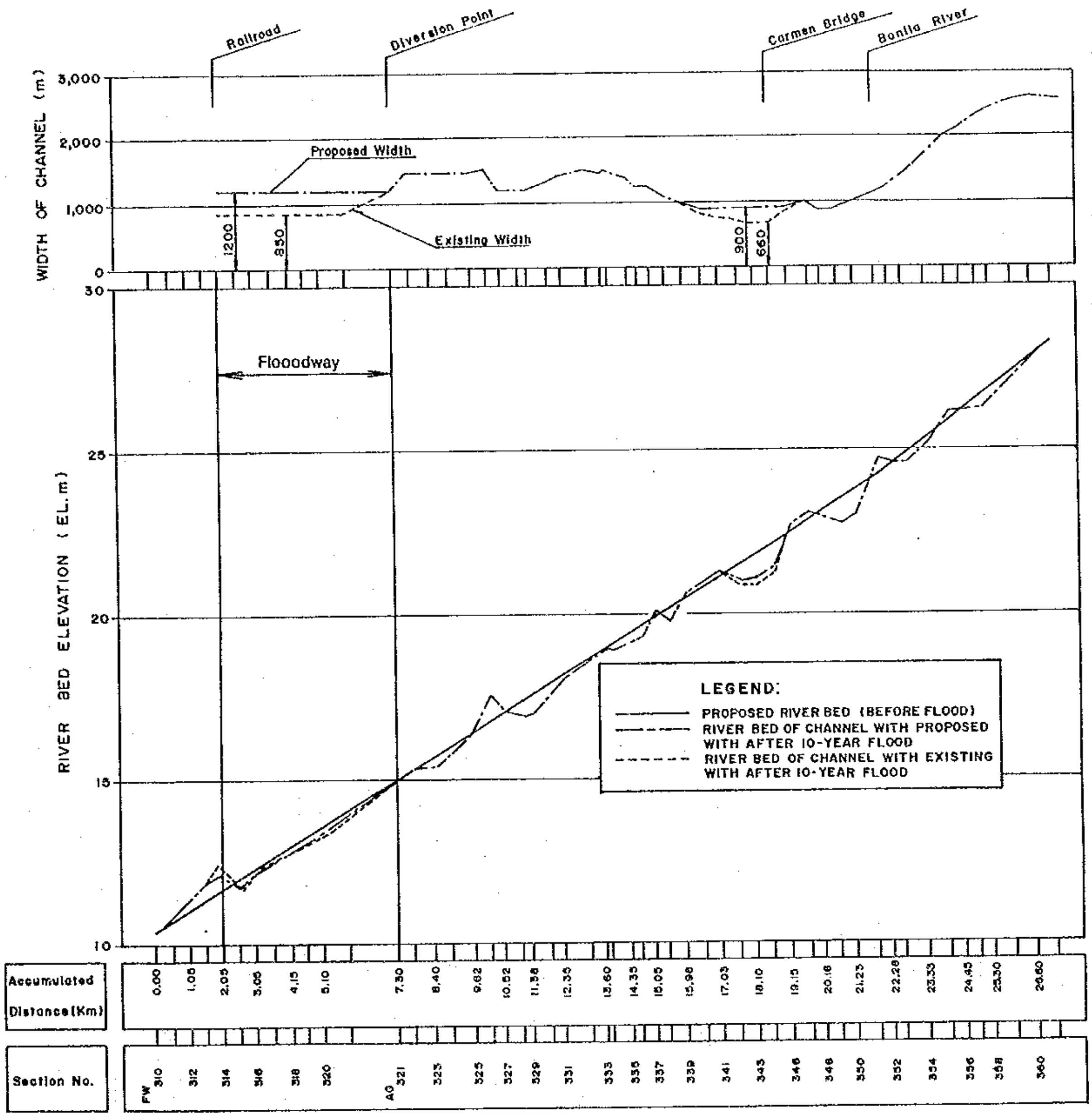


Fig.4.3 RESULT OF RIVER BED FLUCTUATION ANALYSIS (PRIORITY PROJECT)

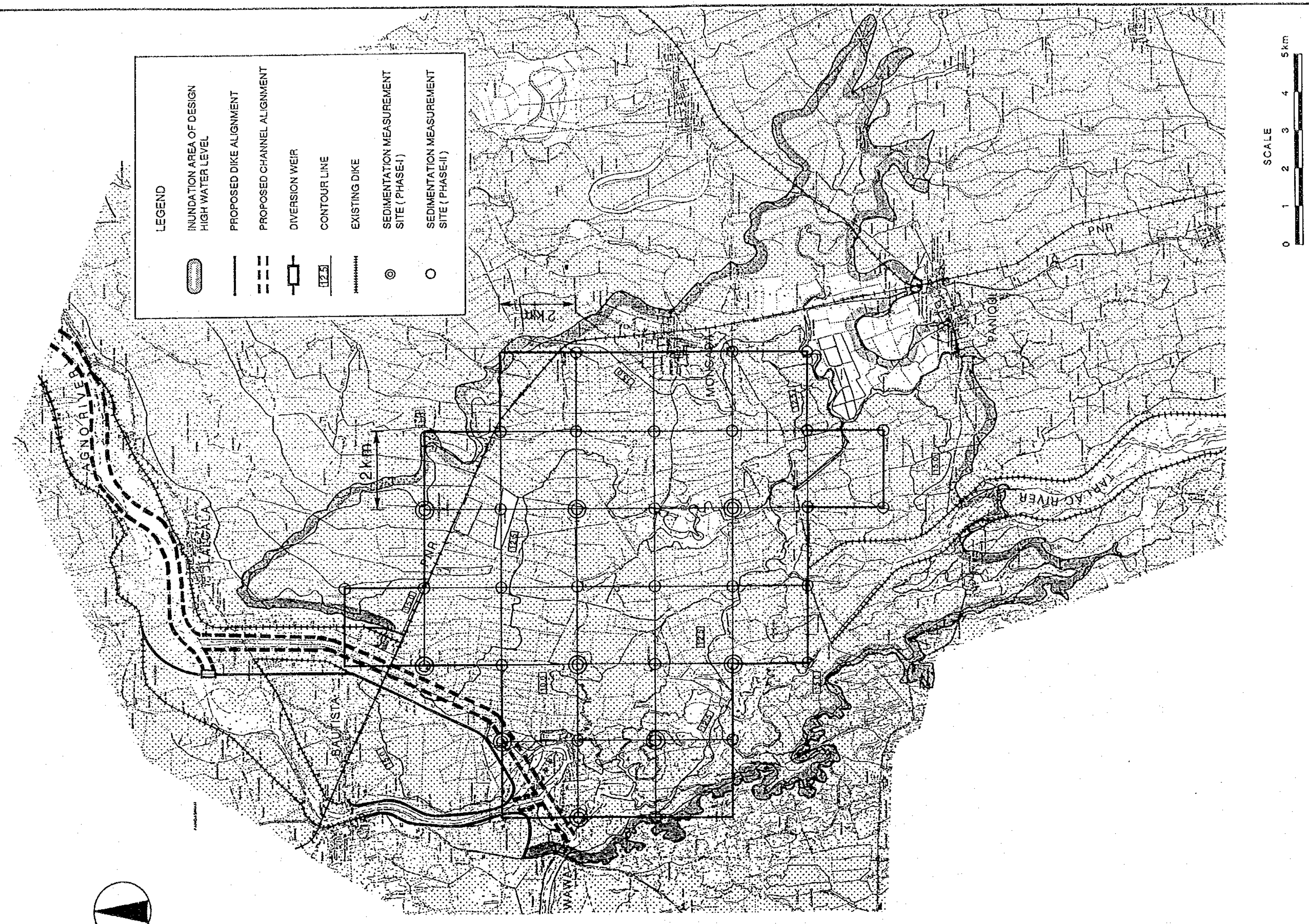


Fig.5.1 PROPOSED MEASUREMENT SITE FOR SEDIMENTATION IN POPONT SWAMP AREA

9.RV

9. RV

RIVER IMPROVEMENT PLAN

RV: RIVER IMPROVEMENT PLAN

TABLE OF CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES

No.		Page

No.		Page

ABBREVIATIONS

1. NAME OF PHILIPPINE GOVERNMENT AGENCIES

AFCS	Agno River Flood Control
AFFWS	Agno River Flood Forecasting and Warning System
ARIS	Agno River Irrigation System
DPWH	Department of Public Works and Highways
DPWH-PMO	DPWH Project Management Office
GOP	Government of the Philippines
LARIS	Lower Agno River Irrigation System
NIA	National Irrigation Administration
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration

2. NAME OF JAPANESE GOVERNMENT AND OTHER OFFICIAL AGENCIES AND ORGANIZATION

GOJ	Government of Japan
JICA	Japan International Cooperation Agency
MOC	Ministry of Construction, Japan

3. MEASUREMENT UNITS

(Length)

mm	millimeter(s)
cm	centimeter(s)
m	meters(s)
km	kilometer(s)

(Time)

sec	second(s)
min	minute(s)
hr(hrs)	hour(s)
dy(dys)	day(s)
mth(mths)	month(s)
yr(yrs)	year(s)

(Area)

m^2	square meter(s)
km^2	square kilometer(s)
ha(has)	hectare(s)

(Volume)

m^3	cubic meter(s)

1. INTRODUCTION

This Supporting Report presents the results of the study of the river improvement plan for the upper Agno River and the Pantal-Sinocalan River which were selected for the priority flood control project (priority project).

The river improvement plans for the Framework Plan and Long Term Plan (a stage development plan for the Framework Plan) were formulated in the Master Plan study, while in Feasibility study the following priority project plan to be urgently implemented was formulated.

The upper Agno River improvement plan for the priority project covers a 69 km long stretch from Wawa bridge to San Roque bridge, and will be implemented for a 10-year flood. The proposed river improvement comprises the following major works:

- Construction of a Floodway in the Bayambang - Alcala stretch
- Construction of a 85.7 km long diking system including a set-back levee
- Improvement of a 48.2 km long low-water channel
- Bank and dike protection works with revetment and groin
- Construction of counterweight fill to prevent liquefaction of the earthdike foundation

The Pantal-Sinocalan river improvement plan for the priority project covers three river stretches; i) main Pantal-Sinocalan River, 27.5 km long; ii) Dagupan River, 19.5 km long; and iii) Ingalera River, 10.7 km. The plan shall be implemented for a 10-year flood which is the same development scale as the Long Term Plan. The proposed river improvement is composed of the following major works:

- Construction of By-pass channel in the lower Sinocalan River
- Construction of 109.4 km long diking system
- Improvement of 33.6 km long low-water channel
- Bank and dike protection works with revetment and groin
- Construction of counterweight fill to prevent liquefaction of the earthdike foundation

2. UPPER AGNO RIVER IMPROVEMENT PLAN

2.1 Present River Conditions

2.1.1 River System

The Agno River is ranked the fifth largest in the country with a basin area of about 5,907 km^2 and a length of 221 km. The Agno River originates in the Cordilla Central Mountains and flows southward. Then, it debauches into a vast alluvial plain and flows down toward Bayambang collecting runoff from the left bank tributaries and joins the Tarlac River, a major tributary of the Agno River.

The junction of the Agno and Tarlac Rivers forms a depression known as Poponto swamp. This area is usually flooded during the rainy season, and hydraulically functions as a natural retarding basin, thus aiding in reducing the flood peak downstream. After joining the Tarlac River, it turns northwestward collecting runoff from the northeastern slopes of the Zambales Mountains, and finally empties into the Lingayen Gulf.

The principal tributaries of the Agno River are the Ambayoan, Viray-Dipalo, Banila and Camiling Rivers which drain from the north.

The river basin map and the river system diagram are shown in Figures 2.1 and 2.2, respectively.

2.1.2 Channel Conditions

(1) General features of the river channel

From the viewpoint of stream form, river channels may be classified as meandering, braided, or straight. Straight channels are only found in the artificial channel stretches near the river mouth and in the Poponto floodway, and in the cut-off channels. The stretch of the main Agno beginning 5 km upstream of the river mouth to the junction with the Viray-Dipalo River shows a meandering channel. Braided channels are readily observed upstream of the junction with the Viray-Dipalo River. Gravel-sand bars are continually being formed in these stretches, the flow is divided into multiple threads and these rejoin and subdivide repeatedly.

The general features of the present river channel of the main Agno River are as follows:

Stretch	River Width (m)	Low-water Width(m)	Channel Depth(m)	River Bed Slope
Lower Agno(Mouth-Tarlac)	1,500-4,000	100-550	4.0-8.0	1/2,000-7,000
Upper Agno(Tarlac-ARIS dam)	450-3,000	75-350	3.0-5.5	1/ 200-1,800

Figure 2.3 shows the channel dimensions, such as river width, channel width, bed slope and channel width-depth ratio, of the upper Agno River. As seen in the figure, the river width ranges about from 450 m to 3,000 m and it's longitudinal variation is irregular because of meandering growth.

(2) River course shifting and channel bed fluctuation

Historical shifting of the river course in the upper Agno River from 1947 is shown in Figure 2.4, which was based on several topographic maps. It is observed that the present diking system in the stretch between Wawa and Asingan is located out of the sifting area of river course while in the upstream reach of Asingan it is located within the past shifting area.

As for the tendency for longitudinal variation of the channel bed fluctuation, it seems that channel bed in the lower reaches from the junction of the Tarlac River and the upper reaches from the junction of the Banila River are aggradating, and the middle reaches are degradating, but, their change is not so high. Figure 2.4 shows change of elevation at the deepest channel bed and sediment deposition volume, estimated by comparing river cross-section data surveyed in 1981 and 1989.

(3) Sediment

Sediment transport capacity of the existing channel is estimated from a sediment formula which is based on river bed material data and hydraulic characteristics of each channel. Details of the sediment calculation method and the results are described in the Suporting Report (SD). The estimated annual transport capacity of the main Agno is summarized as follows:

- From Tarlac junction to inlet of Floodway ; 160×10^3 - 240×10^3 m3/yr
- From inlet of Floodway to Carmen ; 140×10^3 m3/yr
- From Carmen to Banila junction ; 240×10^3 - 500×10^3 m3/yr
- From Banila junction to Ambayoan junction ; 250×10^3 m3/yr
- Upstream of Ambayoan junction ; 600×10^3 m3/yr

2.1.3 River Facilities and Related Structures

(1) Major river facilities for flood control

Due to constant flooding in the Agno River Basin, river facilities for flood control have been constructed by DPWH. At present, there are 34 existing flood control projects, consisting of earth and concrete dikes, revetment, groins (spur dikes), and the Popont floodway channel. The location and a list of existing river facilities in the upper Agno River are shown in Figure 2.5 and Table 2.1, respectively.

(2) Diking system

The diking system is one of the most progressive flood control facilities in the main Agno. In the downstream reaches between the river mouth and the Wawa bridge which has a 44 km long channel, the existing right earthdike and the left earthdike are about 40.5 km long and 16.3 km long, respectively. In the upstream reaches from Wawa bridge which has a 59 km long channel, there is an about 49.0 km long right dike including the 3.2 km concrete dike in Bayambang and Asingan, and about 40.0 km long left dike including the 10.5 km parallel earthdike of the Popont floodway and the 3.6 km concrete dike in Carmen.

(3) Rivetment and groins

Rivetment and spur dikes have been constructed part by part as demand required. The present conditions of these protection works against stream current erosion of dikes and banks in the upper Agno River are shown in Table 2.1 and summarized as follows:

- Revetment of low water channel ; 7.5 km
- Revetment of earth dike ; none

- Boulder dike ; 0.7 km
- Spur dike of low water channel ; 14.2 km
- Spur dike of high water channel; 19.3 km

The eroded dikes and banks can be found in the stretches having a braided channel and meandering with developed bars in the Agno River Basin. Figure 2.6 shows the location of breaches, gaps, and scours caused by past floods from 1984 to 1986. These records of site damage coincides roughly with the locations of the above protection works in the upper Agno River.

