, Technical Standard for River and Erosion Control Engineering, Ministry of Construction, Japan.

Fig. 3.10 TYPICAL CROSS-SECTION (PLAN WITH 10-yr. Design Flood)

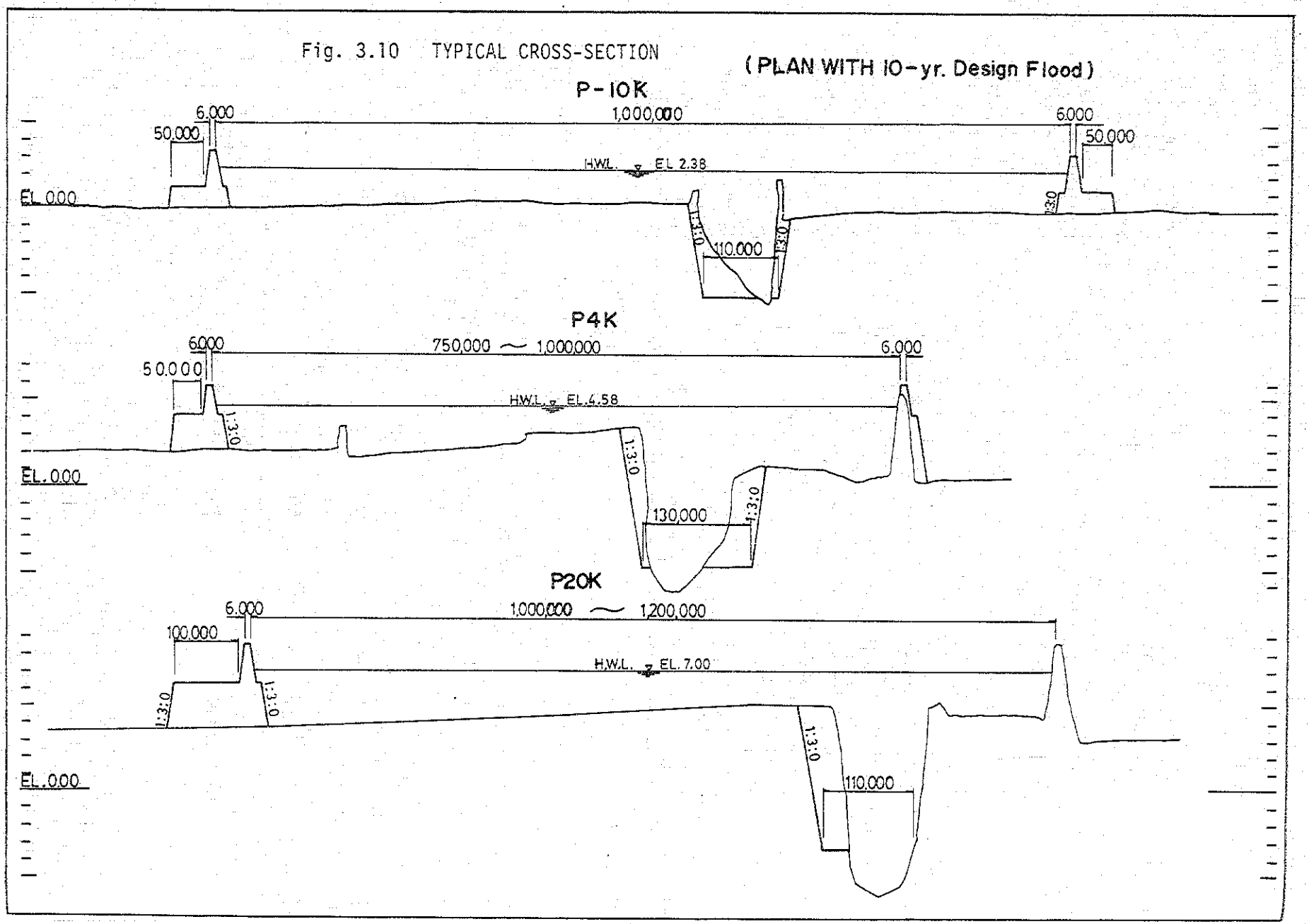


Fig. 3.11(1) FLOOD DISCHARGE DISTRIBUTION
(Plan with 20-yr. Design Flood, First Phase Alternative 1)

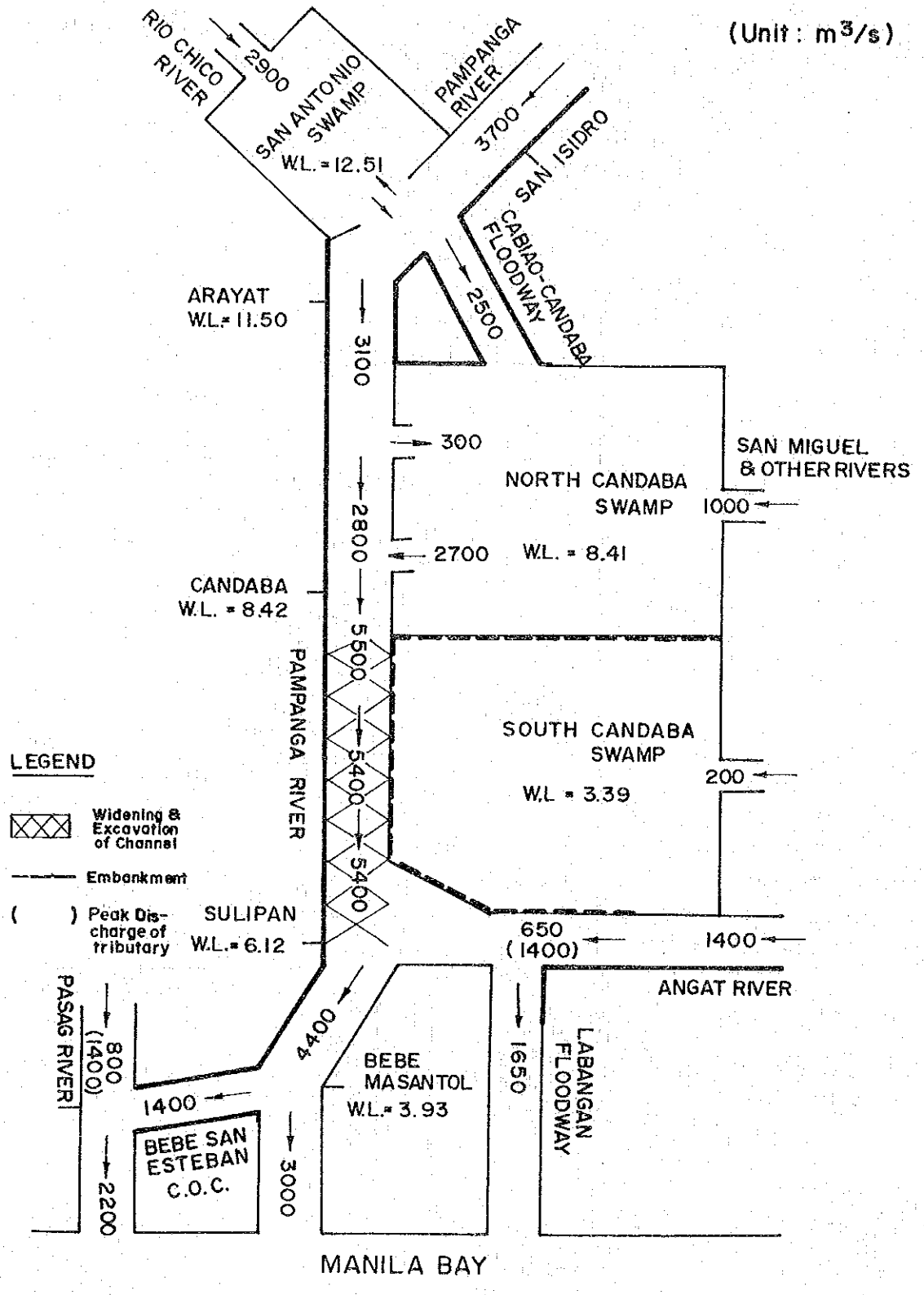


Fig. 3.11(2) FLOOD DISCHARGE DISTRIBUTION
(Plan with 20-yr. Design Flood, First Phase Alternative 2)