(4) Popont floodway facility

The Popont floodway was planned to divert part of the flood water of main Agno to the Popont swamp to improve the hydraulic bottle-neck of the existing river channel in the Bayambang stretch. The construction works were commenced in 1975. At present, extension works of the right dike are planned by AFCS office. The major features of present facilities are as follows:

- Floodway		
Length of stretch	:	6,000 m
Width of floodway	:	800 - 1,000 m
Width of low-water channel	:	30 - 50 m
Length of dike stretch	:	6,000 m (Right), 4,500 m (Left)
- Spillway		
Length	:	1,020 m
Crest elevation	:	18.75 m
Crest height	:	3.55 m

(5) Water intake water structures

Regarding the present irrigation use of water from the Upper Agno River, the Agno River Irrigation System (ARIS) extends from the right bank to irrigate about 14,300 ha of paddy fields in the Pangasinan plain and the Lower Agno River Irrigation System (LARIS) extends from the left bank to cover 10,000 ha. The intake facility of the ARIS is a headworks type, while the one of LARIS has only a inlet with gates. Figures 2.7 and 2.8 show major structural dimensions.

(6) Bridges

There are five road bridges and two railway bridges crossing the upper main Agno. The major features of bridges are as follows:

Name of Bridge	Location	Type of Bridge	Bridge Length(m)	Width(m)	Lowest E.l of Girder(m)
Wawa	Wawa	Concrete	475	7.3	17.85
Calvo	Bayambang	Concrete	160	7.3	17.20
Railway	Bayambang	Steel	-	-	-
(Road)	Floodway	(pier only)	1,020	-	21.20
Railway	Floodway	-	127	4.0	13.60
Plaridel	Carmen	Concrete	650	-	29.95
San Roqe	San Roqe	Concrete	230	7.3	109.80

2.1.4 River Facility Damages due to an Earthquake in 1990

(1) Damages on flood control facilities

River control structural damage due to the earthquake was considerable. It was reported by DPWH that the damage amounted to more than 260 million pesos in the Agno River Basin including the Allied Rivers in terms of the cost required for rehabilitation works.

The most serious damages of the flood control facilities were seen in the upper Agno and Tarlac Rivers in the Agno River Basin. Those typical damages are categorized below:

- Earth dike : Sinking of dike crest, slope sliding, settlement of embankment due to earthquake
- Concrete dike (Mortal facing dike) : Cracks of moltar facing and collapse of head wall with settlement of fill materials inside due to earthquake
- Spur dike : Settlement of cobble stone by earthquake

The extent of dike damaged in the Agno River is summarized as follows based on data inspected and surveyed by AFCS office and the results of site inspection by JICA Study Team in September 1990.

River/Stretch (Right/Left Bank)	River Length (km)	Length of Earthdike	Damage Extent(km) Conc. dike/ Revetment
Main Agno River			
River mouth - Wawa (R)	45.0	2.32	0.11
(L)		0	0.99
Wawa - ARIS dam (R)	54.0	16.60	0.20
(L)		19.56	0.99
Poponto Floodway (R/L)	6.0	1.31	0
Tarlac River (R/L)	37.0	44.92	0.50
Camiling River (R/L)	20.8	0	3.74
Banila River (R/L)	30.9	2.12	0
Viray-Depalo River (R/L)	20.5	1.30	0
Ambayoan River (R/L)	8.7	0	0

Those damages are attributable to not only the earthquake but also to the dike foundation. Liquefacting of sand foundation is one of the most probable causes of such significant damages to the dike. The damages from liquefaction of foundation were found downstream of Asingan in the main Agno, and the damages upstream of Asingan were caused only by the inertial force of the earthquake. Repair and restoration of seismically damaged river facilities was not completely done after the earthquake. As a result, the dike was fractured at five sites as secondary damage due to floods in the upper Agno River on July 1990.

The damage condition in the major stretches of the upper Agno River are shown in Figure 2.9.

(2) Rehabilitation works of DPWH

PMO-AFCS Flood Control Program for Earthquake-Damage Rehabilitation/ Restoration was formulated. Those works in the Agno River Basin total 39 projects with a total cost of 165 million pesos as of February 28, 1991. The major works and the required cost by river stretch are shown in Table 2.2 and summarized below:

River/Stretch	Nos. of Project	Cost (1,000 Pesos)
Main Agno River		
River mouth - Wawa bridge	16	39,512 (24.0%)
Wawa bridge - Carmen	11	42,742 (25.9%)
Carmen - San Mannuel	5	13,520 (8.2%)
(Sub Total)	32	95,774 (58.1%)
Tarlac River	5	58,540 (35.5%)
Other tributaries	7	10,585 (6.4%)
(Total)	44	164,899 (100.0%)

2.1.5 Flow Carrying Capacity

The flow carrying capacity of the existing river channel of the main Agno was estimated by means of non-uniform flow calculations. The carrying capacity is herein defined as the discharge at the water level below the dike crest or the bank by a free board.

The estimated carrying capacity is shown in Figure 2.10 and summarized below:

Stretch	Carrying Capacity	
	Discharge(m3/s)	Return Period(yr)
River mouth - 19km upstream	2,500 - 8,000	2 - 30
19km upstream - Wawa Stretch	4,500 - 13,500	5 -100
Bayambang stretch	1,000 - 2,000	2 - 5
Poponto Floodway stretch	1,000 - 1,500	2 - 8
Alcala - Carmen stretch	1,700 - 10,000	3 -100
Carmen - Asingan stretch	1,500 - 9,000	3 -100
Asingan - San Mannuel Stretch	1,000 - 11,000	3 -100

2.2 Outline of Framework Plan for Agno River Flood Control Plan

The Framework Plan for the upper Agno River was formulated for the flood control target of a 100-year probable flood with a combination of river improvements, the Poponto natural retarding basin, and the Moriones-O'Donnel dam in the Talrac River. The San Roque dam in the upper Agno and the Balog-Balog dam in the Tarlac River are assumed to exist, and flood control functions are only obtained by using the surcharge capacity of the reservoir.

As a stage development plan of the Framework Plan, the Long Term Plan was formulated with an optimum development scale of a 25-year probable flood. Flood control measures of the Long Term Plan consists of river improvements and the Popont natural retarding basin only.

The Framework Plan and the Long Term Plan cover major tributaries in the Agno River system: Tarlac, Camiling, Banila, Viray-Dipalo, and Ambayoan Rivers.

The general layout of the Framework plan and the design discharge distribution are illustrated in Figures 2.11 and 2.12, respectively.

2.3 Basic Concept and Criteria for Plan Formulation of Upper Agno River Improvement

2.3.1 Basic Concept for Plan Formulation

(1) River improvement study area

The river stretch between the Wawa bridge and San Roque bridge in the Agno river, which has a total river length of about 69.0 km, was selected to review the river improvement plan formulated by the Master Plan study.

(2) Priority flood control project and Step-wise plan

The priority project shall be implemented with a 10-year flood scale. In consideration with an early realization of the flood control plan to meet urgent social requirements and the amount of construction funds, the Step-wise plan of river improvement works for the priority project shall be studied.

(3) Design flood discharge

The 10-year flood discharge distribution is shown in Figure 2.13.

(4) Present river facilities

River facilities damaged by the earthquake have been rehabilitated based on the programmed restoration works. The present condition for the basis of plan formulation is assumed for this study to be one after completion of the rehabilitation program.

(5) Flood control measures

Flood control measures in the Study area consist of river improvement, the Poponto natural retarding basin, and the San Roqe dam.

River improvement works in the upper reaches will generally cause a significant increase of flood runoff in the lower reaches. In this respect, the river improvement in the upper Agno should be implemented together with construction of the floodway and the Poponto natural retarding basin, which regulates the flood discharge within an allowable level in the lower reaches.

The river improvement is contemplated by the following countermeasures:

- Construction of diking system including a set-back levee for enhancement of flow carrying capacity
- Excavation of river channel for enhancement of flow carrying capacity and channel stabilization
- Bank and channel stabilization works including a cut-off channel
- Dike protection works against stream current erosion
- Construction and/or improvement of other appropriate facilities

(6) Survey data used for river improvement planning

The following survey data is applied for planning of the upper Agno river improvement in this study.

- Topographical maps with a scale of 1:50,000 and map information as of 1977 published by National Cartography Authority and Map
- Topographical maps with a scale of 1:25,000 based on aerial photography taken in 1989 by JICA and partially in 1981, which cover the whole main Agno River

- Topographical maps with a scale of 1:5,000 based on the above same conditions, which cover existing and planned dike area in the upper main Agno River
- River cross-sections with intervals of about 500 m done by JICA in 1989, which cover the whole upper Agno River
- Survey data on major river structures done by JICA and AFCS office

2.3.2 Criteria for Planning of River Improvement and Floodway

The following criteria are applied to plan river improvement and floodway.

a) River width

- The present diking system in the Study area exists along both banks, covering about 75 % of the total channel length. The river width, therefore, is designed as the river width under present conditions in principle.

- In case a hydraulic bottle-neck and scourring of dike due to inadequate river width and dike alignment are observed, improvement of dike alignment is considered.

b) Channel section

- Compound sections with high-water and low-water channels are adopted to stabilize low-water channel and present diking system.

c) Low-water channel

- The low-water channel is designed with a flow capacity to carry about a 1.0-year to 2.0-year flood in consideration of channel stabilization. It is generally regarded that this discharge has a dominanting effect in determining dimensions and characteristics of river course, channel, and bed.

- Average channel bed elevation under present conditions is considered for the design channel profile and bed elevation. A change of channel bed gradient is kept at less than twice the existing gradient to prevent bed fluctration, and design bed elevation is set at the average of the existing channel.

- Channel bed width is designed with average existing one.

d) High-water channel

- High-water channel elevation is set at the present channel or ground level.

- In case the present high-water channel around the toe of a dike is on irregular land such as an old stream, then groin works and/or filling of the old stream are considered to protect the dike from stream current erosion.

e) High water level (H.W.L)

- High water level is decided based on non-uniform flow calculations.

- With regards to Manning's coefficient of roughness for water level calculations, coefficient of 0.030 to 0.035 for low-water channel and 0.040 to 0.045 for high-water channel are adopted.

- With regards to starting water levels for non-uniform flow water level calculations, the following water levels in the Poponto natural retarding basin are adopted:

10-year flood ;	Water level = 16.00 m
5-year flood ;	Water level = 14.59 m
1-year flood ;	Water level = 10.63 m

f) Dike

- Type : An earth embankment is adopted in principle if there is no special restriction of land use for dike construction. An existing concrete dike shall be maintained as it is or improved with strength countermeasures in certain urban locations where the river channel is immediately adjacent to a densely built-up area.

- Dike crown elevation : it is set at the H.W.L elevation plus a free board as shown below:

Design discharge(m3/s)	Free board(m)
less than 200	0.60
200 to 500	0.80
500 to 2,000	1.00
2,000 to 5,000	1.20
5,000 to 10,000	1.50

- Dike section : The crown width and slope of the dike of the main Agno is in accordance with the Standard for Dike Construction of AFCS shown in Figure 2.14. By applying this standard, a new dike can be improved to form a continuous diking system having an uniform section with the existing one.

- As for countermeasures against liquefaction of the dike foundation, a counterweight earthfill and a pile foundation are used for earth dikes and concrete dikes respectively. The countermeasured stretches and the standard design cross-sections of counterweight earthfill are shown in Figures 2.15 and 2.16, respectively, and are described in the Supporting Report(SD).

g) Bank and dike protection works

- The location plan is described in sub-section 2.4.5.

h) Inner-water drainage facility

- Drainage areas and facility sites are decided based on location of dikes, topographic elements, and the present condition of drainage canals.

- A water gate and sluice way are adopted as a drainage facility. The drainage flow area of these facilities is designed for a 5-

year probable flood estimated by hydrological analysis which considers present land use and drainage canals.

- A drainage pump plant is considered only for urban areas. The necessity of a pump plant and pump capaciy are estimated by hydraulic and economic analysis.

i) Related river facilities

- Existing water intake facilities which hinder the flow of a 10-year design flood and/or are inadequate structural types for the proposed flood control plan, are to be improved as works of Priority Project.

- Existing bridges which do not meet the design elevation of the dike crown and/or design river width, are improved against a 100-year design flood in principle. In case the 10-year flood can flow with the required free board by extending the existing bridge length, those bridges are improved only for the 10-year flood scale.

2.4 Proposed River Improvement Plan

2.4.1 Principle Features of Proposed Plan for the Whole Stretch

(1) River improvement stretch for the Priority Project

The river improvement area for the priority project covers the stretch from Wawa bridge to the San Roque bridge, which has a total river length of about 69.0 km. The left dikes in the upper stretches of the junction with the Viray-Deparo River, however, are not proposed as implementation works for the priority project. This river improvement frees the low land along the upper Agno River and in the Allied River Basin from flooding where the affected inundation area and population are about 1,084 km2 and 945,000, respectively.

(2) Design channel features of river improvement plan

Principle features of the design channel are shown in Table. 2.3 and summarized below:

Stretches	Bayambang - Alcala	Floodway	Alcala -Asingan	Asingan -San Mannuel
Design discharge(m3/s)	500	3,500	4,000-3,500	3,500-2,400
River width(m)	1,300-250	1,200	3,000-900	3,000-300
Gradient of channel bed	1/1,850	1/1,600	1/1,600-665	1/665-230
Channel bed width(m)	100	150	150	Existing
Design water depth(m)	7.85-3.79	8.78-5.85	5.85	5.85-3.30

The design plan, longitudinal profile, and typical cross-sections are illustrated in Figures 2.17 to 2.20, respectively.

The river improvement works in the priority project area are summarized as follows:

- New dike construction	:	46.00 km long earthdike and 7.70 km long set-back levee (refer to Table 2.4)
- Heightening of dike	:	29.50 km long earthdike and 2.50 km long concrete dike (- ditto -)
- Counterweight earthfill of dike	:	42.00 km long
- Channel improvement	:	48.20 km long (- ditto -)
- Revetment	:	23.20 km long for low-water channel 37.30 km long for earthdike (refer to Table 2.5)
- Groins	:	10.55 km long (- ditto -)
- Drainage facilities	:	18 sluiceways (refer to Table 2.6)
- Diversion structures	:	Bayambang diversion channel
- Irrigation facilities	:	2 box culverts with gates of the LAIS
- Briges	:	3 road bridges (Calvo/Floodway/Plaridel) and 2 railway bridges demolished

Detailed study results by the following river stretch are described in sub-sections 2.4.2 to 2.4.4.

- Bayambang - Alcala stretch (AG 181 - AG 321 : 21.94km)
- Alcala - Carmen - Asingan stretch (AG 321 - AG 405 : 26.25km)
- Asingan - San Manuel stretch (AG 405 - AG 474 : 20.26km)

2.4.2 Bayambang - Alcala stretch (AG181 - AG321)

(1) Present river condition

Flood water in this river stretch flows down, passing the main stream in the Bayambang stretch and the Popont floodway, to the Popont swamp. A side-overflow fixed weir exists at the inlet of floodway as a diversion facility. Diverted flood discharge during the high water stage under present conditions is as follows:

Discharge befor diversion (m3/s)	Diverted discharge(m3/s) to Bayambang	to Floodway
2,000	1,800 (90%)	200 (10%)
3,000	2,300 (77%)	700 (23%)
4,000	2,600 (65%)	1,600 (35%)
5,000	3,000 (60%)	2,000 (40%)

In the Bayambang stretch which has a total of 9.64 km of stream, a 8.30 km long right dike with a 0.95 km long concrete dike (gravity wall type) and a 4.6 km long left dike exist running from the inlet of the floodway to the Calvo bridge. No dike has been constructed in the lower reaches from the bridge. The existing river width in the dike stretch range from 2,600 m to 450 m. The width of the bottle neck at the Calvo bridge section is 160 m. The minimum flow carrying capacity in the existing dike stretch is about 500 m3/s.

In the floodway stretch, which is 12.30 km long, a 6.0 km long right and 4.5 km long left dike and a 6.0 km long channel with about 35 m width are complete.