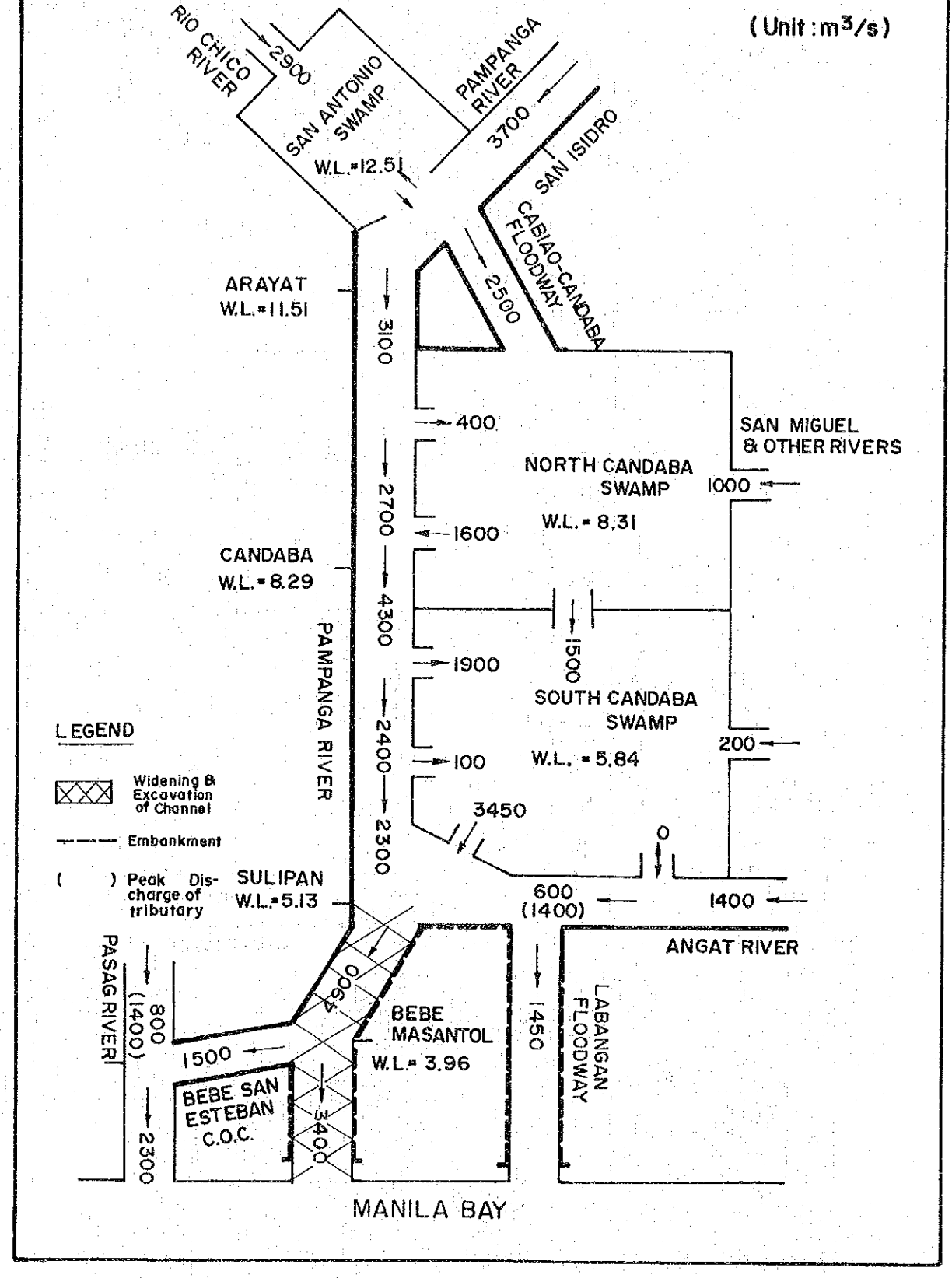


Fig. 3.11(3) FLOOD DISCHARGE DISTRIBUTION
(Plan with 10-yr. Design Flood, First Phase Alternative 3)