(2) Flood diversion system

Considering to the existing carrying capacity and riparian land use in the concrete dike stretch of Bayambang, the Popont floodway is planned as a main stream. On the otherhand, the Bayambang stretch allows some flood discharge to be carried under the present diking system.

The design flood discharge for the Bayambang stretch and the floodway are planned to be controlled with the following distribution.

Flood control plan	Design Discharge (m3/s)	Diverted discharge(m3/s)	
		Popont floodway	Bayambang stretch
Framework (100-yr flood)	9,200	8,200	1,000
Priority project (10-yr flood)	4,000	1,000	500

Non-gated diversion facilities are adopted in order to ease operation and maintenance. A fixed weir type and diversion channel type were compared, and diversion by means of the diversion channel type is consequently introduced. The results of this comparison study are described in the Supporting Report (DS). The major dimensions of the diversion channel are as follows:

- Location : Bayambang stretch side (Sta.AG307)
- Width of channel : 23.0 m
- Elevation of channel bed : 14.05 m

As a maintenance flow in the Bayambang stretch, irrigation water use was considered. With this diversion facility, about 15% (5.0 m3/s of monthly average 33 m3/s) of the dry season stream flow can be distributed to the Bayambang stretch fulfilling the existing private irrigation water use of about 2 m3/s which is taken by about 100 movable pumps.

(3) Popont floodway improvement plan

A 1,200 m wide floodway is planned by providing a set-back levee on the right bank outside the existing 850 m wide floodway and another on the downstream part on the left bank. In the stretch between the existing railway bridge and the Wawa bridge which is located in the retarding basin area, a right dike only is planned.

This set-back levee plan is formulated to enhance the hydraulic effects on flow carrying capacity and stability of the channel and dike in consideration of the existing narrow river width, which corresponds to about 65 % of that in the upper stretch, and the new river course alignment at the inlet of the floodway.

As for the implementation schedule of the set-back levee project, these works shall be done in the Priority Project phase because the heightening works of the existing dike, including the set-back levee stretch, lack coherence to step-wise improvement plan and are not economically feasible.

The low-water channel with a 150 m bed width is planned to carry a 1-year probable flood. The channel improvement in the stretch between the railway and the Wawa bridges is proposed to reduces the habitual submerged area in the Poponto swamp.

(4) Bayambang stretch improvement plan

The proposed river width in the lower reach from the Calvo bridge to the Wawa bridge is 250 m, while the width in the upper reach is planned the same as the existing one because the existing upper dikes have the design dike dimension.

Low-water channel improvement with a 100 m width is required downstream of the diversion facility and at the junction with the floodway channel, a total length of 2.5 km corresponding to 25% of the whole stretch.

(5) Inner-water drainage in Alcala area

With the construction of the floodway right dike and the Bayambang left dike, an adequate inner-water drainage system is required for the Alcala area which has about a 12 km2 drainage area.

The present land use in this area is classified as paddy field and residential land. The former is in the area with a ground elevation from

13.0 m to 17.0 m, the latter has a ground elevation from 15.5 m to 16.0m (M.S.L). On the other hand, the water levels of 5-year and 10-year probable floods in the Poponto natural retarding basin are 14.1 m and 15.6 m under the present storage capacity, respectively.

A inner-water drainage system with 4 drainage gates and a mound construction with a 15 m top elevation is proposed to mitigate submersion damages, in consideration of the present land use and the flood water levels in the Popont natural retarding basin.

(6) Major river improvement works

The river improvement works in the Bayambang - Alcala stretch consist of the following components:

- Construction of a new 9.70 km long earthdike in the Bayambang stretch
- Low-water channel improvement with a total length of 3.70 km in the Bayambang stretch
- Construction of a 3.50 km closure dike with a diversion channel
- Construction of a new 7.10 km long earthdike, a new 4.90 km set-back levee and heightening of 2.40 km of existing dike in the Poponto floodway
- Channelization and low-water channel improvement with a total length of 12.30 km in the floodway
- Revetment works along a total 6.10 km long low-water channel and a total 4.15 km long earthdike including a closure dike in the whole stretch
- Groin works of a total 0.90 km reaches
- Demolition of the existing Popont inlet weir and two railway bridges
- Construction of eight drainage gates
- Construction of two road bridges

2.4.3 Alcala - Carmen - Asingan stretch (AG321-AG405)

(1) Present river condition

The existing diking system confines this whole stretch except at the open levee sites. Among the existing dike stretches, concrete dikes exist on the left bank near the Plaridel bridge in Carmen and on the right bank in Asingan, a total of 5.4 km long. Major bank protection works can be found on the left banks in Alcala and in Carmen, and on the right bank in Villasis, a total length of which is 2.8 km.

The existing river width in the stretch ranges from 650 m to 2,800 m, by which it is assumed that longitudinal variation of flow carrying capacity and sediment transport capacity lacks uniformity. The Carmen stretch forms a bottle-neck with a minimum river width of 650 m and a sharp bend which subtends a deep and narrow section along a concave bank.

(2) River improvement plan

As for the set-back levee on the right bank in the Carmen stretch, it is a prerequisite in the Framework Plan to widen the existing river width to the extent of 900 m (a 2.8 km long stretch) because of significant degradation of the river bed (about 2 m in case of a 100-year probable flood). This water level lowering effect is about 0.50 m for a 100-year probable discharge. The set-back levee works are proposed to be implemented in the Priority Project phase because the heightening works of the existing dike in the proposed set-back levee stretch lacks coherence to the step-wise improvement plan and are not economically feasible.

An open levee system is proposed for the Tolongan, the Logasit, and old Agno Rivers, and a back levee is adopted for the Banila River.

The existing concrete dike in Carmen is improved with heightening of an average 0.6 m for the existing 3.6 km long stretch. Concrete dike heightening was adopted based on a comparative study with earth dike heightening plan which found the latter to involve significant land compensation and resettlement of residents along the left bank.

The proposed low-water channel improvement works are composed of enlargement of the channel width to 150 m and a cut-off channel to reduce potential bank erosion.

(3) Major river improvement works

The river improvement works in the Alcala - Carmen - Asingan stretch consist of following components:

- Heightening of a total of 17.65 long earth dike and a 2.5 km long concrete dike with restoration works
- Construction of a new 2.8 km long set-back levee in Carmen, a new 4.0 km long earth dike in Asingan with demolition of a existing concrete dike, and a total of 12.95 km long open levee and back levee.
- Low-water channel improvement with a total length of 26.25 km
- Revetment works along a total of 11.95 km low-water channel and a total of 12.85 km dike including the closure dike
- Groin works of a total of 5.65 km long stretch
- Construction of six drainage gates
- Extension works of the Plaridel bridge
- Improvement of two irrigation facilities of the LARIS

2.4.4 Asingan - San Manuel stretch (AG405 - AG474)

(1) Present river condition

This stretch forms braided channels composed of interconnected channels separated at random by sandy gravel bars, and flood flow readily spreads wide together with a heavy sediment load. Flow velocity in this stretch is around 3.6 m/s - 5.5 m/s for a 10-year probable flood. Thus, scouring acting on the toe and slope of dikes is destructive. The dike foundation on the right bank is highly permeable due to sand and gravel formation in the stretch from Sta. AG 421 to Sta. AG470. The present dike in the stretch has no flood control function due to damage by past floods and the 1990 earthquake.

(2) River improvement plan

One of the satellite technical matters for river improvement planning in this stretch is dike stabilization against flood flow taking into consideration the above mentioned river characteristics. Thus, the diking system is designed as follows:

- In the right dike stretch between Asingan and the junction of the Ambayoan River, the proposed dike alignment is set along the existing one, and dike revetment and boulder dikes are proposed in the whole stretch.
- In the right dike stretch between the junction of the Ambayoan River and Sta. AG470, a new dike is aligned over paddy land aside the old Agno River area, and adequate dike protection works are proposed. The existing dikes in this stretch are demolished, but the dike from Sta. AG467 to Sta. AG470 is planned to be maintained as guide wall to prevent: i) flood flow with high velocity from colliding directly against the new dike and ii) the main stream from shifting to the old river area.
- No diking system is proposed on the right bank in the upper reach from the junction of the Viray-Depalo River after taking into account the extent of inundation area without a dike and the flood retarding effect to downstream.

The low-water channel improvement works, such as excavation and cut-off in the upper reach of the Viray-Depalo River junction, are recommended to be followed after completion of the San Roque dam because the maintenance works of low-water channel would not overcome the supply of heavy sediment conveyed from the upstream basin under present conditions.

(3) Major river improvement works

The river improvement works in the Asingan - San Manuel stretch consist of following components:

- Heightening of a total of 9.45 km long earth dike
- Construction of a new 12.25 km long earth dike
- Low-water channel improvement with a total length of 5.95 km
- Revetment works along a total of 5.15 km low-water channel and a total of 20.3 km dike
- Groin works of a total 4.0 km long stretch
- Construction of one drainage gate

2.4.5 Bank and Dike Protection Works from Stream Current Erosion

(1) Countermeasurs against stream current erosion

The following countermeasures are adopted for bank stabilization and dike protection works:

a) Revetments are used for such purpose as stabilizing concave banks and bends and preventing dike erosion.

b) Groins are used to;
   - direct flow from one bend into the next bend downstream
   - fair out sharp bends to a large radius of curvature to provide a more desirable channel alignment
   - close off secondary and old channels
   - concentrate flow in a limited width within a wider channel
   - prevent scouring action on the toe of earthdikes
   - reduce flow velocity to prevent lateral erosion of earthdikes

c) Cut-off channel works are used to;
   - improve channel alignment
   - decrease maintenance of bends protection works or to reduce potential bank erosion

(2) Place of protection works

Places requiring protection works are planned based on the following criteria:

a) Low-water channel revetment is adopted for:
   - Concave bank of channel stretches where heavy scouring occured and no adequate protection works exist
   - Channel stretches where the mean flow velocity is higher than 3.5 m/s for a 10-year probable flood
   - Channel stretches where the distance between channel and dike toe is less than 50 m and flow velocity of low-water channel is higher than 2.5 m/s for a 10-year probable flood

b) Low-water channel groin is adopted for:

- Concave bank of channel stretches where heavy scouring occured and no adequate protection works done in case existing bed width is wider than design one

c) Cut-off channel is done in the following stretch:

- Ratio of meandering width to meandering length is larger than 0.5

d) Earthdike revetment is adopted for:

- Breaches and gaps sites caused by past floods
- Distance between dike toe and channel is less than 50 m

e) High-water channel groin is adopted for:

- Old river channel stretch near dike toe
- Braided channel stretch where mean flow velocity is higher than 3.0 m/s for a 10-year probable flood (boulder dike type)

3 PANTAL-SINOCALAN RIVER IMPROVEMENT PLAN

3.1 Present River Condition

3.1.1 River System

The Pantal-Sinocalan River heads from the northern mountains and flows southwest before turning on a northwestern course, and finally empties into the Lingayen Gulf. The catchment area and river length are about 1,115 km2 and 75.5 km, respectively. The river holds the tributaries such as: the Macalong, Mitura, Ingalera, and Dagupan Rivers which drain from its left bank. The major portion of the watershed of these tributaries is located in the plain area.

The river basin map and the river system diagram are shown in Figures 2.1 and 2.2, respectively.

Figure 3.1 shows the topographic characteristics of the lower reaches of the Pantal-Sinocalan River Basin. It is observed that the ground decends from the main river toward the Agno River, which is caused by the history of the Agno river course shifting. The Pantal and the lower and middle reaches of the Dagupan Rivers are the old Agno River.

3.1.2 Channel Condition

(1) General features of river channel

In view of stream form, the Pantal River stretch, which is the old Agno river, shows a straight channel, and the Sinocalan and Tagumising River stretches form a meandering channel. The cut-off channels can be found in the Sinocalan River around Calasiao town.

The general features of the present river channel of the Pantal-Sinocalan and the major two tributaries, the Dagupan and the Ingalera Rivers, are as follows:

River/Stretch	Channel Width(m)	Channel Depth(m)	Bed Slope
Pantal-Sinocalan R.			
·Pantal R. stretch	350 - 210	7.0 - 3.9	1/400
·Marusay R.stretch	110	5.2 - 3.9	1/3,300
·Sinocalan R. stretch	280 - 50	6.4 - 3.3	1/3,300-1,300
·Tagumising R. stretch	200 - 40	7.2 - 3.8	1/1,100- 550
Dagupan R.			
·Pantal junction - ·Capangbogan junction	280 - 90	12.0 - 6.0	1/3,000
·Capangbogan junction - Elang junction	30 - 20	7.8 - 2.3	1/10,000
Ingalera R.			
·Sinocalan junction - Marasiqui	100 - 60	7.0 - 3.0	1/5,000

Figure 3.2 shows the channel dimensions such as meandering width/length, channel width, depth, and bed slope of the main river.

(2) Sediment

The estimated annual transport capacity including wash load of the main Pantal-Sinocalan ranges from 450,000 - 550,000 m3/yr. As for the tendency of longitudinal variation of the channel bed fluctuation, it is estimated that the bed in the lower reaches of the junction with the Ingalera River and the upper reaches of Binalonan are aggradating, and the middle reaches are degradating.

(3) River mouth clogging

Excessive sedimentation by river and/or littoral current at the river mouth may block river flow and cause problems such as flooding, hindering navigation, and environment aspects.

The results of investigations on river mouth clogging are summarized as follows:

- The littoral current flows eastward at river mouth. Tide level ranges from about 2.30 m to about 0.70 m in gage height, and the average Mean Sea Level (M.S.L) is 1.45 m in gage height. (refer to Table 3.1)

- A sand bar is developing from the left side and water depth at the river mouth is shallow, only 1 m, although a 60 m width portion with a maximum depth of 7 to 8 m exists along the left bank.

- The width of the river mouth has been naturally maintained at about 200 to 300 m in spite of seasonal fluctuations; i.e., it is wider in the rainy season and narrower in the dry season.

- In the dry season, the water depth sometimes becomes shallow due to sedimentation, however, the river mouth has never been closed completely. Motorized fishing boats navigate along the deeper portion of the channel.

- The river mouth has never been dredged, however, dredging works have been done in the upper reaches of the Pantal River and in the lower reaches of the Marusay River since 1986 to enhance the flow carrying capacity for floods.

- Wave erosion on the right bank near the river mouth is in the advanced stages.

3.1.3 River Facilities and Related Structures

(1) Major river facilities for flood control

Existing river facilities for flood control in the Pantal-Sinocalan River are bank protection works such as groins and revetments, and only a total of about 3 km long earth-dike along the main river in Santa Barbara. Spur dikes and boulders are widely used for bank protection works. A locations and a list of existing river facilities in the Pantal-Sinocalan River are shown in Figure 2.5 and Table 3.2, respectively.

(2) Water use facilities

The irrigation intake dam for Sinocalan River Irrigation System exists at Santa Barbara in the main river. A improvement plan of rubber gate type with a width of 28 m and bottom elevation of 3.10 m is proposed by NIA. The two units of syphon cross the main river around 21 km and 34 km upstream of the river mouth in order to supply irrigation water. Their main features are shown in Figure 3.3.

As regards to facilities for other river water use in the project study area, the many intake check-gates for fish cultures are constructed along the downstream stretch of the Pantal-Sinocalan River, and the three ferry ports exist in the downstream of the Pantal River.

(3) Bridges

Many bridges crossing the rivers exist in the project study area. The main features of bridges are listed in Table 3.3. The total number of bridges by river are as follows:

River	Stretch	Number of Bridges
Main Pantal-Sinocalan	River mouth - Sta. S70	13
Dagupan River	Junction - Sta. D27	6
Ingalera River	Junction - Sta. I13	12

3.1.4 River Facility Damages due to Earthquake in 1990

(1) Damages to flood control facilities

It was reported by DPWH that the damage amounted to about 86 million pesos in the Allied River Basins in terms of the cost required for rehabilitation works. The Pantal-Sinocalan River Basin accounted for 17.4 million pesos. The major damage was to revetments and boulder dikes.

(2) Rehabilitation works of DPWH

PMO-AFCS Flood Control Program for Earthquake-Damage Rehabilitation/ Restoration was formulated, which in the Allied River Basin consist of 29 projects with a total cost of 86 million pesos as of February 28, 1991. The major works and the required cost are shown in Table 3.4.

3.1.5 Flow Carrying Capacity

The flow carrying capacity of the existing river channel for the main Pantal-sinocalan, Dagupan and Ingalera Rivers was estimated by means of non-uniform flow calculations based on river cross-sections surveyed after the Master Plan Study. The carrying capacity is defined as the bankfull discharge.

The estimated carrying capacity is summarized as follows:

River/Stretch	Carrying Capacity	
	Discharge (m3/s)	Return Period(yr)
- Main Pantal-Sinocalan River		
River mouth - Ingalera junction	100 - 500	1 - 2
Ingalera junction - Mitura junction	100 - 900	1 - 10
Mitura junction - Binalonan	200 - 900	3 - 25
- Dagupan River		
Pantal junction - Capangbogan junc.	300 - 500	2 - 5
Capangbogan junction - Elang junc.	60 - 250	1 - 5
- Ingalera River		
Sinocalan junction - Marasiqui	80 - 450	1 - 20

Figure 3.4 shows longitudinal profiles of the calculated water levels of some probable floods for the existing main river.

3.2 Outline of Framework Plan for Pantal-Sinocalan River Flood Control Plan

The Framework Plan for the Pantal-Sinocalan River was formulated for a flood control target of a 50-year probable flood with a combination of river improvement, a new Binalonan floodway in the upstream stretch of Sinocalan River and a new By-pass channel in the downstream stretch of Sinocalan River. The Binalonan floodway aimes to divert flood of the upper Sinocalan (Tuboy River) to the Angalacan River, a tributary of the Cayanga River. The Dagupan By-pass channel diverts the entire flood water of the main stream to downstream of Dagupan River, and flood water flows down to the Pantal River.

As a stage development plan of the Framework Plan, the Long Term Plan was formulated with an optimum development scale of 10-year probable flood. Flood control measures for the Long Term Plan consists of river improvement and a Dagupan By-pass channel only. Construction of the the Bonalonan floodway was planned as works to be done after river improvement works of the Cayanga-Patalan River from the study of implementation program.

The Framework Plan and Long Term Plan cover major tributaries in the Pantal-Sinocalan River system; Dagupan, Ingalera, Macalong and Mitura Rivers.

The general layout of the Framework Plan and the design discharge distribution are illustrated in Figures 3.5 and 3.6, respectively.

3.3 Preliminary Study for Alternative Flood Control Plan for Urban Stretch through Dagupan City

3.3.1 Necessity of Updating River Improvement Plan in Dagupan Urban Stretch for Framework Plan

The flood control plan in the downstream stretch of the Sinocalan River, called the Marusay River, was planned with river improvement works consisting mainly of dike construction and dredging works along the present river channel.

On the other hand, geotechnical data, new topographic maps with scales of 1:25,000 and 1:5,000, and new river cross-sections were made available in this study stage, and the following technical and socio-economic issues were identified.

a) The foundation soils in this area consist of loose sand from the ground surface to a depth of 5 m while a soft silty soil layer exists under the sand layer below elevation -15 m. Seepage, liquefaction, and consolidation settlement problems are highly probable. For designing the river width, not only carrying capacity but also a stable dike foundation should be considered.

b) For construction of a diking system having an adequate river width, commercial areas along the stretch need to be acquired. The number of commercial buildings and houses is roughly estimated below:

- in case of 120 m river width ; a total number of 730
- in case of 220 m river width ; a total number of 1,060

To resolve the above issues of the urban stretch, an alternative study was conducted based on additional data surveyed.

3.3.2 Alternative Plans

For the urban stretch of the Sinocalan River, the following alternatives are set out. The design flood discharge diagrams for the alternatives are shown in Figure 3.7, and have a flood target control of 50-year probable flood.

Alternative 1: Sole River Improvement

This plan aims to increase the carrying capacity of the urban stretch solely by enlarging low-water channel and constructing a diking system.

Alternative 1A = A river improvement with a 120 m river width in the urban stretch along the existing river channel (refer to Figure 3.8)

Alternative 1B = A river improvement with a 220 m river width in the urban stretch along the existing river channel (refer to Figure 3.9)

Alternative 2: Dagupan By-pass Plan

This plan aims to divert the major part of the flood discharge of the Sinocalan River toward the Dagupan River through a by-pass channel and to discharge it finally into the Pantal River downstream of Dagupan City. With this By-pass channel the river widening works for the urban stretch can be minimized.

Alternative 2A = Construction of Dagupan by-pass to discharge the whole flood, and provide only a drainage canal for the urban stretch. (refer to Figure 3.10)

Alternative 2B = Construction of Dagupan by-pass and river improvement with a 120 m river width in the urban stretch along the existing river channel. The maximum diverted discharge is 500 m3/s, which can flow down through the parallel concrete dike with about a 1.5 m height. (refer to Figure 3.11)

Alternative 3A: Sinocalan Floodway Plan (refer to Figure 3.12)
This plan aims to divert the major part of the flood discharge of the Sinocalan River and the Dagupan River directly into the Lingayen Gulf through a floodway. With this floodway the water level in the urban stretch can be lowered to an appropriate level for minimization of dike dimension and a number of resettlments.

Alternative 4A: Dagupan Floodway Plan (refer to Figure 3.13)
This plan aims to lower the flood water level downstream of the urban stretch and the back water level of the urban stretch by providing a floodway which diverts the flood discharge of Dagupan River directly to the sea instead of passing through the Pantal River. With this floodway the water level in the urban stretch can be lowered to an appropriate level for minimization of dike dimension and a number of resettlments.

The design channel features for alternatives are shown in Table 3.5. Figures 3.14 to 3.19 show the longitudinal profiles for the alternatives.

3.3.3 Proposed Plan

Of the above six alternatives of the flood control plan for the urban stretch of the Sinocalan River, the Alternative 2A, Dagupan By-pass channel only, is the least costly plan and is proposed as the flood control plan in the urban stretch of Sinocalan River. The economic cost of each alternative is shown in Table 3.6 and summarized as follows:

(Unit:1,000pesos)

Item	Alternative 1A	1B	2A	2B	3A	4A
Main Construction	785,707	742,917	801,546	880,707	1,413,554	1,213,062
Land Compensation	31,970	54,770	28,070	38,800	39,030	36,650
Resetlement of Buildings /Houses	2,172,620	2,980,480	242,320	1,589,320	581,600	2,223,360
	(1,540)	(1,870)	(920)	(1,080)	(940)	(1,740)
Total	2,990,297	3,778,167	1,071,936	2,508,827	2,034,184	3,473,072

Note; ( ) shows number of resettlement buildings and houses

3.4 Basic Concept and Criteria for Plan Formulation of Pantal-Sinocalan River Improvement

3.4.1 Basic Concept for Plan Formulation

(1) River improvement study area

The following river stretches were selected to review the river improvement plan formulated by the Master Plan Study based on additional survey data.

- Pantal-Sinocalan River: From River mouth to upstream of Tulong bridge (37.2 km length)
- Dagupan River : From Sinocalan River junction to upstream of Elang River junction (19.5 km length)
- Ingalera River : From Pantal River junction to downstream of Nagsangaan bridge (19.0 km length)

(2) Priority flood control project and Stage-wise plan

The priority project shall be implemented with a 10-year flood scale which is the same development scale as the Long Term Plan. The priority project area shall be decided in consideration of the existing carrying capacity and flooding conditions in Dagupan, Calasiao and Santa Barbara area for a 10- year probable flood. Thus, downstream stretches of the Dagupan and Ingalera Rivers will be covered as the priority project area. In consideration with an early realization of the flood control plan to meet urgent social requirements and amount of the construction fund, the Step-wise plan of the river improvement works for the priority project shall be studied.

(3) Design flood discharge

The 10-year flood discharge distribution is illustrated in Figure 3.20.

(4) Present river facilities

In this study the present condition for the basis of plan formulation is assumed to be the one after completion of the rehabilitation program by DPWH.

(5) Flood control measures

The flood control measures in the Study area consist of river improvement and the new Dagupan By-pass channel. The works consist of the following countermeasures:

- Construction of diking system for enhancement of flow carrying capacity
- Dredging and excavation of channel for enhancement of flow carrying capacity and channel stabilization
- Bank and channel stabilization works including cut-off channel
- Dike protection works against stream current erosion
- Construction and/or improvement of other appropriate facilities

(6) Survey data used for River improvement planning

The following survey data is applied for planning river improvement in this study.

- Topographic maps with a scale of 1:50,000 and map information as of 1977 published by National Cartography Authority Map
- Topographic maps with a scale of 1:25,000 and 1:5,000 made based on aerial photographs taken in 1989 by JICA and partially in 1981, which cover the whole Study area.
- River cross-sections with an interval of about 500 m done in 1990 by JICA and DPWH.

In the Master Plan study phase, only topographic maps with a scale of 1:50,000 and some river cross-sections at major existing bridges were available.

3.4.2 Criteria for Planning of River Improvement and By-pass Channel

The following criteria are applied for planning river improvement and By-pass channel.

a) River width

- No dike exists in the Pantal-Sinocalan River except for about a 3.0km long stretch downstream of Santa Barbara.

- Thus, the river width is designed considering existing meandering width and present land use on riparian areas mainly.

b) Channel section

- For the Sinocalan River, a compound section with high-water and low- water channels is adopted to stabilize low-water channel and to increase of flow area.

- For the Pantal, Dagupan and lower Ingalera Rivers, a single section is adopted in principle, considering the present flow capacity of the low-water channel which is about a 5-10 year flood in case of no back-water affect.

c) Low-water channel

- Channel alignment is designed with a smooth meandering form. Improvement of the existing channel alignment is done in the meandering stretches having a larger meander width than 80% of design river one.

- Low-water channel is designed with its flow capacity to carry an about 1.0-year to 2.0-year flood in consideration of channel stabilization. It is generaly regarded that this discharge has a dominanting effect in determining dimensions and characteristics of river course, channel, and bed.

- Average channel bed elevation under present conditions is considered for the design channel profile and bed elevation. A change of channel bed gradient is kept at less than two to prevent bed fluctuation, and design bed elavation is set at the average of the existing channel.

- Channnel bed width is designed to average existing one.

d) High-water channel

- High-water channel elevation is set at the present channel or ground level. In case the high-water channel around the toe of a new dike is on irregular land such as an old stream, then groin works and filling of old stream are considered to protect the dike from stream current erosion.

e) High water level (H.W.L)

- High water level is decided by the water level of non-uniform flow calculations.

- With regard to Manning's coefficient of roughness for water level calculations, coefficients of 0.028 to 0.035 for low-water channel and 0.040 to 0.045 for high-water channel are adopted.

- With regards to starting water levels at the river mouth for non-uniform flow water level calculations, the tide level of 0.80 m which is average yearly maximum tide level is adopted.

f) Dike

- Type : An earth embankment is adopted in principle if these is no special restriction of land use for dike construction.

- Dike crown elevation : it is set at the H.W.L elevation plus a freeboard as shown in Figure 3.21, which is the same criteria for the upper Agno River.

- Dike section : In accordance with the Standard for River and Sabo Engineering by MOC of Japan as shown in Figure 3.22.

- As for countermeasures against liquefaction of the dike foundation, a counterweight earthfill is used for earthdikes. The counter-measured stretches and standard design cross-sections are shown in Figures 2.15 and 3.22, respectively, and are described in the Supporting Report (SD).

g) Bank and dike protection works

- Those location plan described in sub-section 3.5.5.

h) Inner-water drainage facility

- Drainage area and facility sites are decided based on dike location, topographic elements, and the present condition of drainage canals.

- The drainage flow area of the above facilities is designed for a 5-year probable flood estimated by hydrological analysis which considers present land use and drainage canals.

- A drainage pump plant is considered only for urban area. The necessity of a pump plant and pump capacity are estimated by hydraulic and economic analysis.

i) Related river facilities

- Existing water intake facilities which hinder the flow of a 10-year design flood and/or are inadequate structural types for the proposed flood control plan, are to be improved as works of the Priority Project.

- Existing briges which do not meet the design elevation of the dike crown and/or design river width, are improved against a 50-year design flood in principle. In case the 10-year flood can flow with the required free board by extending the existing bridge length, those bridges are improved only for the 10-year flood scale. Reconstruction of foot-bridges is not covered by this Priority Project.

3.5 Proposed River Improvement Plan

3.5.1 Principle Features of Proposed Plan for the Whole Stretch

(1) Design channel features of river improvement plan

Principle features of design channel in the Study area (defined in sub-section 3.4.1) are shown in Table 3.7 and summarized below:

- Main Pantal-Sinocalan River

River/Stretch	River mouth - Ingalera R.	Pantal-Sinocalan Ingalera R. - Catablan R.(P59)	P 59 - P 70
Design discharge(m3/s)	2,000-1,250	1,250-650	650-350
River width(m)	600- 220	200-150	100
Gradient of channel bed	1/2,350	1/1,850	1/1,150
Channel bed width(m)	60- 40	30	25
Design water depth(m)	6.6	6.6-5.95	5.95-5.14

- Tributaries

River/Stretch	Dagupan R. By-pass - Capangbogan R.	Dagupan R. Capangbogan R. - Elang R.	Ingalera R. Sinocalan R. - Marasiqui	Ingalera R. Marasiqui - I.18
Design discharge (m3/s)	700-550	400	360	260
River width	450-150	100	120	100
Gradient of channel bed	1/10,000	1/5,800	1/5,000-2,500	1/1,800
Channel bed width(m)	Existing	25	20	15
Design water depth(m)	6.6-6.0	6.0-6.6	6.6-6.3	6.1

The design plan, longitudinal profile, and typical cross-sections are shown in Figures 3.23 to 3.31, respectively.

(2) River improvement area for Priority Project

The following three river stretches are selected as the Priority Project area to be urgently implemented:

- Pantal-Sinocalan River: From River mouth to upstream of the Catablan River junction (27.5 km length)
- Dagupan River : From By-pass channel junction to upstream of Elang River junction (19.5 km length)
- Ingalera River : From Pantal River junction to downstream of Bogtong bridge;Sta.I8+0.8km (10.7 km length)

In planning these stretches, the following points were considered:

- The most significant area economically is the towns of Dagupan, Calaciao, and Santa Barbara,and there neighboring areas.

- The lower reaches of the junction with the Mitura have in sufficient flow carrying capacity for a 10-year probable flood. In the upper stretch of Santa Barbara, the submerged areas from a overbanking flood are limited by the embankment of the ARIS irrigation canal.

- In the Dagupan River, the elevation of banks in the stretch between the junction with the by-pass channel and 19 km upstream of the junction is lower than the back water level of the main river. No configuration of ground and facilities exist near the channel to prevent overbanked flood water from spreading to Dagupan city area.

- In the Ingalera River, the elevation of banks in the 3.5 km long upper stretch of the junction with the Sinocalan is lower than the back water level of the Sinocalan River. Part of the flood water in the 9 km long upper stretch of the junction with the Sinocalan can spread to Calasiao town area.

(3) Major river improvement works for Priority Project

The river improvement works in the Priority project area are shown in Tables 3.8 to 3.11 and summarized as follows:

Major Work Items	Pantal-Sinocalan R.	Dagupan R.	Ingalera R.
• New earthdike construction(km)	48.50	41.90	19.00
• Channel improvement(km)	15.85	7.00	10.70
• Protection works of L.W.C low-water channel(km)	6.25	0.55	0.80
• Protection works of dike and dike foundation(km)	7.06	2.87	0.93
• Drainage gates(pcs.)	16	11	3
• Bridges(pcs.)	5	5	4
• Water intake (pcs.)	4	17	0

Detailed study results are described in sub-sections 3.5.2 to 3.5.4.