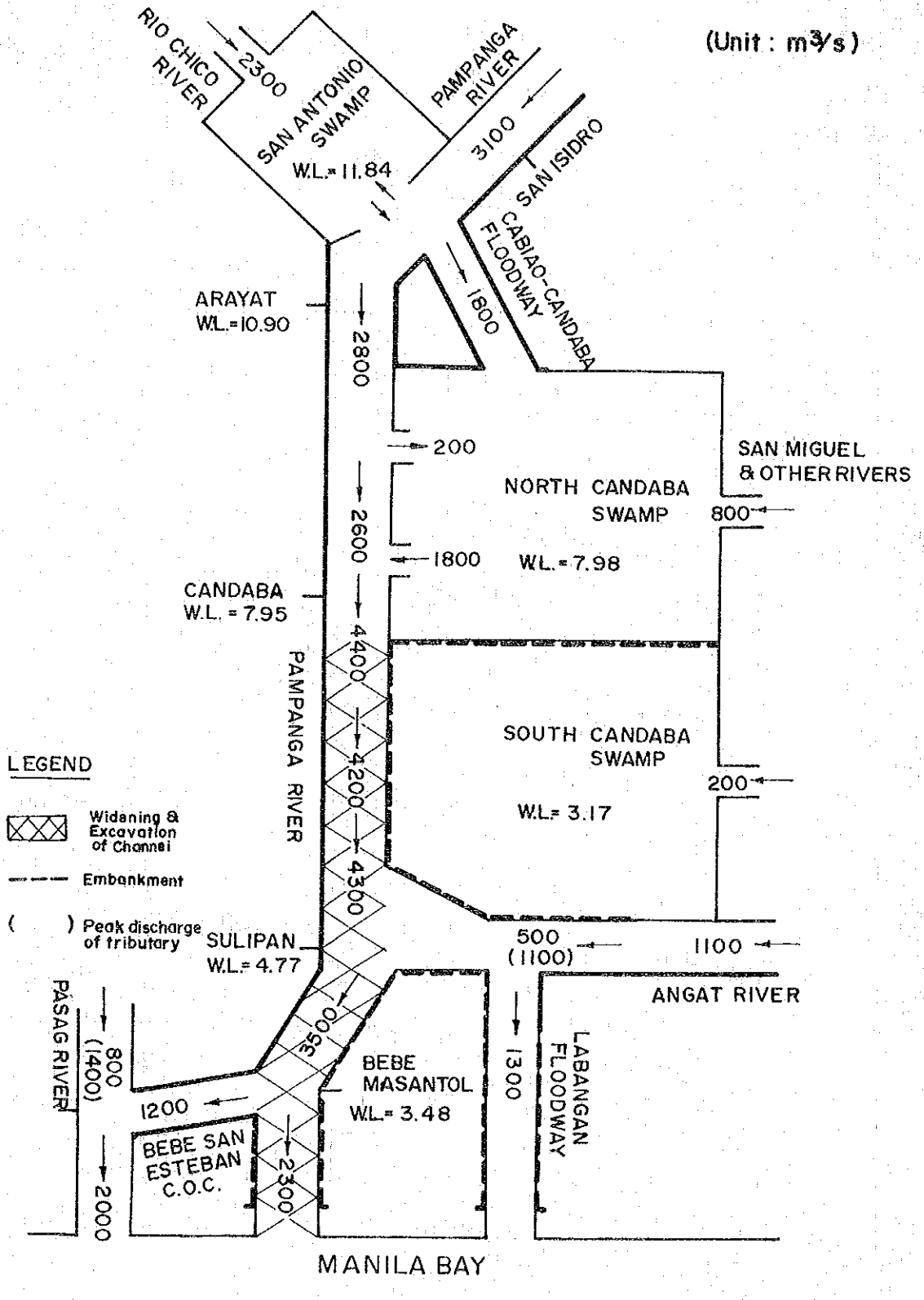


Fig. 3.12(1) PROPOSED CHANNEL CROSS-SECTION

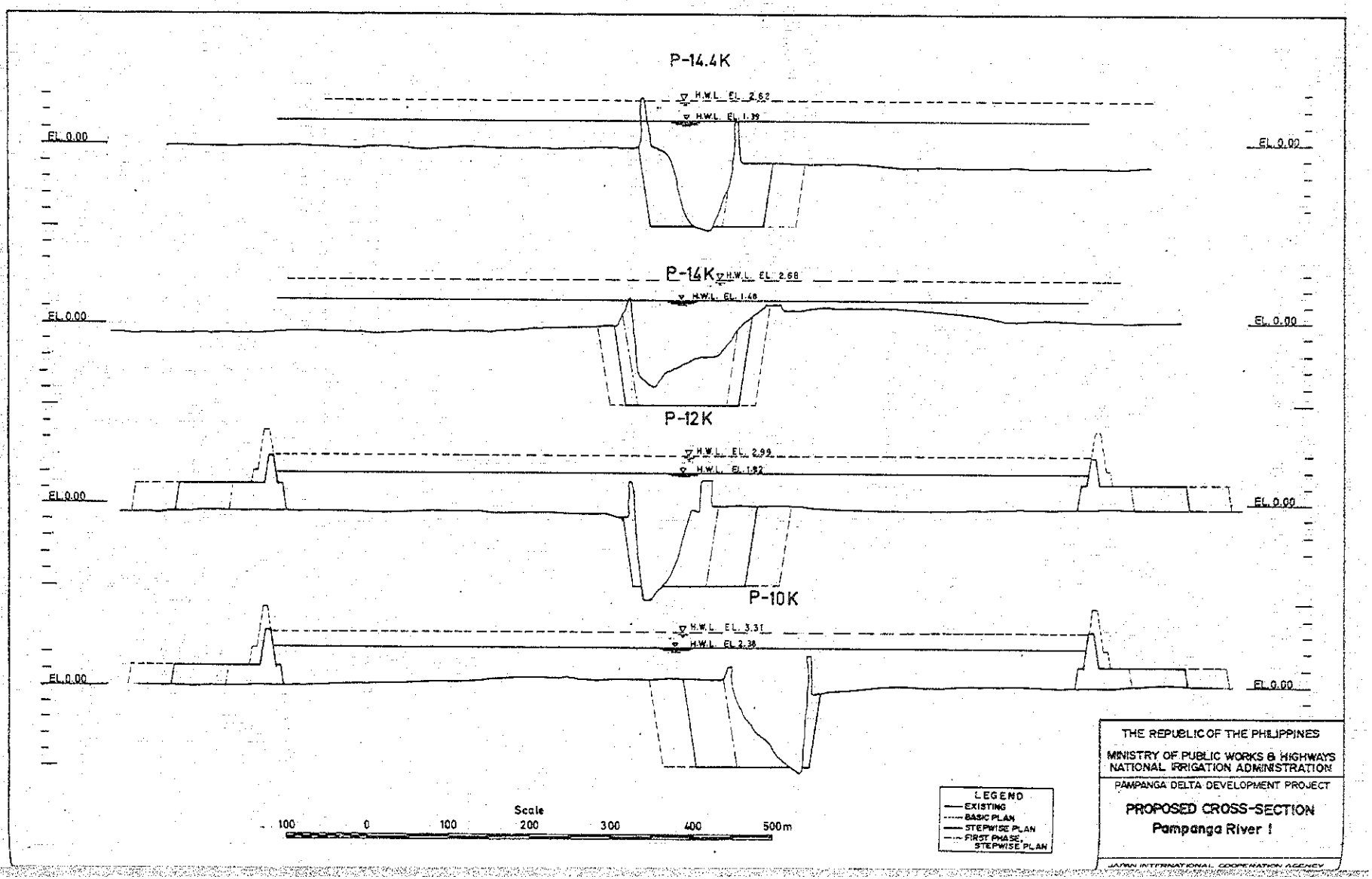


Fig. 3.12(2) PROPOSED CHANNEL CROSS-SECTION

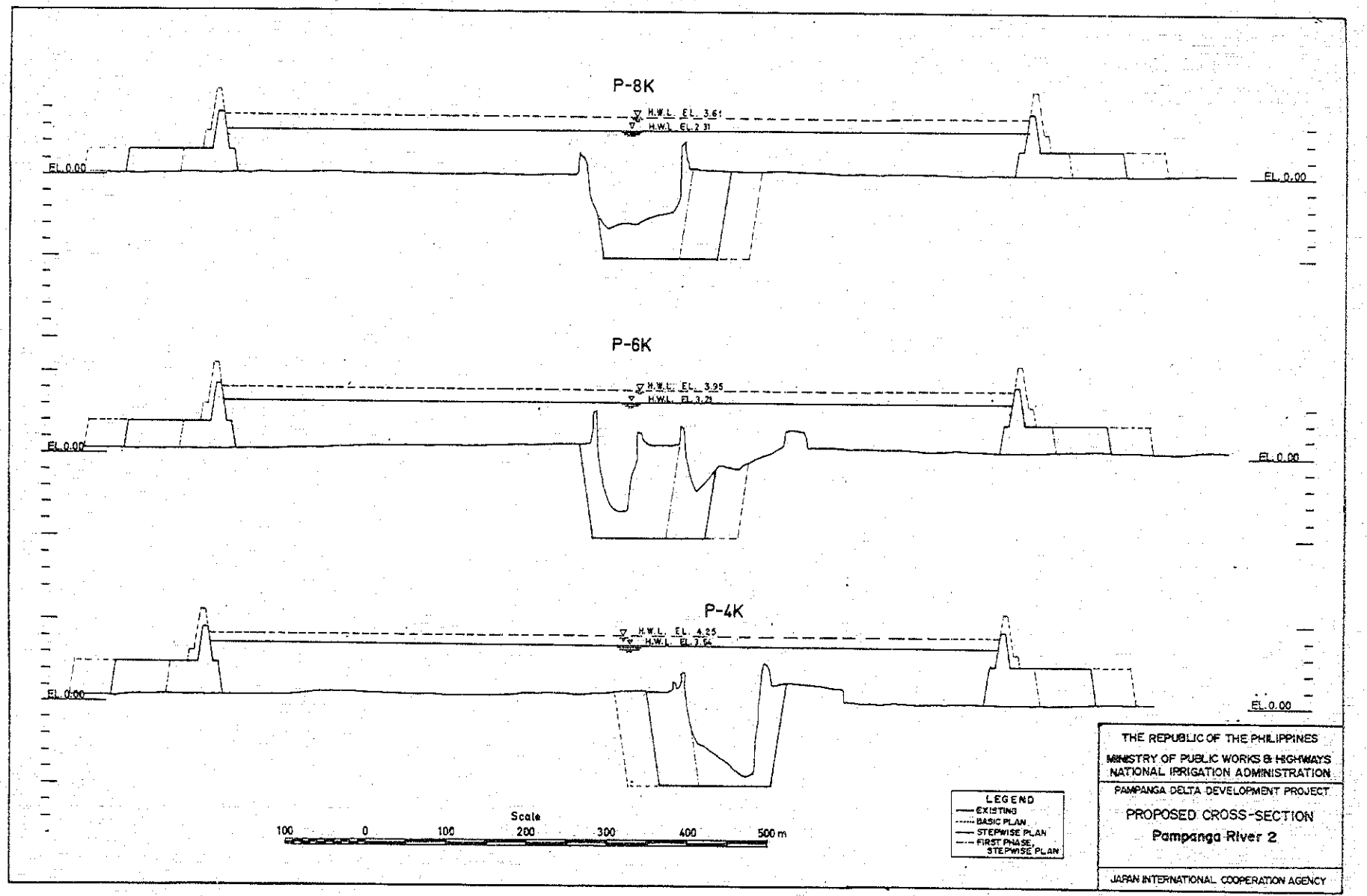


Fig. 3.12(3) PROPOSED CHANNEL CROSS-SECTION