3.5.2 Main Pantal- Sinocalan River

(1) River improvement plan for the Priority Project

a) Pantal River stretch

The minimum design river width of the Pantal River stretch including the lower Dagupan River from the junction with a new Bay-pass channel is set at 400 m. In the stretch where the existing bed elevation is higher than the design one, a low-water channel bed 60 m wide is proposed. The existing sectional form remains in the greater stretch because this stretch is the old Agno River and has sufficient flow area to carry the design flood by only constructing a dike with about 1.2 m - 2.2 m height.

In the junctioning plan for two tributaries, the Caloocan and Bolosan Rivers, water gates are provided to prevent inundation by back water.

The sectional form and bed elevation of the river mouth are designed to standard dimensions since there is no special problem for river mouth clogging, drainage of inner-water, and navigation under the present river condition.

b) By-pass channel stretch

The by-pass channel plan aims to divert the whole flood discharge of the Sinocalan River at about 0.8 km downstream of the junction of the tributary Ingalera toward the tributary Dagupan River and to discharge it finally into the main Pantal River downstream of Dagupan City. With this by-pass channel the existing river stretch in Dagupan City has only a flood control function as a drainage canal.

The proposed route of the by-pass channel was selected finally in consideration of resettlement issue based on the new topographic map with a scale of 1:5,000. The length, river width, and channel bed width are 3.20 km, 220 m, and 40 m, respectively.

c) Water gates in Dagupan urban stretch

Two water gates are provided for flood control, navigation, and water quality maintenance in the Dagupan urban stretch (Marusay River) of the Sinocalan River; the lower gate at junction with the Pantal River and the upper gate at the dike site of the by-pass channel.

The lower gate aims to drain inner-water in Dagupan urban area which has a 6.33 km2 catchment area and to provide navigation. The design width of this gate is planned at 10 m, which allows the navigation of the community transport boats and small fishing boats (about 2,500 person trip/day) to be maintained. A loading yard for one naval ship and one dredger is planned at the Pantal River side of the gate. The results of inner-water drainage study are described in Sub-section 3.5.6.

The upper gate aims to take in water for maintaining water quality in the Marusay River from the Pantal River. The design width of this gate is planned at 10 m wide, by which the 95-day discharge (about 30 m3/s) is taken in. The discharge required for maintenance flow in the Marusay River stretch is described in the Suporting Report (EI).

d) Upper stretch of the junction with the Ingalera River

The proposed diking system is composed of a parallel earthdike with a 200 m river width in the downstream reach of the junction with the Quinabalotan River and a left earthdike only in the upstream reach of the junction.

The proposed low-water channel improvement plan is mainly composed of enlargement of the channel to 30 m wide and a cut-off channel to reduce potential bank erosion. In designing this sectional form and bed elevation, the structural dimensions of the existing syphons and the reconstruction plan of Sinocalan irrigation dam by NIA were considered.

e) Seawater intrusion

Seawater intrusion is estimated under two channel conditions; i) present river and ii) improved river. The study results are described in the Supporting Report (HY) and summarized as follows:

- Existing channel ; about 13 km from the river mouth (about 0.5 km upstream of junction of the Ingalera River)
- Improved channel ; about 14 km from the river mouth (about 1.5 km upstream of junction of the Ingalera River)

Therefore, the Sinocalan irrigation dam of the existing intake facility which is located about 24 km from the river mouth will not be affected by seawater intrusion under the improved channel condition.

The design plan, longitudinal profile, and typical cross-sections are shown in Figures 3.23 to 3.25, respectively.

(2) Major river improvement works for Priority Project

The river improvement works in the main Pantal-Sinocalan River stretch consist of the following components:

- Construction of a new 48.5 km long earthdike
- Low-water channel improvement with a total length of 15.85 km including a 3.1 km by-pass channel
- Construction of counterweight earthfill against liquefacting of earthdike foundation in a total of 32.0 km reaches
- Revetment works of a total 6.25 km long for low-water channel and a total 7.06 km long for earthdike
- Groin works in a total 0.08 km reaches on secondary channel
- Construction of 17 drainage gates, of which 5 gates are for navigation and fish ponds
- Construction of 3 intake culverts with a gate for fish cultivation, 1 box culvert with a gate for the irrigation dam, and 1 water gate for maintenance flow
- Construction of 5 bridges
- Demolition of 1 railway bridge and 3 road bridges

3.5.3 Dagupan River

(1) River improvement plan for Priority Project

The existing channel characteristic of the Dagupan River change downstream or upstream of the junction with the Capanbogan River which is located about 11.5 km upstream of the junction with the Pantal River, because the downstream reaches are the old Agno River.

The diking system is designed with 450 m - 150 m river width in the downstream reach and 100 m river width in the upstream.

The stretch subject to low-water channel improvemnt is composed of two major plans; i) in the downstream reach the existing channel is the same as the design one except for a 0.7 km cut-off channel and ii) in the upstream reach a 25 m wide low-water channel and a cut-off channel are designed.

The design plan, longitudinal profile, and typical cross-sections are shown in Figures 3.26 to 3.28, respectively.

(2) Major river improvement works

The river improvement works in the Dagupan River stretch consist of the following components:

- Construction of a new 41.9 km long earthdike
- Low-water channel improvement with a total length of 7.0 km
- Construction of counterweight earthfill against liquefacting of the earthdike foundation in a total of 11.0 km reaches
- Revetment works along a total 0.55 km long low-water channel and a total 2.87 km long for earthdike
- Construction of 11 drainage gates
- Construction of 16 intake culverts with gate for fish cultivate
- Construction of 5 bridges
- Demolition of 1 road bridge

3.5.4 Ingalera River

(1) River improvement plan for Priority Project

The diking system is designed with 120 m river width, and for a total 2.1 km long stretch where the bank elevation is higher than the design dike crown the diking system is not required. The low-water channel with a 20 m wide bed is proposed in consideration of the existing channel width which only allows about a 5-year probable flood can be carried through.

The design plan, longitudinal profile, and typical cross-sections are shown in Figures 3.29 to 3.31, respectively.

(2) Major river improvement works

The river improvement works in the Ingalera River stretch consist of the following components:

- Construction of a new 19.0 km long earthdike
- Low-water channel improvement with a total length of 10.7 km including a 3.0 km cut-off
- Construction of counterweight earthfill against liquefacting of the earthdike foundation in a total of 1.1 km reaches
- Revetment works along a total 0.80 km long low-water channel and a total 0.93 km long for earthdike
- Construction of 3 drainage gates
- Construction of 4 bridges
- Demolition of 2 road bridges

3.5.5 Bank and Dike Protection Works from Stream Current Erosion

Bank stabilization and dike protection works are contemplated basically by the same types of protection works adopted to the Agno River. However, the Pantal-Sinocalan River shows a different river regimen and hydraulic elements from those of the upper Agno River, and is in a different present developed level of flood control facilities than the Agno.

The geotechnical conditions of river stretches are mainly if thick fine to medium sand which can be easely eroded, however, mean flow velocity for a 10-year probable flood in the Priority Project stretches ranges 1.2m/s - 1.5m/s in the Pantal-Sinocalan and Ingalera Rivers and 0.7m/s - 1.0 m/s in Dagupan River.

Therefore the places and type for protection works is set as follows:

- Low-water channel revetment is adopted mainly in the upper reach from the junction of the Ingalera River which has a developed meandering channel in the Priority project stretches.
- Dike revetment with foundation protection works is adopted in closure dike stretches and at dike foundation, crossing channels.
- A groin type is not used to prevent the opposite bank erosion in consideration to design channel width.

3.5.6 Inland Drainage Plan in Daupan City Area

The rain water drainage system in the urban area of Dagupan City was damaged by the earthquake on July, 1990. Rehabilitation and improvement is now underway as shown in Figure 3.32.

Construction of a new by-pass is proposed in the flood control plan. The flood flow from the upstream reaches is diverted into the Dagupan River through a new-by-pass channel and no flood inflow is allowed in the urban stretch of Dagupan City. Thus, the existing downstream stretch of the Sinocalan River, about a 9.0 km channel length, will be a main canal to drain rain water collected from a drainage area of 6.33 km^2 as shown in Figure 3.33. In this connection, the inland drainage plan is preliminary studied as discussed below.

(1) Basic conditions

a) Criteria for the drainage plan

- Probable flood discharge from the drainage area is estimated by the rational method (refer to Sector Report on Meteohydrology).
- Storage capacity below El. 0.0 m is assumed as dead capacity. (refer to Figure 3.34)

- Outer-water level is calculated by using a rating curve constructed based on the non-uniform flow calculation. (refer to Figure 3.35)
- Mean sea level (MSL=El.0.0m) is adopted as a starting water level for the simulation.
- The design of water gate dimensions (terminal drainage facility) considers drainage capacity and the navigation.

b) Probable discharge and outer-water level estimated

Probable discharge and outer-water level is summarized as follows:

- Peak discharge from inland drainage area
  - 5-year probable discharge= 49.7m^3/s
  - 10-year probable discharge= 57.7m^3/s
- Outer-water level (flood water level in Dagupan River)
  - 5-year: peak water level= El. 0.83m
  - 10-year: peak water level= El. 1.32m
- Flood discharge hydrograph and water level hydrograph are shown in Figure 3.36.

c) Dimensions of water gate
- Width : w = 10.0m
- Bed elevation : El. = -4.40m

d) Hydraulic analysis

The following operation methods were applied in a hydraulic simulation.
- Natural drainage method : gate operation only
- Pumping drainage method : joint operation by drainage pump and gate

The hydraulic simulation was conducted for the following combination of different probable flood occurrences:

Case	Outer land	Inner land
Case-1	5-year	5-year
Case-2	10-year	5-year
Case-3	10-year	10-year

(2) Simulation Results

The simulation results are shown in Figure 3.36 and summarized below:

Case of Flood		Drainage type		
		Gate only	Pump $Op=5m^3/s$	Pump $Op=10m^3/s$
Case-1	Max.W.L (El.m)	0.76	0.68	-
	Area(ha)	93	65	-
Case-2	Max.W.L (El.m)	0.91	0.74	0.66
	Area(ha)	185	90	60
Case-3	Max.W.L (El.m)	1.00	0.77	0.72
	Area (ha)	205	95	85

Note: Max.W.L : Maximum inundation water level
Area : Inundation area   Op : Pump drainage capacity

(3) Proposed Drainage Plan

a) Estimation of inland damage

The direct damage due to inland inundation is estimated based on the following major assets in consideration of present land use therein:

- residential house damage
- building damage
- household effects damage
- inventory stock/equipment damage

The distribution of houses and buildings are estimated based on topographic map with scale of 5,000 as listed below.

Elevation(m)	Land area(km^2)	Number of Building	Number of House
0.3 - 0.5 m	0.15	43	170
0.5 - 1.0 m	1.90	334	1,147
Total	2.05	377	1,317

The above buildings and houses are located above El. 0.3 m. Thus, no inundation damage in the inland area will be occurred while the outer water level is below El. 0.3 m which corresponds to a 1.5 year probable flood. The estimated inland flood damage under the drainage by gate operation are summarized below:

Probable Flood	Inundation Water Level	Building*1	House*2	Total Damage (10^3 Pesos)
1.5-yr	0.30m	0	0	0
2.0-yr	0.55m	80	300	1,080
5.0-yr	0.76m	215	760	3,840
10.0-yr	1.00m	387	1,317	10,112

Note; *1 Number of submerged buildings
*2 Number of submerged houses

b) Preliminary cost-benefit analysis

A preliminary economic cost-benefit analysis was conducted by using the estimated project cost of pumping stations and benefits thereby. The benefits are estimated as the reduction of cumulative annual average probable flood damage under the condition with pumping facilities. The results of cost-benefit analysis are summarized below.

Pump Capacity	Reduction of Damage (Pesos)	Construction Cost (Pesos)	Benefit-Cost Ratio	EIRR (%)
P = $3m^3/s$	453.6×10^3	57×10^6	0.12	1.66
P = $5m^3/s$	654.1×10^3	70×10^6	0.17	3.09
P = $10m^3/s$	785.7×10^3	100×10^6	0.12	1.47

c) Proposed drainage plan

The pump drainage of inland water in Dagupan city area is assessed to be economically infeasible. However, a total number of 975 buildings/houses will be submerged by a 5-year probable flood without a drainage pump. As countermeasures to mitigate inundation damages of the inland drainage basin, the following drainage plan might be recommended:

- To divert part of the inland flood discharge from the water gate site to the Bolosan River of which junction with the Pantal River locates at a point 1.3 km downstream of the proposed gate, through a new drainage canal along the right dike of the Pantal River.

- The water level of the Pantal River at the junction of the Bolosan River is lower by about 0.4 m than that at the site of proposed gate in Dagupan City. Thus, no inundation for a 5-year probable flood in the city might be expected.

TABLES

Table 2.1 EXISTING FLOOD CONTROL FACILITIES IN UPPER AGNO RIVER

STRETCH OF DIKING SYSTEM	EARTH-DIKE (km)	GRAVITY WALL/REVET. (km)	L.W.C REVETMEN (km)	SPUR DIKE (km)	BOULDER (km)
Bayambang Baby Dike Section	0.98 (R)	0	0	0	0
Bayambang-Villasis Dike Section	18.37 (R)	1.89 (R)	0	11.20 (R)	0
Villasis-Asingan Dike Section	12.00 (R)	0.40 (R)	0	3.00 (R)	0
Asingan-Sn.Manuel Dike Section	17.40 (R)	2.20 (R)	0	7.00 (R)	1.10 (R)
Anulid-Bautista Dike Section	5.80 (L)	0	0	0	0
Anulid-Poponto Dike/Floodway	4.67 (L)	0	0	3.80 (L)	0
	6.03 (R)	0	0	9.50 (R)	0
Alcala-Sto.Tomas Dike Section	7.20 (L)	4.73 (L)	7.50 (L)	0	0.70 (L)
Rosales-Lagasit Dike Section	4.00 (L)	1.20 (L)	0	0	0
Lagasit-Sta.Maria Dike Section	12.06 (L)	0	0	0	0
Sta.Maria-Tayug Section	0 (L)	0	0	0	0