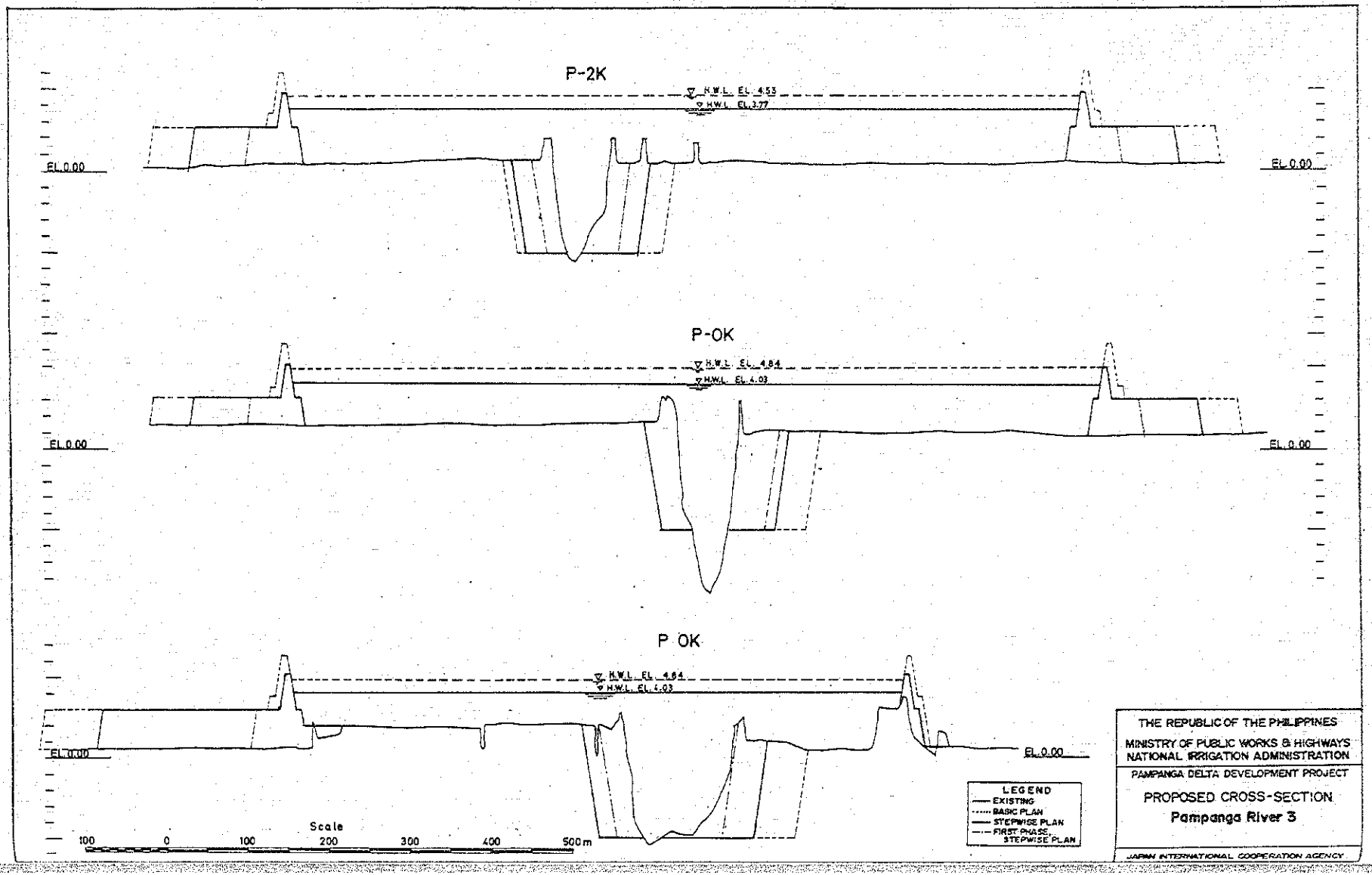


Fig. 3.12(4) PROPOSED CHANNEL CROSS-SECTION

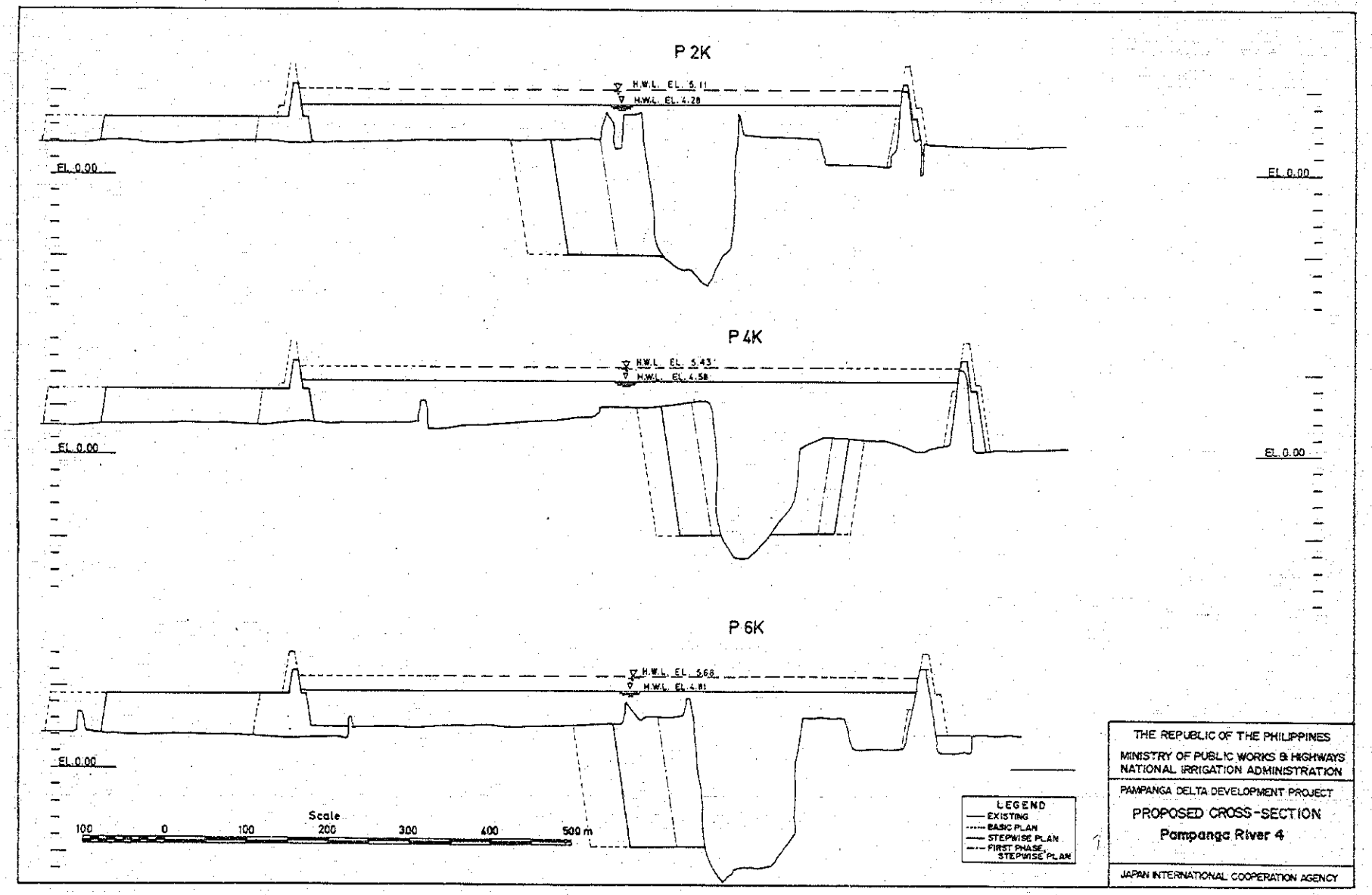


Fig.3.12(5) PROPOSED CHANNEL CROSS-SECTION

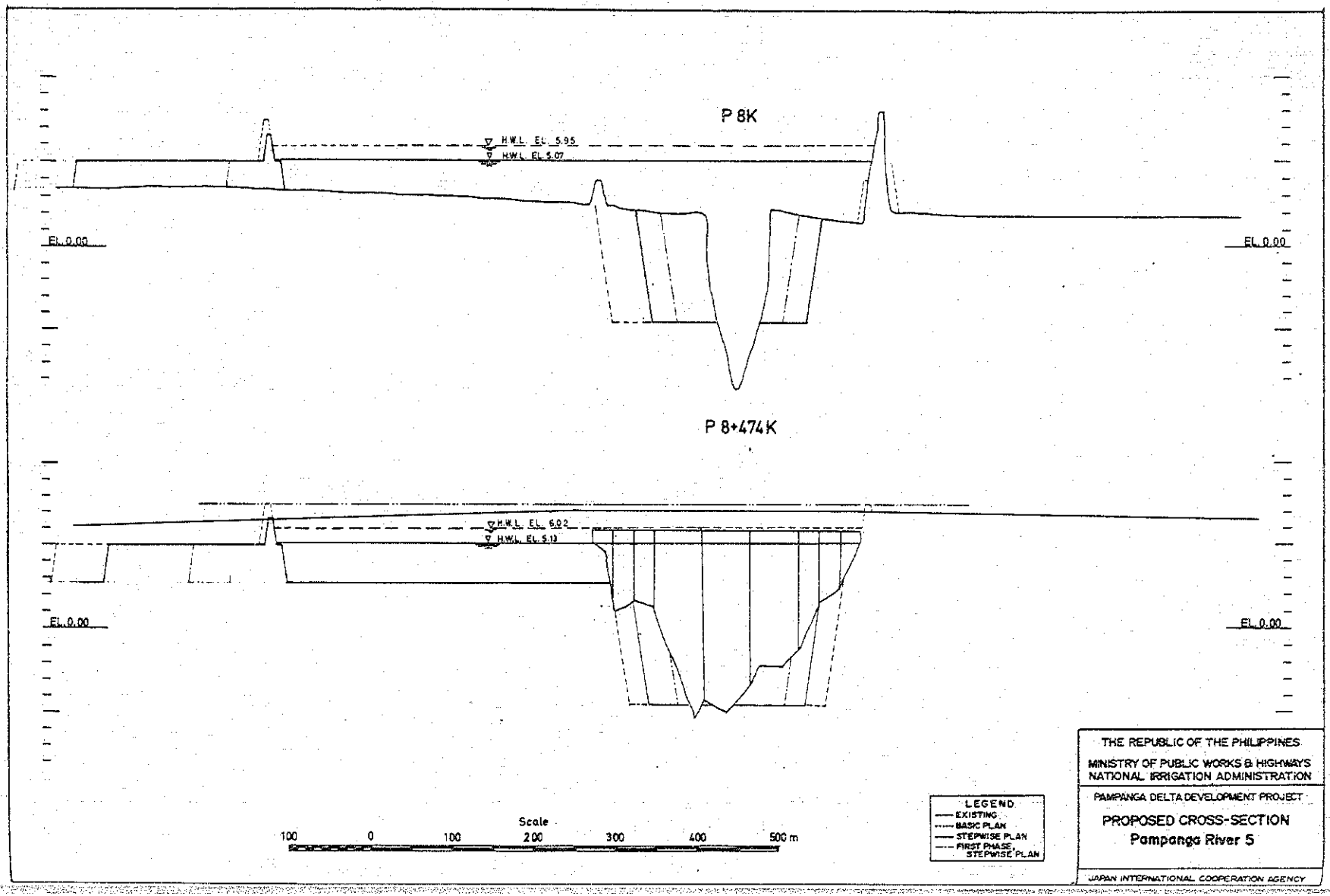