NOTE:(R):RIGHT BANK,(L):Left bank
L.W.C ; Low-water channel

Table 2.2 (1/3) PMO-AFCS FLOOD CONTROL PROJECT FOR EARTHQUAKE-DAMAGE REHABILITATION RESTRATION

Project/Description/Location	Cost x10 ^{3}P	Major Work
I AGNO RIVER CONTROL PROJECT		
I.1 RIVERMOUTH TO WAWA, BAYAMBANG, PANG. STRETCH		
1. Pantal spurdikes sta. 0 + 590 to sta. 0 + 830 Pantal, Bugallon, Pang.	2,500	Restoration of Spurdikes
2. Boulder spurdikes sta. 0 + 530 to sta. 0 + 570 Pantal, Bugallon, Pang.	500	Restoration/ Rehabilitation of Spurdike
3. Asinan Spurdikes sta. 0 + 120 to sta. 0 + 180/sta = 0+000 to sta 0 + 185 & sta 0 +000 to sta to 0 + 185 & sta 0 + 212 to sta 0 + 709.35 Asinan, Bugallon Pang.	3,500	Restoration of Spurdikes/ Boulder banks
4. Rosario-Lingayen Earthdike sta. 36 + 940 to sta. 36 + 660 Tumbor, Naguelguel, Lingayen Pang.	2,815	Restoration/ Rehabilitation of Spurdikes
5. Brgy. Naguelguel, Tumbar sta. 36 + 980 to sta. 37 + 260 Lingayen, Pang.	3,840	Restoration/ Rehabilitation of Spurdikes
6. Brgy. Bocboc West sta 0 + 160 to sta 0 + 320 sta. (-) 0 + 540 to sta. (-) 0 +700 Aguilar, Pang.	2,326	Restoration / Rehabilitation of Spurdikes
7. Aguilar Spurdikes sta. (-) 0 + 500 to sta. (-) 0 + 000; sta. 0 + 040 to sta. 0 + 120 Bocboc, Aguilar, Pang.	2,326	Restoration of Spurdikes
8. Urbiztondo-San Carlos Flood Control sta. 23 + 800 to sta. 24 + 200; sta. 24 + 980 to Sta. 25 + 260 Brgy. Salinap & Bocboc, San Carlos Pang.	5,000	Rehabilitation of Spurdikes
9. Malibong spurdikes sta. 1 + 600 to sta 1 + 720 Urbiztondo, Pang.	1,000	Restoration of Spurdikes
10. Brgy. Malibong sta. 1 + 760 to Sta. 1 + 880 Urbiztondo Pangasinan	1,000	Restoration of Spurdikes
11. Urbiztondo boulder bank protection sta. 0 + 225 to sta. 0 + 275 Poblacion, Urbiztondo, Pang.	1,000	Restoration/ Rehabilitation of boulder bank (Spurdikes)
12. Brgy. Poblacion, Urbiztondo, Pang. sta. 0 + 172 to sta. 0 + 225 (Boulder bank protection)	1,000	Restoration/ Rehabilitation of boulder banks
13. Sawat spurdikes sta. 2 + 840 to sta. 3 + 000 Sawat, Urbiztondo, Pang.	1,000	Restoration of Spurdikes
14. Sitio Quetaguet, Brgy. Sawat sta. 2 + 640 to sta. 0 + 800 Urbiztondo, Pang. (Spurdike)	1,000	Restoration/ Rehabilitation of spurdikes
15. Const. of boulder spurdikes Brgy. Malioed, sta 0+000 to sta 0 + 180 Bayambang, Pang.	3,000	Rehabilitation of Spurdikes
16. Bayambang-Urbiztondo-San Carlos-Lingayen Earthdike, sta 920 to Sta. 1 + 160; Sta. 2 + 720 to Sta. 4 + 320 ; Sta. 11 + 200 to Sta. 11 + 480; Sta. 12 + 800 to Sta. 12 + 400/ sta 2 + 720 to sta 4 + 094 Urbiztondo, Pang.-Phase II	7,705	Restoration of Earthdike/boulder apron
Total	39,512	

Table 2.2 (2/3) PMO-AFCS FLOOD CONTROL PROJECT FOR EARTHQUAKE-DAMAGE REHABILITATION RESTRATION

Project/Description/Location	Cost x10³P	Major Work
I.2 WAWA, BAYAMBANG TO CARMEN, ROSALES STRETCH		
17. Bayambang revetment sta 19+200 to sta 19+115/ sta 19 + 200 to sta 19 + 014 Bayambang, Pang.	1,000	Restoration of conc. Revetment/ boulder apron
18. Const. of drainage & clearing of silted canal,sta 0+000 to Sta 1+000, Pob. Bayambang, Pang.	1,500	Rehabilitation of drainage canal
19. Anulid-Bautista Earthdike Section, sta 1 + 920 to Sta. 2 + 991.84 Bautista, Pang.	140	Restoration of Earthdike
20. Villasis-Bayambang Earthdike Section Sta 9+240 to Sta 11+960; Sta 11+960 to Sta 14+600; Sta 14+600 to Sta +18+000/Sta. 14+381 to Sta. 15+173 Gualsic, Caranglaan, Ataynan along Villasis-Bayambang, Pang - Phase II	32,220	Restoration of Earthdike/ boulder apron
21. Anulid-Poponto Floodway sta 0+050 to sta 0+464 San Vicente, Alcala, Pang.	882	Restoration of Earthdike
22. Sto. Tomas-Alcala Section sta 5 + 640 to sta 6 + 560; sta 7+040 to sta 7+200; sta 7+880 to sta 7+960; sta 8+250 to sta 9+010/sta 8+250 to sta 8+760/sta 9+010 to sta 9+118 Alcala, Pang.-Phase II	7,000	Restoration of Earthdike/ boulder dike/ boulder apron
Total	42,742	
I.3 CARMEN, ROSALES TO SAN MANUEL, PANG. STRETCH		
23. Carmen-Rosales Gravity Wall sta 1 + 720 to sta 1 + 660 Tumana West, Rosales, Pang.	226	Restoration of Wall
24. Villasis-Asingan Earthdike-Section sta 9+000 To sta 12+000 Villasis, Asingan, Pang.	8,336	Restoration of Earthdike
25. Asingan Revetment, sta 1+730 to sta 1+997.50 Cabalitian, Asingan Pang.	1,050	Restoration of Conc.Revetment
26. Sta. Maria-Tayug Earthdike-Section Sta 8+100 To sta 8 + 810 Sta. Maria, Tayug, Pang. - Phase II	2,000	Restoration of Earthdike
27. Asingan-San Manuel Earthdike-Section Sta 23+500 to sta 23+822 Asingan-San Manuel, Pang.-Phase II	1,908	Restoration of Earthdike
Total	13,520	
II TRIBUTARIES TO AGNO RIVER		
II.1 TOTONOGEN - BANILA RIVER CONTROL PROJECT.		
28. Totonogen Earthdike; sta0+000 to sta 1+200(left);sta 0 + 000 to sta 0+950 (right) Tumana East, Rosales, Pang.	1,240	Restoration/ Rehabilitation of Earthdike
29. Banila Eadrthdike-Section sta 0+000 to sta (-) 0+640/ Sta 0+880 to sta 0+749.70 Bulangao, Pang. - Phase II	765	Restoration of Earthdike/ boulder bank
30. Const.of earthdike & boulder bank protection, sta 5+900 to sta 6+784.24 Brgy. Barat, Umingan, Pang.	1,530.70	Rehabilitation of Earthdike
31. Banila Earthdike sta 0+880 To sta 1+842.40 Umingan, Pang - Phase II	1,500	Restoration of Earthdike
Total	5,035.70	

Table 2.2 (3/3) PMO-AFCS FLOOD CONTROL PROJECT FOR EARTHQUAKE-DAMAGE REHABILITATION RESTRATION

Project/Description/Location	Cost x10 ^{3}P	Major Work
II.2 VIRAY - DEPALO RIVER CONTROL PROJECT		
32. Viray - Depalo Earthdike Section sta (-) 1+760 to sta(-) 2+265 & sta (-)2+685 to sta (-)3+058 (Left); sta (-) 0+175 to sta (-) 0+775 (Right) sta (-) 2+189 to sta (-) 2+265 & sta (-) 2+685 to sta (-) 3 + 058 Tayug, Natividad, Pang - Phase II	1,809	Restoration of Earthdike/ boulder apron
33. Viray - Depalo Earthdike sta (-) 5+500 to sta (-) 5+365 Bantug, San Quintin, Pang.	750	Restoration of Earthdike
Total	2,559	
II.3 AMBAYAOAN RIVER CONTROL PROJECT		
34. Ambayaoan Earthdike and boulder bank protection San Rafael, Sobol, Salincub, San Nicolas, Pang.	2,990	Restoration / Rehabilitation of Earthdike
Total	2,990	
II.4 TARLAC RIVER CONTROL PROJECT		
35. Dredging of Tarlac River sta 2+400 to sta 24 +000	200	Repair/ Restoration of Dike
(25 - km) by Bulldozing	50,000	Dredging
36. Tagak Earthdike and boulder bank protection - Olo River Control Project, sta 0+000 to sta 0+740 Olo - Cacamposan, Mangatarem, Pang.	1,500	Restoration of Earthdike
37. Pottot - Bunao gravity wall sta 0+000 to sta 0+688.40 Mangatarem, Pang.	1,000	Restoration of of gravity wall
38. Pottot - Bunao River Control Project sta 0+000 to sta 0+ 320 Brgy. Bugtong - Bunao, Mangatarem, Pang.	3,840	Restoration/ Rehabilitation of conc.Revetment
39. Const. Earthdike and Boulder Spurdike, Baracbac River Control Project, sta 0+000 to sta 0+430 (Right) sta (-) 0+160 to sta 1 +785 (Left) Brgy. Bugtong, Centro, Mangatarem, Pang.	2,000	Rehabilitation of Earthdike
Total	58,540	

Table 2.3 FEATURES OF DESIGN CHANNEL OF UPPER AGNO RIVER

River:Agno River
Design Flood: 10-yr

Item	Unit	Retarding	Floodway	Bayambang	Agno R
		AG.181- FW.314	FW.314- FW.320B	AG.282B -AG.307	FW.320B -AG.351
Discharge	m3/s	-	3500	500	4000
Length of Stretch	m	7100	3800	9640	15930
Gradient of Channel Bed	-	1/1600	1/1600	1/1850	1/1600
River width	m	-	1200	250-1300	900-1900
Width of Channel Bed	m	150	150	80-100	150
Gradient of H.W.L	-	Level	1/1600	1/1680	1/1600
Dike Height (Ave.)	m	4.00	3.05	2.05	3.05
Water Depth	m	8.78-5.85	5.85	5.85	5.85
Low Channel Depth (Ave.)	m	4.00	4.00	5.00	4.00

Item	Unit	Agno R			
		AG.351- AG.367	AG.367- AG.414	AG.414- AG-453	AG.453- AG.460
Discharge	m3/s	3500	3500	3500	2400
Length of Stretch	m	8170	8150	5330	3120
Gradient of Channel Bed	-	1/1300	1/665	1/440	1/280
River Width	m	1250-3000	3000-2000	2000-1200	1500-3000
Width of Channel Bed	m	150	150	100/Exist.	Existing
Gradient of H.W.L	-	1/1300	1/665	1/440	1/280
Dike Height (Ave.)	m	2.80	2.50	2.20	1.50
Water Depth	m	5.85-430	4.30	4.00	3.30
Low Channel Depth (Ave.)	m	3.50	3.00	3.00	3.00

Item	Unit	Agno R.		
		AG.460- AG.464	AG.464- AG.469	AG.469- AG.474
Discharge	m3/s	2400	2400	2400
Length of Stretch	m	1990	2420	2800
Gradient of Channel Bed	-	1/230	1/230	1/230
River Width	m	3000-2200	2200-1100	1100-300
Width of Channel Bed	m	Existing	Existing	Existing
Gradient of H.W.L	-	1/230	1/180	1/230
Dike Height (Ave.)	m	1.50	1.70	1.20
Water Depth	m	3.30	3.30-4.70	4.70-5.30
Low Channel Depth (Ave.)	m	3.00	3.50	5.00

Table 2.4 SUMMARY OF DIKE CONSTRUCTION AND LOW-WATER CHANNEL IMPROVEMENT WORKS IN UPPER AGNO RIVER

(Unit: km)

STRETCH	BAYAMBANG-ALCALA		ALCALA-ASINGAN	ASINGAN-SAN MANUEL	WHOLE
	Bayambang (L=9.64)	Floodway (L=12.30)	AG321 - AG405 (L=26.25)	AG405 - AG474 (L=20.26)	(L=68.45)
DIKE CONSTRUCTION					
(Right Dike)					
New Dike	4.80	9.50 (SB=2.4)	7.25 (SB=2.8)	12.25	38.80
Heightening	0.00	2.40	10.00	3.55	15.95
Existing	7.45	0.65	10.90	2.85	21.85
No Diking Sys.	0.00	0.00	0.00	0.00	0.00
(Left Dike)					
New Dike	4.90	2.50 (SB=2.5)	12.50 <1	0.00	19.90
Heightening	0.00	0.00	10.15	5.90	16.05
Existing	4.00	3.00	12.90	0.50	20.40
No Diking Sys.	0.00	0.00	0.00	14.31	14.31
(Total)					
New Dike	9.70	12.00 (SB=4.9)	19.75	12.25	53.70
Heightening	0.00	2.40	20.15	9.45	32.00
Existing	11.45	3.65	23.80	3.35	42.25
No Dike Sys.	0.00	0.00	0.00	14.31	14.31
LOW-WATER CHANNEL IMPROVEMENT					
New channel	2.50	5.50	0.00	0.00	8.00
Enlargement	1.20	6.80	25.35	5.05	38.40
Cut off	0.00	0.00	0.90	0.90	1.80
Existing	5.94	0.00	0.00	14.31	20.25

Note SB: Set Back LEVEE
<1: Including Back water Dike of Tributaries (L=9.50)

Table 2.5 (1/2) LIST OF NEW PROTECTION WORKS FOR RIVER FACILITIES IN UPPER AGNO RIVER

Stretch	Location		Purpose	Length (m)
Bayambang	AG.281-AG.288	(R)	PW-D	200
	AG.281	(R)	RW-L.W.C	450
	AG.298	(R)	RW-L.W.C	150
	AG.302	(L)	GW-L.W.C	500
	AG.302	(L)	RW-L.W.C	150
Floodway	AG.181	(L)	PW-L.W.C	600
	AG.282	(R)	PW-D	750
	AG.282	(R)	RW-L.W.C	1250
	AG.282	(R)	GW-L.W.C	400
	FW.320B-AG322	(R)	PW-D & F-D	3200 & 1500
	AG.321	(R)	RW-L.W.C	2000
	Diversion Channel	(R)	RW-L.W.C	750
	Diversion Channel	(L)	RW-L.W.C	750
Floodway-Asingan	AG.323-AG326	(L)	PW-D	2500
	AG.323-AG326	(L)	RW-L.W.C	2250
	AG.325	(L)	GW-H.W.C	800
	AG.333	(R)	GW-H.W.C	400
	AG.335-AG.339	(L)	PW-D	1800
	AG.334-AG.338	(L)	RW-L.W.C	1800
	AG.337	(L)	GW-H.W.C	350
	AG.337	(R)	GW-H.W.C	200
	AG.339	(R)	GW-H.W.C	250
	AG.339-AG.346	(R)	PW-D	3200
	AG.340-AG.346	(R)	RW-L.W.C	2300
	AG.341	(L)	RW-L.W.C	450
	AG.342	(R)	GW-L.W.C	700
	AG.346	(R)	GW-L.W.C	250
	AG.344-AG.350	(L)	PW-D	2500
	AG.348	(L)	RW-L.W.C	800
	AG.351-AG.353	(R)	PW-D	700
	AG.351-AG.353	(R)	RW-L.W.C	900
	AG.353	(R)	GW-L.W.C	300
	AG.354-AG.356	(L)	RW-L.W.C	1000
	AG.358	(R)	GW-L.W.C	200
	AG.360	(R)	GW-L.W.C	150
	AG.362	(L)	GW-L.W.C	250
	AG.365	(R)	GW-L.W.C	300
	AG.367-AG.368	(R)	RW-L.W.C	800
	AG.369-AG.404	(R)	RW-L.W.C & PW-D	2100 & 2100
	AG.368	(R)	GW-L.W.C	300
	AG.368-AG.404	(R)	GW-L.W.C	750

Note (R) : Right Bank (L) : Left Bank

RW-L.W.C : Revetment works of Low water channel
GW-L.W.C : Groin works of Low water channel
GW-H.W.C : Groin works of High water channel
PW-D : Protection works of Dike
F-D : Foundation works of Dike

Table (2/2) LIST OF NEW PROTECTION WORKS FOR RIVER FACILITIES IN UPPER AGNO RIVER

Stretch	Location		Purpose	Length (m)
Asingan-San Manuel	AG.404	(L)	RW-L.W.C	300
	AG.405-AG.413	(R)	PW-D	9900
	AG.408-AG.413	(L)	PW-D	2000
	AG.407	(R)	GW-L.W.C	600
	AG.408-AG.413	(L)	RW-L.W.C	2100
	AG.410	(L)	GW-L.W.C	500
	AG.412	(L)	RW-L.W.C	450
	AG.413-AG.415	(R)	GW-H.W.C	600
	AG.421-AG.423	(L)	GW-H.W.C	1000
	AG.455-AG.457	(R)	GW-H.W.C	700
	AG.453-AG.456	(R)	PW-D & F-D	2100
	AG.456-AG.467	(R)	PW-D	3700
	AG.465-AG.466	(R)	GW-L.W.C	600
	AG.466-AG.470	(R)	Secondary Dike	1800
	AG.470	(R)	PW-D	300
	AG.470-AG.474	(R)	RW-L.W.C	2300
	AG.473-AG.474	(R)	PW-D	500

NOTE: (R): Right Bank (L): Left Bank
RW-L.W.C : Revetment works of Low water channel
GW-L.W.C : Groin works of Low water channel
GW-H.W.C : Groin works of High water channel
PW-D : Protection works of Dike
F-D : Foundation works of Dike

Table 2.6 LIST OF NEW DRINAGE FACILITIES IN UPPER AGNO RIVER

Stretch	Location (Sta.)		Drainage Area (km2)	Facility	
				type	B x H x Pcs.
Bayambang	AG.180	(R)	5.0	Sluice way	2.0 x 2.0 x 2
	AG.282A +300 m	(L)	4.8	Sluice way	2.0 x 2.0 x 2
	AG.290	(L)	0.6	Sluice way	D = 0.8
	AG.293 + 100 m	(R)	1.3	Sluice way	1.5 x 1.5 x 1
	AG.298	(L)	1.8	Sluice way	2.0 x 2.0 x 1
	AG.299	(R)	3.3	Sluice way	2.0 x 2.0 x 2
Floodway	AG.286 +1200 m	(R)	9.2	Sluice way	2.0 x 2.0 x 4
	FW.314	(R)	2.7	Sluice way	2.0 x 2.0 x 2
Floodway-Asingan	AG.321	(L)	0.7	Sluice way	1.5 x 1.5 x 1
	AG.325 + 350 m	(L)	1.4	Sluice way	1.5 x 1.5 x 1
	AG.336 + 300 m	(L)	0.4	Sluice way	D = 0.8
	AG.352	(L)	2.0	Sluice way	2.0 x 2.0 x 1
	AG.359 + 200 m	(L)	0.8	Sluice way	1.5 x 1.5 x 1
	AG.368 + 200 m	(L)	3.4	Sluice way	2.0 x 2.0 x 2
	AG.368 + 400 m	(R)	0.3	Sluice way	D = 0.8
	Banila R.	(R)	0.5	Sluice way	D = 0.8
	Banila R.	(R)	0.3	Sluice way	D = 0.8
Asigan-San Manuel	AG.409	(R)	3.8	Sluice way	2.0 x 2.0 x 2

Note; B: Width (m), H: Heigh (m), D: Diameter (m)

Table 2.7 CALCULATION WATER LEVEL OF POPONTO FLOODWAY

(1) EXISTING RIVER WIDTH (Unit:m,m3/s)

Station	River	100-yr. Flood		10-yr. Flood			10-yr. Flood		
	width(m)	Q(m/s)	H1(m)	Q2(m3/s)	H1(m)	H2(m)	Q3(m3/s)	H1(m)	H2(m)
Retarding Basin	-	-	16.67	-	16.00	16.00	-	16.00	16.00
FW-314	850	8200	17.70	3500	16.43	16.48	3000	16.32	16.37
FW-318	860	8200	20.20	3500	18.31	18.57	3000	18.03	18.29
FW-320(B)	820	8200	21.79	3500	19.77	20.05	3000	19.46	19.76
AG-322	1400	9200	22.98	4000	21.04	21.04	4000	20.55	20.80

(2) SET-BACK LEVEE (1200m) (Unit:m,m3/s)

Station	River	100-yr. Flood		10-yr. Flood			10-yr. Flood		
	width(m)	Q1(m3/s)	H1(m)	Q2(m3/s)	H1(m)	H2(m)	Q3(m3/s)	H1(m)	H2(m)
Retarding Basin	-	-	16.67	-	16.00	16.00	-	16.00	16.00
FW-314	1200	8200	17.40	3500	16.28	16.32	3000	16.21	16.24
FW-318	1200	8200	19.67	3500	18.05	18.24	3000	17.82	18.00
FW-320(B)	1200	8200	21.36	3500	19.65	19.89	3000	19.38	19.64
AG-322	1400	9200	22.50	4000	20.65	20.85	4000	20.46	20.66

NOTE:
H1: River Bed Width = 180m
H2: River Bed Width = 150m
Q1: Diversion Discharge = 1000 m3/s
Q2: Diversion Discharge = 500 m3/s
Q3: Diversion Discharge = 1000 m3/s

Table 3.1 TIDE LEVEL DATA OF SAN FERNANDO STATION, LA UNION

(Unit:m, Gage height)

Year	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Mean
1. MONTHLY MEANS SEA LEVEL(NSL)													
1984	1.29	1.32	1.33	1.43	1.54	1.57	1.57	1.65	1.59	1.59	1.50	1.43	1.464
1985	1.33	1.39	-	-	1.43	1.58	1.54	1.57	1.53	1.47	1.42	1.35	1.461
1986	1.31	1.30	1.35	1.37	1.43	1.47	1.48	1.47	-	1.44	1.35	-	1.397
1987	-	-	-	-	-	-	1.44	1.44	1.45	1.41	1.47	1.39	1.433
1988	1.34	1.40	1.44	1.44	1.47	1.57	1.52	1.55	1.60	1.61	1.48	-	1.490
1989	1.37	1.36	1.44	1.48	1.55	1.55	1.61	1.63	1.60	1.54	1.42	1.32	1.489
2. MONTHLY MEANS HIGH WATER(MHW)													
1984	1,74	1.73	1.68	1,74	1.88	1.95	1.96	1.98	1.88	1.93	1.88	1.83	1.848
1985	1.76	1.80	-	-	1.82	2.00	1.95	1.93	1.85	1.81	1.85	1.89	1.866
1986	1.78	1.72	1.72	1.75	1.81	1.85	1.86	1.90	-	1.79	1.84	-	1.802
1987	-	-	-	-	-	-	1.75	1.68	1.67	1.66	1.88	1.85	1.748
1988	1.83	1.78	1.69	1.78	1.85	1.98	1.92	1.86	1.93	1.98	1.91	-	1.865
1989	1.80	1.79	1.82	1.85	1.91	-	2.03	2.01	1.93	1.90	1.84	1.80	1.880
3. MONTHLY MEANS LOW WATER(MLW)													
1984	0.94	1.03	1.07	1.16	1.19	1.23	1.17	1.38	1.34	1.28	1.10	1.06	1.162
1985	1.01	1.00	-	-	1.14	1.25	1.18	1.24	1.26	1.18	1.07	0.96	1.137
1986	0.95	1.00	1.04	1.04	1.08	1.15	1.16	1.22	-	1.14	1.09	-	1.007
1987	-	-	-	-	-	-	1.12	1.01	0.99	0.96	1.15	1.03	1.043
1988	0.97	1.05	1.13	1.13	1.16	1.23	1.19	1.23	1.32	1.28	1.14	-	1.166
1989	1.02	1.05	1.15	1.17	1.24	-	1.24	1.32	1.34	1.23	1.07	-	1.183

4. MAXIMUM MONTHLY AND YEARLY LEVEL

Year	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Max.
1984	2.05	2.01	1.89	1.95	2.07	2.20	2.25	2.21	2.03	2.22	2.09	2.04	2.25
1985	2.01	2.13	-	-	2.07	2.37	2.31	2.13	2.00	2.03	2.09	2.14	2.37
1986	2.11	1.97	1.87	2.01	2.17	2.22	2.25	2.19	-	1.99	2.06	-	2.25
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	2.08	2.06	1.96	2.00	2.12	2.27	2.21	2.09	2.19	2.30	2.72	-	2.30
1989	2.10	2.00	1.99	2.04	1.15	2.13	2.32	2.24	2.19	2.17	2.06	2.01	2.32

5. MINIMUM MONTHLY AND YEARLY TIDE LEVEL

Year	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Min.
1984	0.79	0.81	0.81	1.04	1.09	1.01	1.05	1.03	1.14	1.10	0.91	0.76	0.76
1985	0.82	0.88	0.88	-	1.07	0.89	0.95	1.04	0.99	0.88	0.82	0.72	0.72
1986	0.73	0.71	0.71	0.87	0.83	0.90	0.80	0.98	-	0.93	0.87	0.71	0.71
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	0.70	0.78	0.78	0.91	0.95	0.96	0.97	1.05	1.00	0.99	0.95	0.70	0.70
1989	0.77	0.77	0.77	1.03	1.02	0.95	0.95	1.00	1.00	0.94	0.80	0.66	0.66

Table 3.2 EXISTING FLOOD CONTROL FACILITIES IN PANTAL-SINOCALAN RIVER

RIVER/STRETCH	EARTH-DIKE (km)	GRVITY WALL & RIVET. (km)	CUT-OFF CHANNEL (km)	OTHERS
Mam Pantal-Sinocalan R.				
Pantal River	0	0	0	Rivetment of Fish pond Embankment
Marusay River	0	1.5	0	
Sinocalan River	3.0	0	1.6	Spur dike partially constructed
Tagumising River	0	0.8	0	- ditto -
Toributaries				
Mitura River	0	0.2	0	

Table 3.3 INVENTORY OF EXISTING BRIDGES IN ALLIED RIVERS

River	Name of Bridges	Location: Municipality	Location: Barangay	Station No.	Road	Type	Dimension: Length (m)	Dimension: Width (m)	Dimension: Depth (m)	Remarks
Sinocalan	Quintos Br.	Dagupan City	Poblacion	S - 12	A.B Fernandez Ave.	Concrete	100.00	12.20	2.35	Slightly Damage
Sinocalan	Magsaysay Br.	Dagupan City	Poblacion	S - 13	Perez Blvd.	-	-	-	-	Under Construction
Sinocalan	Gov. Estrada Br.	Calasiao	Poblacion	S - 23	National	Concrete	103.00	10.00	4.00	Good Condition
Sinocalan	Railroad Br.	Calasiao	Talibaeo	S - 24	PNR	Steel	-	-	-	
Sinocalan	Maramba Br.	Sta. Barbara	Tuliao	S - 39	National	Concrete	62.00	9.00	4.10	Good Condition
Sinocalan	Foot bridge	Sta. Barbara	Ventinella	S - 40	Barangay	Hanging	50.00	2.00	5.10	Newly Repair
Sinocalan	Sinocalan Br.	Sta. Barbara	Ventinella	S - 43	National	Concrete	55.00	11.00	4.80	Good Condition
Sinocalan	Foot bridge	Sta. Barbara	Maningding	S - 45	Barangay	Hanging	56.00	1.50	2.60	
Sinocalan	Banaoang Br.	Sta. Barbara	Banaoang	S - 47	Barangay	Bailey	74.00	3.80	4.60	Newly Repair
Sinocalan	Leet Br.	Sta. Barbara	Banaoang	S - 51	Barangay	Bailey	72.00	3.60	5.20	Not Passable, Needs Repair & Maintenance
Sinocalan	Calegu Br.	Urdaneta	Calegu	S - 60	Provincial	Concrete	84.00	7.60	4.85	Good Condition
Sinocalan	Tulong Br.	Urdaneta	Camantiles	S - 68	Provincial	Concrete	105.00	7.60	4.25	Good Condition
Ingalera	San Pablo Br.	Calasiao	San Pablo	I - 1	Barangay	Concrete	48.00	7.50	2.40	Good Condition
Ingalera	Longos Br.	Calasiao	Longos	I-3+0.4km	Barangay	Bailey	45.00	3.80	3.05	Needs Repair & Maintenance
Ingalera	Doyong Br.	Calasiao	Doyong	-	National	Concrete	45.00	7.50	4.65	Good Condition
Ingalera	Railroad Br.	Calasiao	Buenlag	-	PNR	Steel	43.00	3.40	4.05	Not Operational
Ingalera	Foot bridge	Calasiao	Songkoy	I - 5	Barangay	Bamboo	23.00	-	2.10	
Ingalera	Foot bridge	San Carlos	Nilentap	I-5+1.6km	Barangay	Bamboo	21.00	-	-	
Ingalera	Macabito Br.	Calasiao	Macabito	I - 7	Provincial	Concrete	44.00	7.80	5.60	Good Condition
Ingalera	Bogtong Br.	Calasiao	Macabito	I-8+0.6km	National	Concrete	30.00	8.20	5.93	Good Condition
Ingalera	Ican Br.	Malasiqui	Ican	I-9+1.0km	Provincial	Wooden	13.00	3.20	4.55	Passable, But Need Repair & Maintenance
Ingalera	Footbridge	Malasiqui	Barang	I - 11	Barangay	Bamboo	-	-	-	-
Ingalera	Footbridge	Malasiqui	Barang	I-11+0.3km	Footrail	Bamboo	-	-	-	-
Ingalera	Embarcadero Br.	Malasiqui	Barang	I - 13	Provincial	Concrete	55.00	9.00	5.00	Good Condition
Dagupan	Manat Br.	Binmaley	Manat	D - 12B	National	Steel	190.00	6.00	4.30	Good Condition
Dagupan	Footbridge	San Carlos	Quintong	D-18+0.3km	Barangay	Wooden	82.00	1.00	1.50	-
Dagupan	Colomboyan Br.	San Carlos	Calomboyan	D - 20	Barangay	Bailey	30.00	3.70	1.80	-
Dagupan	Pang Pang Br.	San Carlos	Pang Pang	D - 22	Barangay	Wooden	22.00	3.30	1.80	-
Dagupan	Pangoloan Br.	San Carlos	Pangoloan	D-24+0.3km	Barangay	Wooden	18.00	3.20	2.40	-
Dagupan	Palaris Br.	San Carlos	San Juan	D - 26	National	Concrete	76.00	9.00	4.90	Good Condition

NOTE: Depth is from lowest member of bridge to water level on July,1991.

Table 3.4 PMO-AFCS FLOOD CONTROL PROJECT FOR EARTHQUAKE-DAMAGE REHABILITATION RESTRATION

Project/Description/Location	Cost x10 ^{3}P	Major Work
ALLIED RIVERS		
PANTO - SINOCALAN RCP		
. Pantal Revetment @ sta 0+000 to sta 0+121	5,070	Restoration of Revetment
. Pantal Revetment @ sta 0+200 to sta 0+360 Zamora West, Dagupan City	500	Sandfilling by Dredge machine
. Nalsian Revetment - Marusay RCP sta 0+450 To sta 0+525.50	476	Restoration of Revetment
. Marusay bank protection sta 0+000 to sta 0+220; sta (-) 0+010 to sta 0+576.40 Phase II	2,015	Restoration of Boulder bank
. Const. of Earthdike - Marusay RCP sta 2+520 to sta 3+720/sta 3 + 720 to sta 5 + 575 Brgy. Dalongue, Sta. Barbara, Pang.	3,000	Rehabilitation of Earthdike/ boulder bank
. Marusay RCP - Tuliao, Alibago, Banaoang, Sta. Barbara, Pang. sta 0+000 to sta 1+240	500	Restoration of Earthdike
. Sinocalan RCP - Sta Barbara Earthdike, sta 0+000 to sta 0+310 Brgy. Ventinilla, Sta. Barbara, Pang.	500	Restoration of Earthdike
. Mitura RCP - Mitura Revetment sta 0+300 to sta 0+500 Urdaneta, Pang.	865	Restoration of Revetment
. Const. of drainage riprapping of eroded approach - Tolong RCP sta (-) 0+020 to sta (-) 0+140 Brgy. Mabanogbog, Urdaneta, Pang.	500	Restoration of Revetment
. Tolong Revetment - Tolong RCP sta 0+260 to sta 0+313 Urdaneta, Pang.	253	Restoration of Revetment
. Tagamusing Revetment - Tagamusing RCP sta 0+127 to sta 0+194.10 Phase I	260	Restoration of Earthdike
. Colobong Revetment - Colobong RCP sta 0+000 to sta 0 + 621.10 San Manuel, Pang.	500	Restoration of Gravity wall
. Bolosan RCP - Sta 0+000 to sta 3+119 Mangin, Dagupan City	1,500	Dredging
. Bolosan RCP; sta (-)2 +100 to sta (-) 0+143 Bued - Quesban - Ambunao Calasiao, Pang.	1,500	Dredging
Total	17,439	

Table 3.5 (1/2) CHANNEL FEATURES OF ALTERNATIVES IN LOWER STRETCH OF PANTAL-SINOCALAN RIVER (FRAMEWORK PLAN)