Fig. 3.12(6) PROPOSED CHANNEL CROSS-SECTION

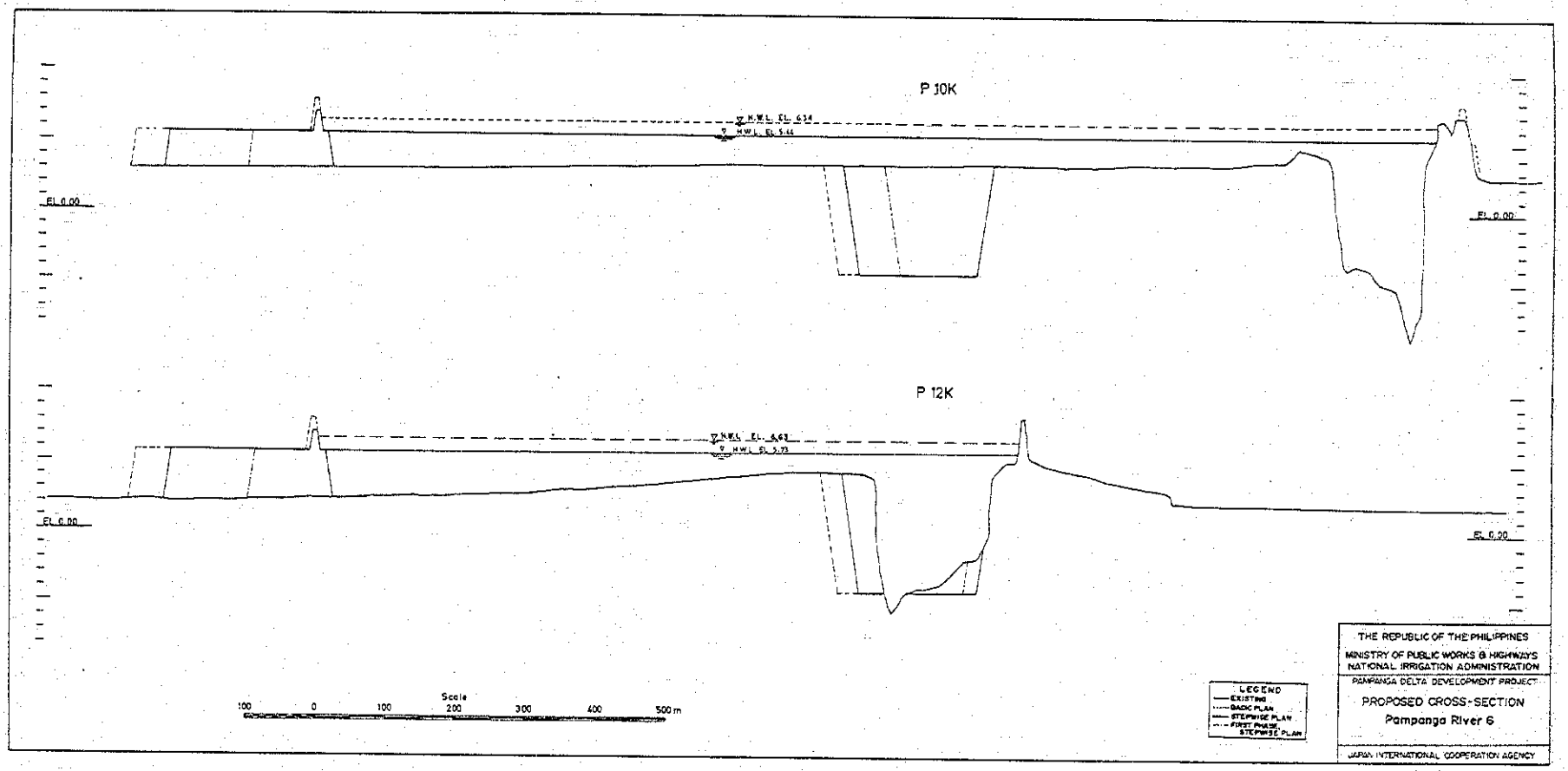


Fig. 3.12(7) PROPOSED CHANNEL CROSS-SECTION

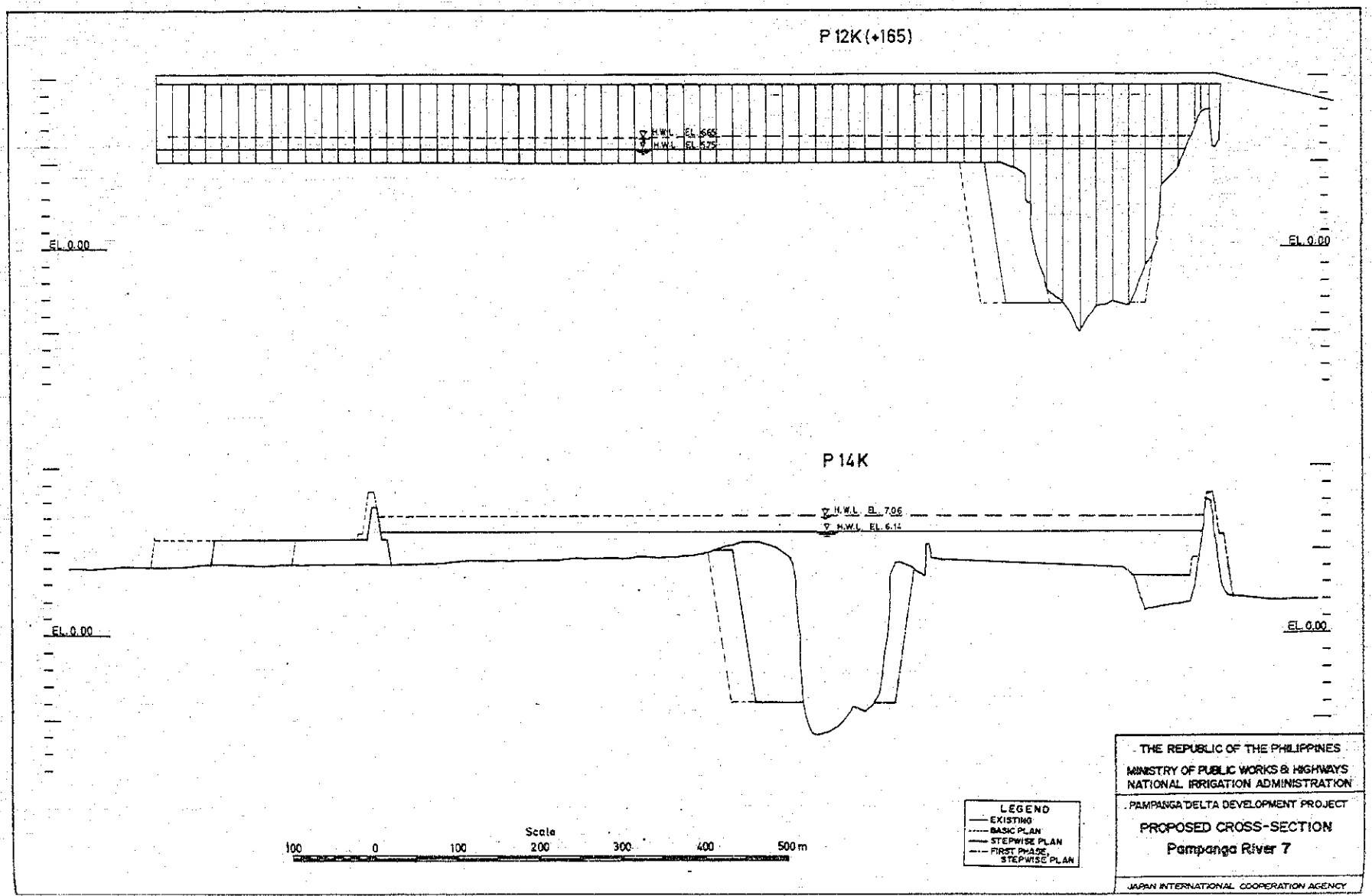


Fig. 3.12(8) PROPOSED CHANNEL CROSS-SECTION

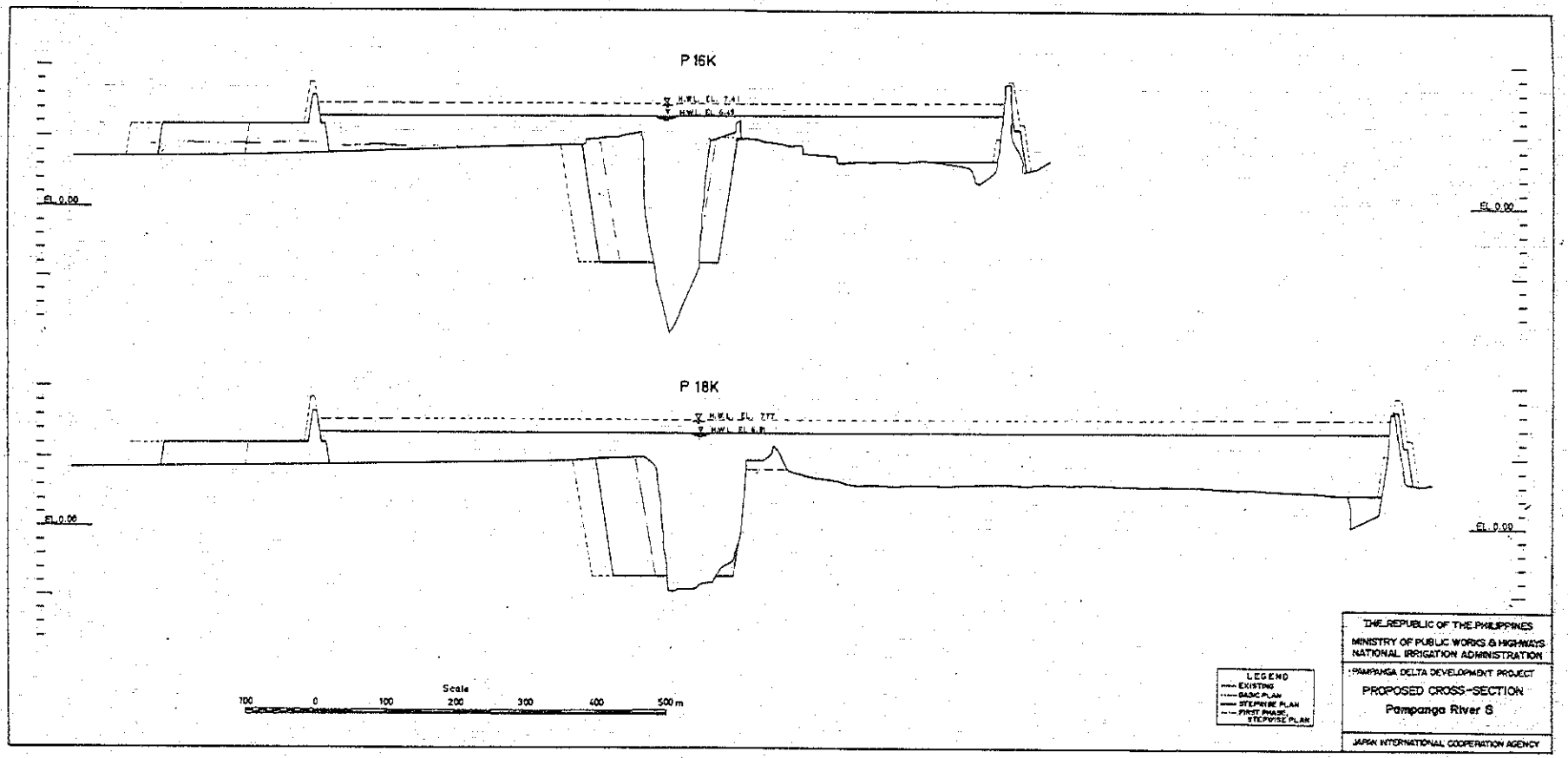


Fig. 3.12(9) PROPOSED CHANNEL CROSS-SECTION

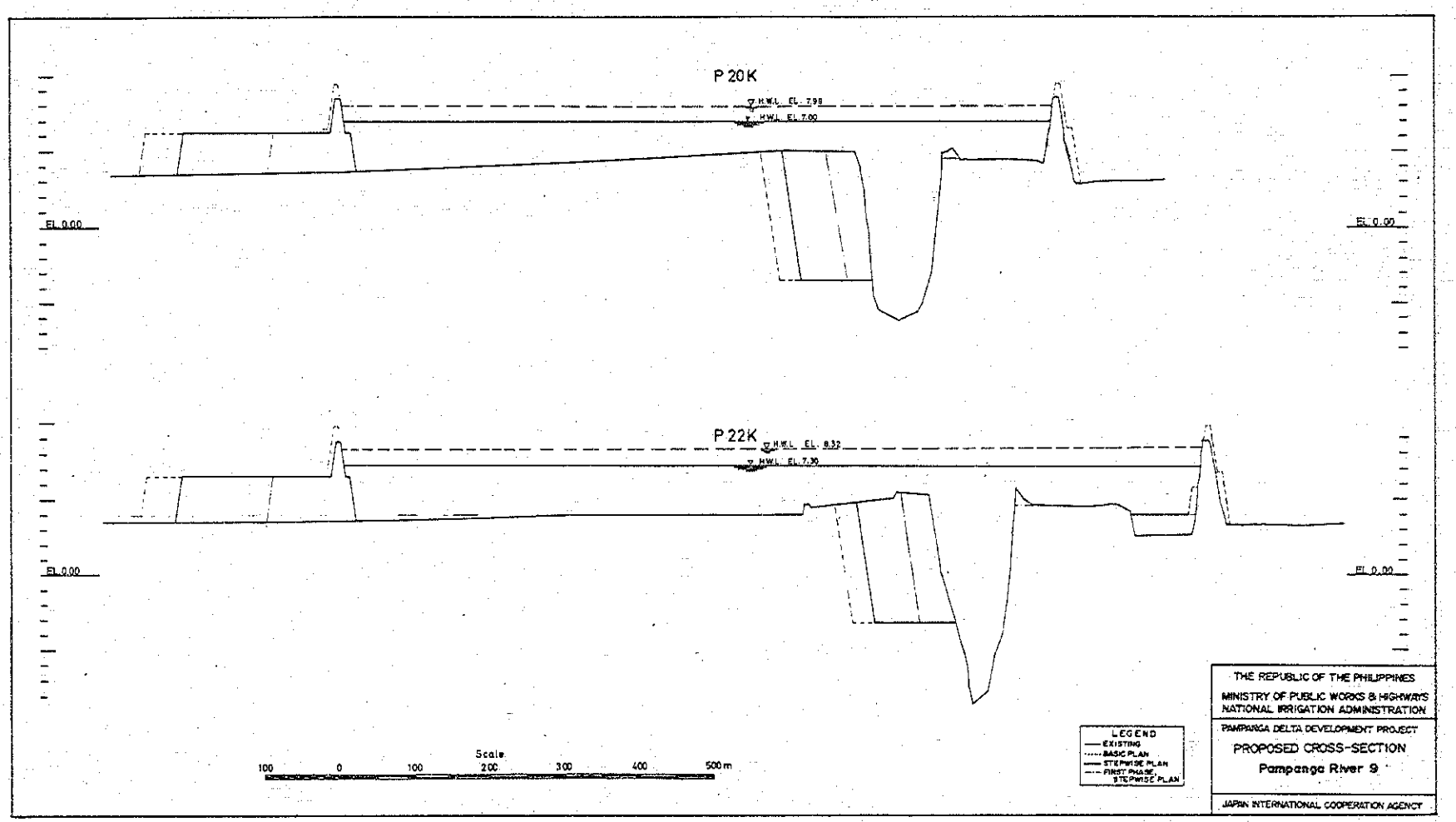


Fig. 3.12(10) PROPOSED CHANNEL CROSS-SECTION

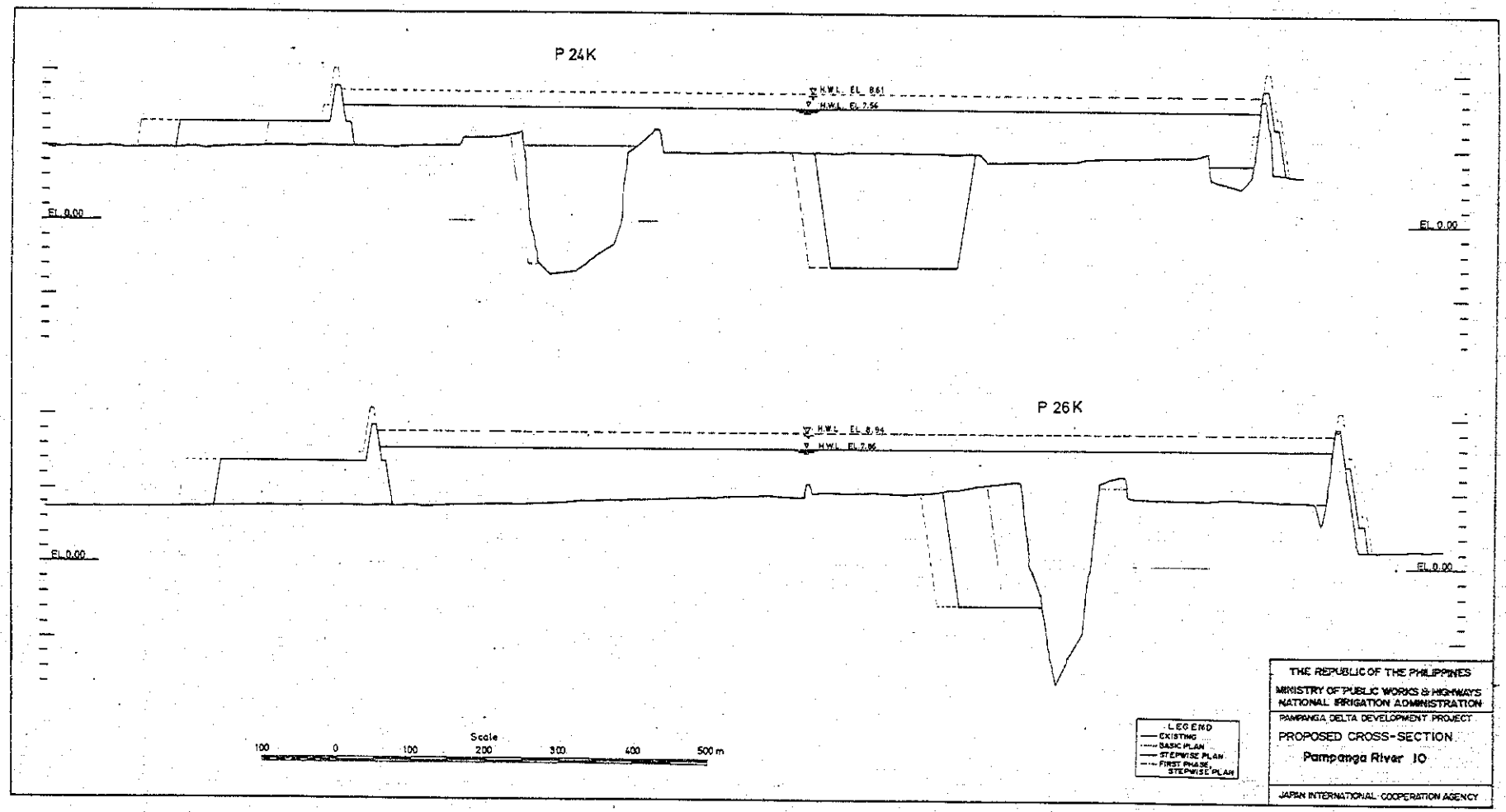


Fig. 3.12(11) PROPOSED CHANNEL CROSS-SECTION

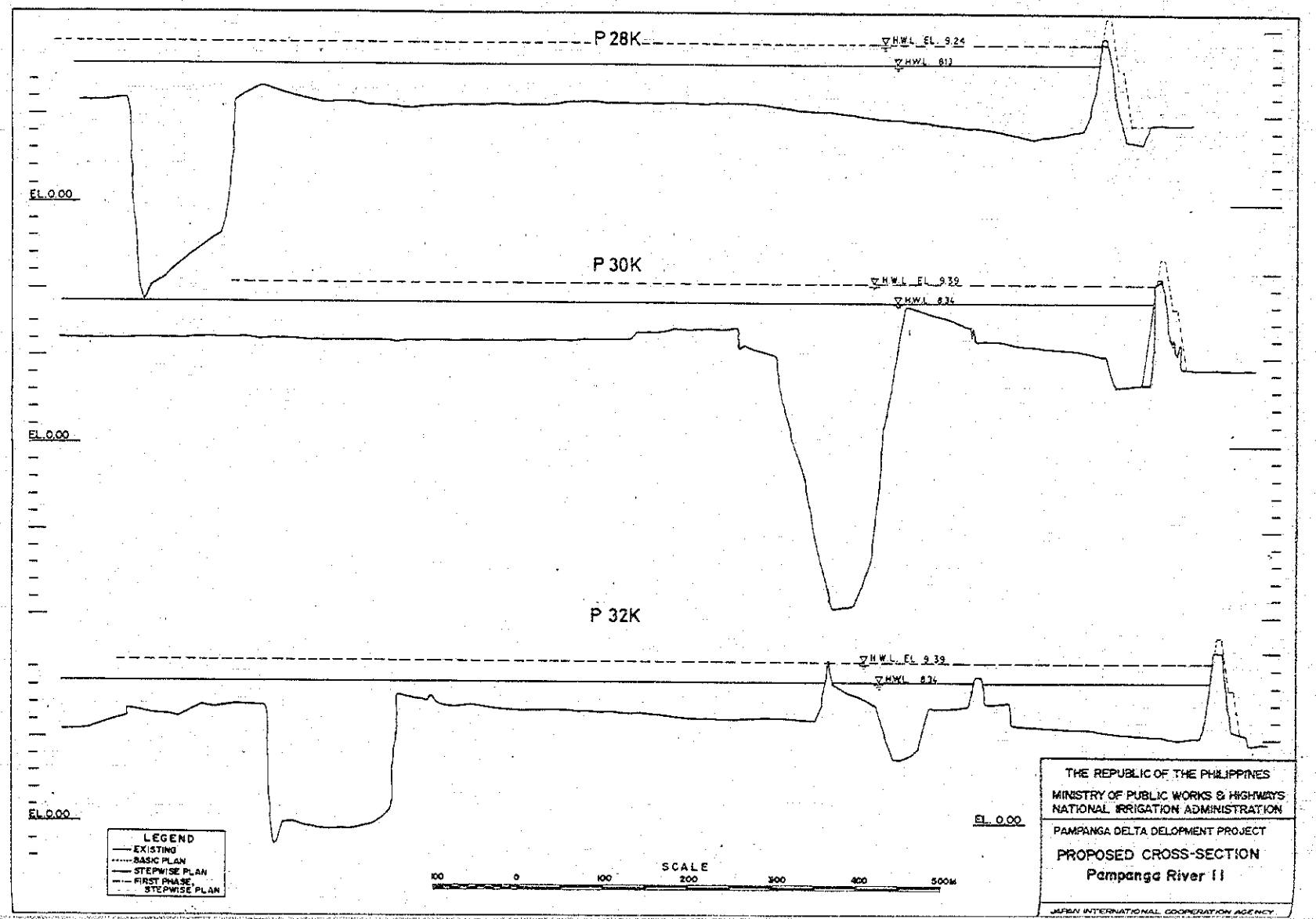


Fig. 3.12(12) PROPOSED CHANNEL CROSS-SECTION

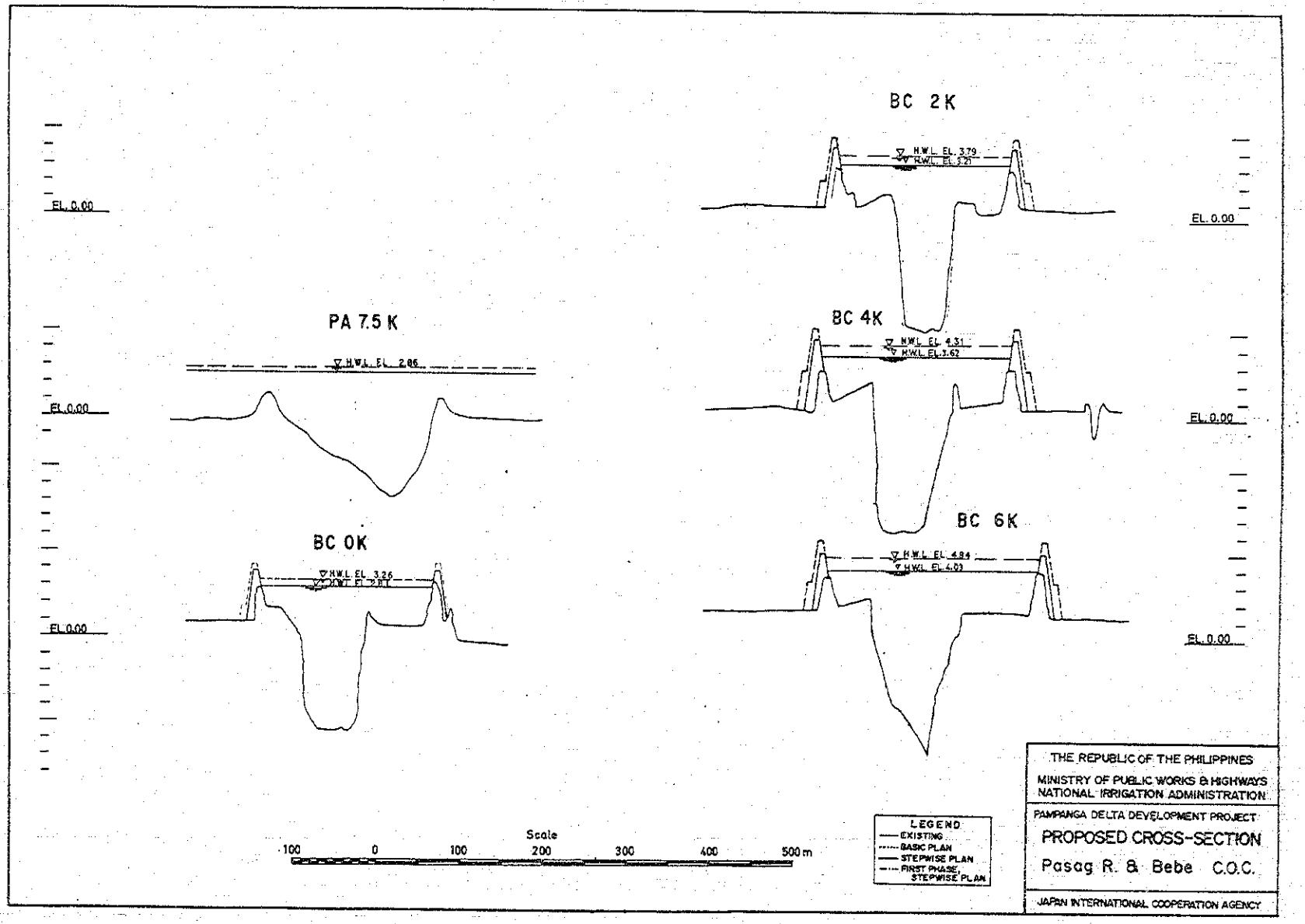


Fig. 3.12(13) PROPOSED CHANNEL CROSS-SECTION

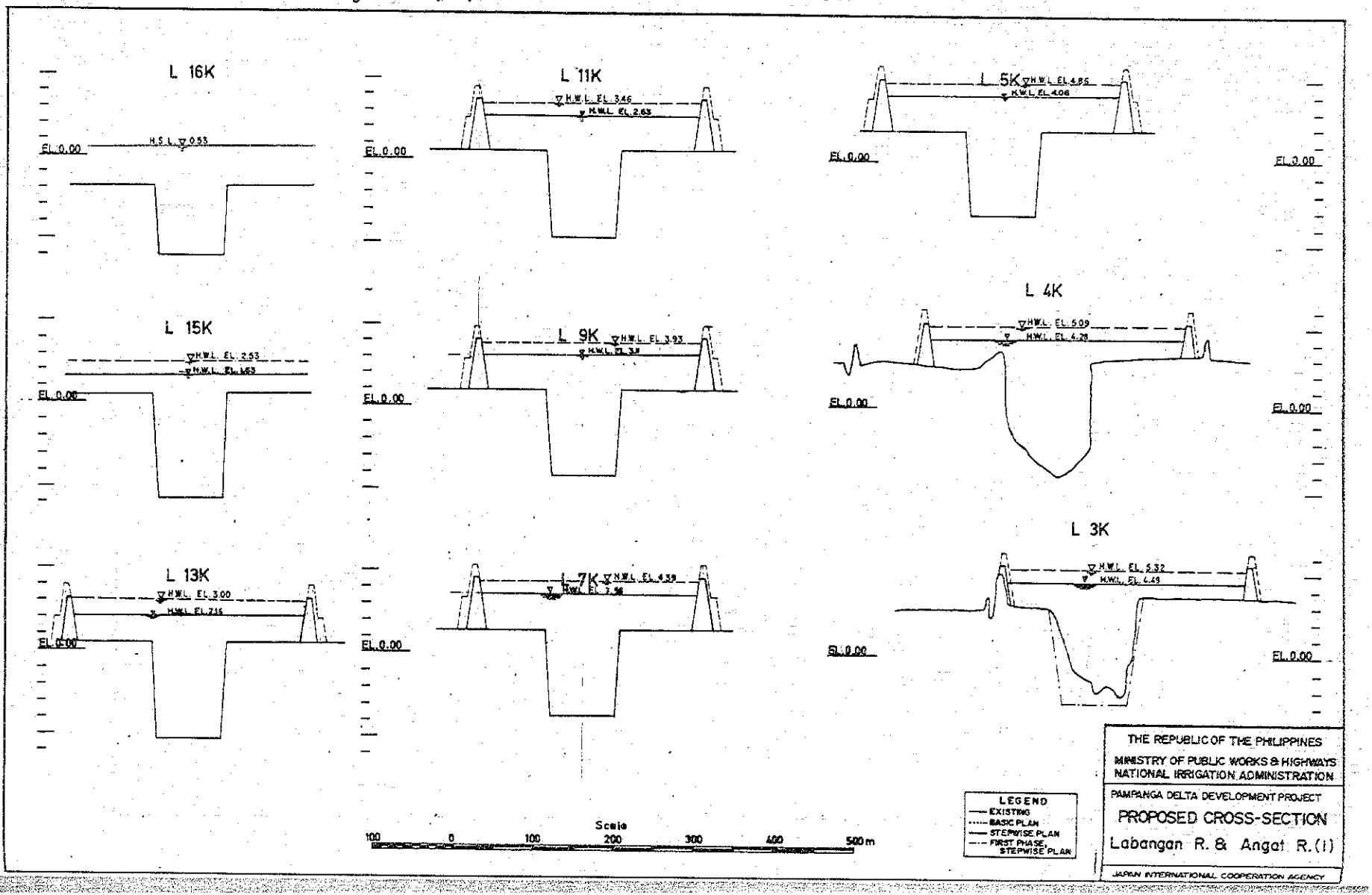


Fig. 3.12(14) PROPOSED CHANNEL CROSS-SECTION

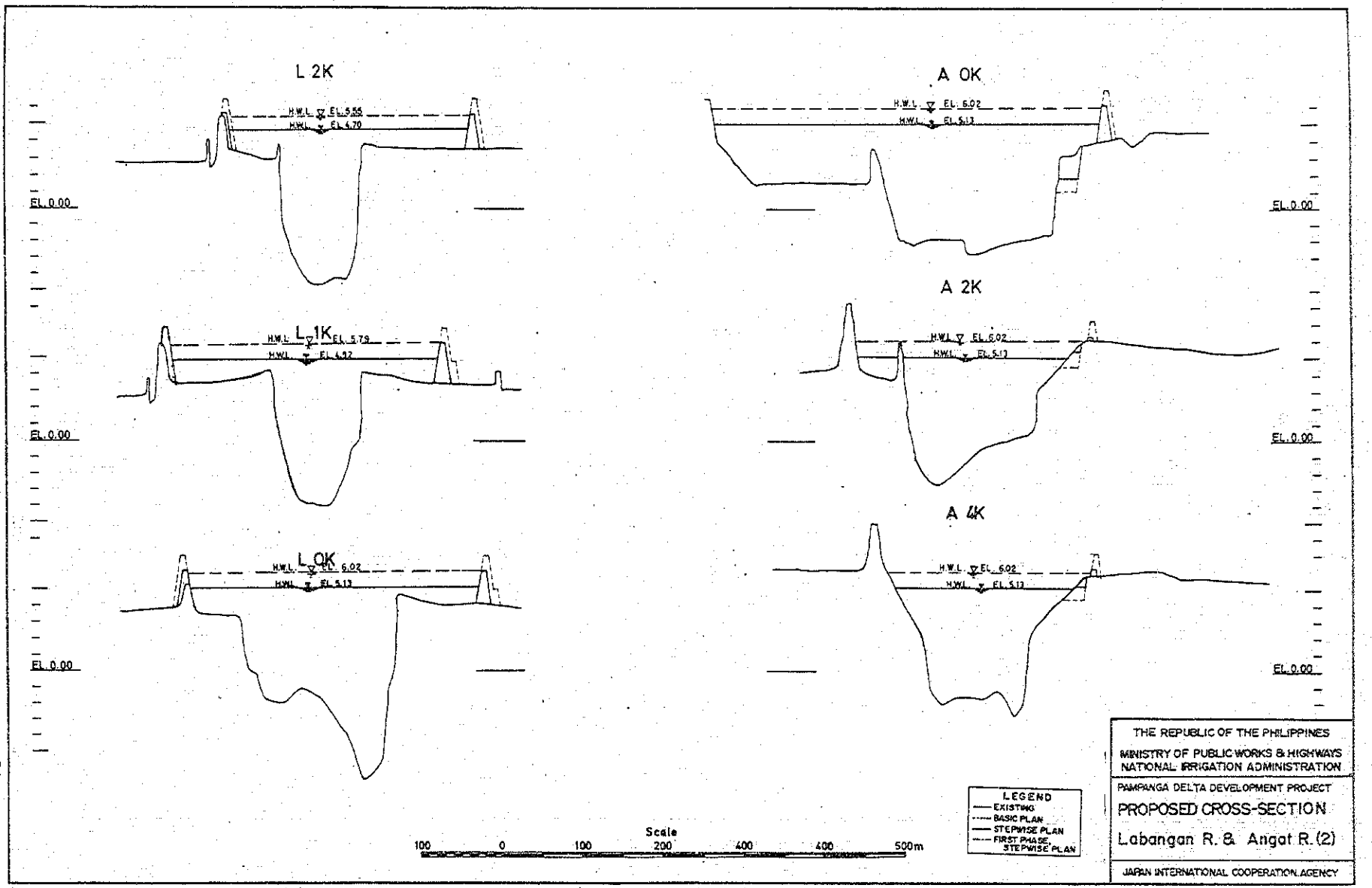


Fig. 3.12(15) PROPOSED CHANNEL CROSS-SECTION

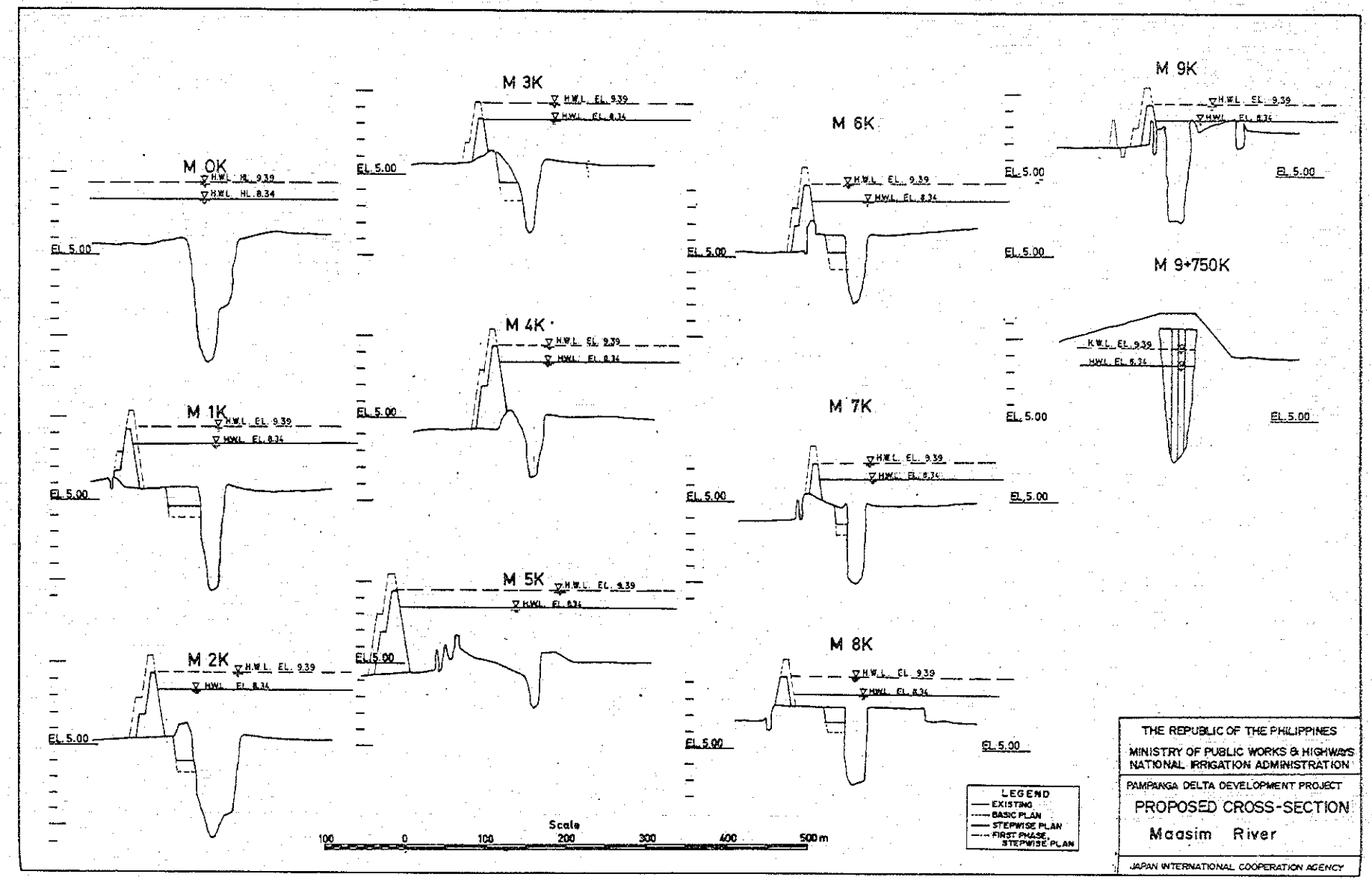
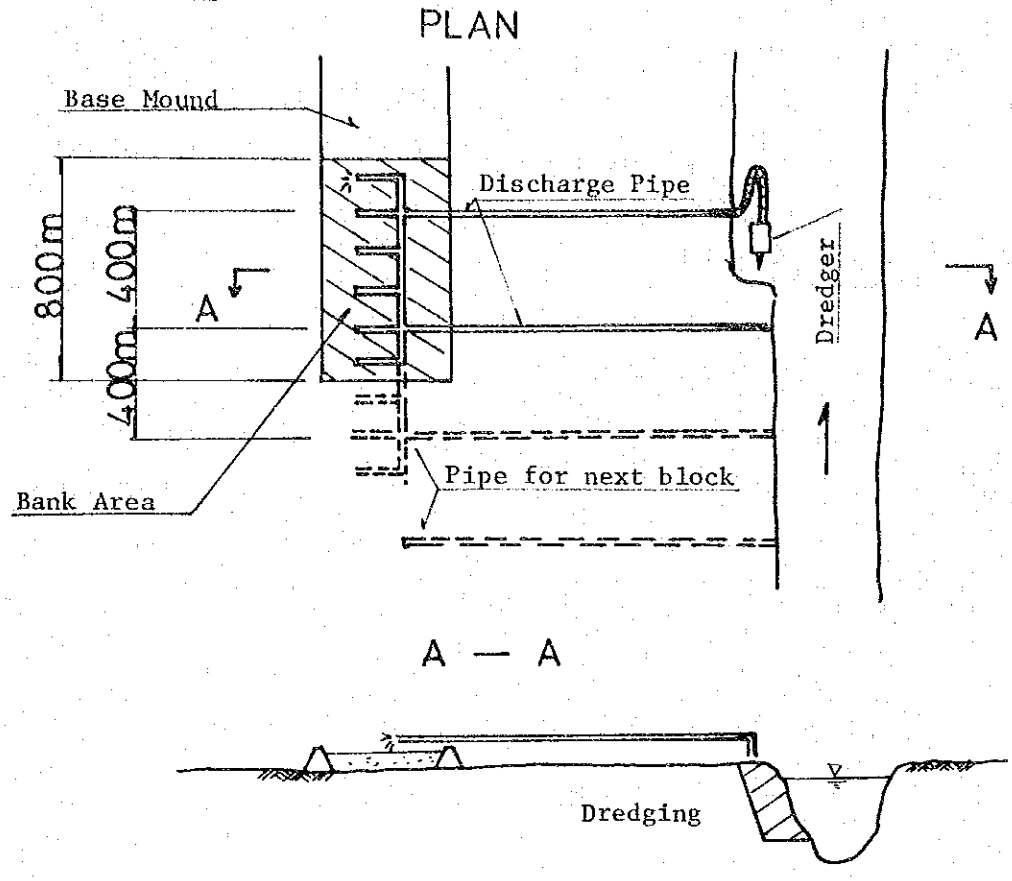


Fig. 3.13 METHOD OF DREDGING WORK

First Phase



Second Phase