(1) Sole River Improvement Alternative : 1A

Stretches	Discharge (m3/s)	River Width (m)	Channel Bed Width (m)	Dike Height (m)	Type of Dike
Pantal R. (S1-S6)	2900	700-400	60	2.0-3.1	Earth
Marusay R. (S7-S14)	1650	150-120	40	3.1-4.2	Earth
Sinocalan R. (S14-S21)	1650	220	40	4.2-5.4	Earth

(2) Sole River Improvement Alternative : 1B

Stretches	Discharge (m3/s)	River Width (m)	Channel Bed Width (m)	Dike Height (m)	Type of Dike
Pantal R. (S1-S6)	2900	700-400	60	2.0-3.1	Earth
Marusay R. (S7-S14)	1650	220	40	3.1-4.0	Earth
Sinocalan R. (S14-S21)	1650	220	40	4.0-5.4	Earth

(3) By-Pass Channel Alternative : 2A

Stretches	Discharge (m3/s)	River Width (m)	Channel Bed Width (m)	Dike Height (m)	Type of Dike
Pantal R. (S1-S6)	2900	700-400	60	2.0-3.1	Earth
Marusay R. (S7-S14)	0	Existing (No improvement)			No Dike
Sinocalan R. (S14-S18)	0	Existing (No improvement)			No Dike
Dagupan R. (S7B-D3)	2700	300	60	3.1-3.7	Earth
By-Pass (F10A-F14)	1650	220	40	3.7-4.4	Earth
Sinocalan R. (S17A-S21)	1650	220	40	4.4-4.1	Earth

Table 3.5 (2/2) CHANNEL FEATURES OF ALTERNATIVES IN LOWER STRETCH OF PANTAL-SINOCALAN RIVER (FRAMEWORK PLAN)

(4) By-Pass Channel Alternative : 2B

Stretches	Discharge (m3/s)	River Width (m)	Channel Bed Width (m)	Dike Height (m)	Type of Dike
Pantal R. (S1-S6)	2900	700-400	60	2.0-3.1	Earth
Marusay R. (S7-S14)	500	150-120	30	3.1-3.2	Earth
Sinocalan R. (S14-S17A)	500	120	30	3.2-3.3	Earth
Dagupan R. (S7B-D3)	2200	300	60	3.1-3.7	Earth
By-Pass (F10A-F14)	1150	220	40	3.7-4.4	Earth
Sinocalan R. (S17A-S21)	1650	220	40	4.4-4.1	Earth

(5) Floodway Alternative (Sinocalan Floodway :3A)

Stretches	Discharge (m3/s)	River Width (m)	Channel Bed Width (m)	Dike Height (m)	Type of Dike
Floodway (F1-F9)	2200	350	60	3.2-5.4	Earth
(F10-F14)	1150	220	40	5.4-4.9	Earth
Sinocalan R. (F14-S21)	1650	220	40	4.9-4.4	Earth
Pantal R.(S1-S6)	700	700-300	30	1.0-2.0	Earth
Marusay R. (S7-S14)	500	100	30	1.0-1.8	Concrete
Sinocalan R. (S14-S17A)	500	120	30	1.8-2.8	Earth

(6) Floodway Alternative (Dagupan Floodway : 4A)

Stretches	Discharge (m3/s)	River Width (m)	Channel Bed Width (m)	Dike Height (m)	Type of Dike
Pantal R. (S1-S6)	1850	700-400	60	1.6-2.8	Earth
Marusay R. (S7-S14)	1650	120	40	2.8-3.7	Earth
Sinocalan R. (S14-S21)	1650	220	40	3.7-4.1	Earth
Floodway (F1-F7+2km)	1200	250	60	2.2-2.5	Earth

Table 3.6 PROJECT COST COMPARISON OF ALTERNATIVES

(Million Pesos)

Item	1A	1B	2A	2B	3A	4A
Main construction						
Main Works	1113	1059	1145	1144	1318	1245
Preparatory Works	111	105	114	114	132	124
Miscellaneous Works	184	175	189	189	217	205
Sub-Total	1408	1340	1448	1448	1667	1575
Compensation Cost	1077	1501	224	875	365	1121
Total	3226	3656	2251	3036	2721	3507

Table 3.7 (1/2) FEATURES OF DESIGN CHANNEL OF PANTAL-SINOCALAN RIVER

River: Main Pantal-Sinocalan R.
Design Flood: 10-yr

Item	Unit	Pantal R.	By-Pass		Sinocalan R.
		R.M-D.O	D.O-P.1	P.1-S.21+0.4k	S.21+0.4k-S.47+0.3k
Discharge	m3/s	2000	1850	1250	900
Length of Stretch	m	2840	1910	4000	10950
Gradient of H.W.L	-	1/2350	1/2350	1/2350	1/1850
River Width	m	600-400	400	220	200
Width of Channel Bed	m	60	40	40	30
Gradient of H.W.L	m	1/2350	1/2350	1/2350	1/1850
Dike Height (Ave.)	m	3.0	3.8	4.0	3.8
Water Depth	m	6.6	6.6	6.6	6.6
Low Channel Depth (Ave.)	m	4.8	4.0	3.8	3.8

Item	Unit	Sinocalan R		
		S.47+0.3k-S.58+1.0k	S.58+1.0k-S.65	S.65-S.70
Discharge	m3/s	650	650	350
Length of Stretch	m	7780	5270	4500
Gradient Channel Bed	-	1/1600	1/1150	1/900
River Width	m	150	100	100
Width of Channel Bed	m	30	30	20
Gradient of H.W.L	-	1/1850	1/1150	1/1150
Dike Height (Ave.)	m	2.8	2.5	2.3
Water Depth	m	6.6-5.95	5.95	5.95-5.14
Low Channel Depth (Ave.)	m	4.5	4.5	4.0

Table 3.7 (2/2) FEATURES OF DESIGN CHANNEL OF PANTAL-SINOCALAN RIVER

River: Dagupan R

Design Flood: 10-yr

Item	Unit	Dagupan R.		
		D.3- D.12B+0.3k	D.12B+0.3k -D16+0.3k	D.16+0.3k -D.27+0.45k
Discharge	m3/s	700	550	400
Length of Stretch	m	5250	4500	9750
Gradient of Channel Bed	-	1/10000	1/10000	1/10000
River Width	m	450-250	250-150	100
Width of Channel Bed	m	Existing	Existing	25
Gradient of H.W.L	-	Level	1/10000	1/5800
Dike of Height (Ave.)	m	2.8	2.8	2.8
Water Depth	m	6.5	6.5	6.0
Low Channel Depth (Ave.)	m	Existing	Existing	4.0

River: Ingalera R.

Design Flood: 10-yr

Item	Unit	Ingalera R.		
		I.1-I.8	I.8-I.13	I.13-I.18
Discharge	m3/s	360	360	260
Length of Channel Bed	m	9920	4690	4390
Gradient of Channel Bed	-	1/5000	1/2500	1/1800
River Width	m	120	120	100
Width of Channel Bed	m	20	20	15
Gradient of H.W.L	m	1/5000	1/3400	1/1800
Dike of Height (Ave.)	m	0.9	0.6	0.5
Water Depth	m	6.6	6.3	6.1
Low Channel Depth (Ave.)	m	6.5	6.5	6.4

Table 3.8 SUMMARY OF DIKE CONSTRUCTION AND LOW-WATER CHANNEL IMPROVEMENT WORKS IN PANTAL-SINOCALAN RIVER

(Unit: km)

STRETCH	PANTAL-SINOCALAN R.		DAGUPAN R.	INGALERA R.	WHOLE
	Lower<1 (L=8.75)	Upper<2 (L=18.75)	Junction - D.27+0.45km (L=19.50)	Junction - I.8+0.7km (L=10.70)	(L=57.70)
DIKE CONSTRUCTION					
(Right Dike)					
New Dike	9.10	13.10	20.70	9.10	52.00
No Diking Sys.	0.00	9.20	0.00	1.20	10.40
(Left Dike)					
New Dike	7.90	18.40	21.20	9.90	57.40
No Diking Sys.	0.00	0.00	0.00	0.90	0.90
(Total)					
New Dike	17.00	31.50	41.90	19.00	109.40
No Diking Sys.	0.00	9.20	0.00	2.10	11.30
LOW-WATER CHANNEL IMPROVEMENT					
New channel	3.10	0.00	0.00	0.00	3.10
Enlargement	1.20	9.60	4.90	7.70	25.40
Cut off	0.25	1.70	2.10	3.00	7.05
Existing	4.20	7.45	12.50	0.00	24.15

Note <1; Lower Stretch : From Rivermouth to Ingalera R. Junction
<2; Upper Stretch : From Ingalera R. Junction to Catablan R. Junction

Table 3.9 (1/3) LIST OF NEW PROTECTION WORKS FOR RIVER FACILITIE IN PANTAL- SINOCALAN RIVER

River	Location		Purpose	Length (m)
Pantal R.	S.1 - S.2	(R)	P.W-RM	850
	S.2	(L)	RW-L.W.C	250
	S.2	(L)	PW-D	250
	S.3	(L)	PW-D & F-D	800 & 700
	S.3 + 400m	(R)	PW-D & F-D	150 & 150
	S.6	(R)	PW-D & F-D	150 & 150
Dagupan R.	D.2 - D.3	(L)	PW-D	250
	D.2	(L)	F-D	300
By - Pass	P.1		Moundsill	220
	P.5 + 400m	(L)	PW-D & F-D	100 & 50
	P.6 + 150m	(R)	PW-D & F-D	100 & 50
	P.6 + 300m	(L)	PW-D & F-D	150 & 80
	P.7	(R)	PW-D	300
	P.7	(R)	RW-L.W.C	250
Sinocalan R.	S.21 - S.22	(L)	PW-D	500
	S.21 - S.22	(L)	RW-L.W.C	400
	S.21 - S.22	(L)	RW-L.W.C	50
	S.24	(L)	PW-D	100
	S.25	(R)	RW-L.W.C	150
	S.25 + 200m	(L)	RW-L.W.C	150
	S.25 + 300m	(R)	RW-L.W.C	150
	S.26	(L)	PW-D	100
	S.26 + 150m	(L)	PW-D	100
	S.26 - S.27	(R)	RW-L.W.C	200
	S.28 - S.29	(L)	PW-D	300
	S.28 - S.29	(L)	RW-L.W.C	250
	S.28 + 250m	(R)	RW-L.W.C	150
	S.30	(L)	PW-D & F-D	50 & 50
	S.30 + 150m	(R)	PW-D & F-D	80 & 80
	S.34 + 500m	(R)	RW-L.W.C	150
	S.34 + 650m	(R)	PW-D & F-D	80
	S.34 + 800m	(R)	PW-D & F-D	80
	S.36 + 150m	(R)	PW-D & F-D	80
	S.37 + 50	(R)	PW-D & F-D	80
	S.37 + 150m	(L)	PW-D & F-D	150 & 100
	S.37 + 200m	(R)	RW-L.W.C	150

Note, (R) : Right Bank
(L) : Left Bank
RW-L.W.C ; Revetment works of Low water channel
GW-L.W.C ; Groin works of Low-water channel
GW-H.W.C ; Groin works of High-water channel
PW-D ; Protection works of Dike
F-D ; Foundation woks of Dike
PW-RM ; Protection works of River mouth

Table 3.9 (2/3) LIST OF NEW PROTECTION WORKS FOR RIVER FACILITIES IN PANTAL- SINOCALAN RIVER

River	Location		Purpose	Length (m)
Sinocalan	S.37 + 200m	(R)	PW-D	200
	S.41	(R)	PW-D	200
	S.41	(R)	RW-L.W.C	150
	S.41 - S.42	(L)	PW-D	300
	S.41 - S.42	(L)	RW-L.W.C	200
	S.43	(R)	RW-L.W.C	150
	S.43	(R)	PW-D	100
	S.43 + 150m	(R)	PW-D & F-D	80 & 50
	S.43 + 250m	(R)	PW-D & F-D	80 & 50
	S.46	(L)	PW-D	350
	S.46	(L)	RW-L.W.C	300
	S.46 + 300m	(R)	RW-L.W.C	200
	S.47 + 200m	(L)	RW-L.W.C	150
	S.48 + 150m	(R)	GW-H.W.C	80
	S.51	(L)	RW-L.W.C	150
	S.53 + 100m	(L)	RW-L.W.C	500
	S.54 + 200m	(L)	RW-L.W.C	200
	S.54 + 450m	(R)	RW-L.W.C	250
	S.55	(R)	RW-L.W.C	250
	S.55	(L)	RW-L.W.C	200
	S.55	(L)	PW-D	200
	S.55 + 600m	(L)	RW-L.W.C	200
	S.56 + 400m	(L)	PW-D & F-D	150 & 80
	S.56 + 900m	(L)	PW-D & F-D	100 & 50
	S.58 + 550m	(L)	PW-D	500
	S.58 + 550m	(L)	RW-L.W.C	200

NOTE, (R): Right Bank
(L): Left Bank
RW-L.W.C; Revement Works of Low Water Channel
GW-L.W.C; Groin Works of Low-Water Channel
GW-H.W.C; Groin Works of High-Water Channel
PW-D; Protection Works of Dike
F-D; Foundation Works of Dike
PW-RM; Protection Works of River Mouth

Table 3.9(3/3) LIST OF NEW PROTECTION WORKS FOR RIVER FACILITIES IN PANTAL- SINOCALAN RIVER

River	Location	Purpose	Length (m)
Dagupan R.	D.12A - D.12B(L)	PW-D	650
	D.12B + 250m (L)	PW-D & F-D	200 & 150
	D.14 + 900m (R)	PW-D & F-D	200 & 100
	D.15A + 400m (L)	PW-D	50
	D.15A + 500m (R)	PW-D & F-D	120 & 50
	D.15B + 600m (L)	RW-L.W.C	350
	D.16 + 300m (L)	PW-D & F-D	100 & 50
	D.17 (L)	PW-D	100
	D.18 (R)	PW-D	100
	D.19 (R)	PW-D	100
	D.19 (L)	PW-D & F-D	100 & 40
	D.19 - D.20 (L)	PW-D & F-D	400 & 80
	D.19 + 500m (R)	PW-D	200
	D.20 (L)	PW-D	100
	D.21 + 50m (L)	PW-D	100
	D.21 + 450m (R)	PW-D	100
	D.21 + 600m (R)	PW-D	50
	D.25 + 100m (R)	PW-D	200
	D.25 + 100m (R)	RW-L.W.C	200
Ingalera R.	I.1 - 1.2 (L)	RW-L.W.C	450
	I.2 + 400m (L)	PW-D	200
	I.2 + 450m (R)	PW-D & F-D	50 & 30
	I.2 + 750m (L)	PW-D & F-D	150 & 30
	I.3 + 400m (L)	PW-D & F-D	50 & 30
	I.4 + 550m (L)	PW-D & F-D	50 & 30
	I.4 + 1400m (L)	PW-D & F-D	100 & 30
	I.4 + 2000m (L)	PW-D & F-D	100 & 30
	I.5 (R)	RW-L.W.C	200
	I.6 + 1000m (R)	PW-D & F-D	80 & 40
	I.7 (R)	PW-D & F-D	150 & 50
	I.7 + 250m (L)	RW-L.W.C	150

NOTE, (R): Right Bank
(L): Left Bank
RW-L.W.C; Revetment Works of Low Water Channel

Table 3.10 (1/2) LIST OF NEW DRAINAGE AND INTAKE FACILITIES IN PANTAL SINOCALAN RIVER

Name of River	Location (Sta.)	Purpose	Drainage Area(km2)	Facility Type	Facility B x H - Pcs	Remarks
Pantal R.	S-2 - 200 m (L)	D,F,N	31.0	Water gate	10 x 5	45 m3/s
	S-3 (R)	D,F,N	2.8	Sluice way	2 x 2 - 2	
	S-3 + 350 m (R)	D,F,N	73.0	Water gate	20 x 5	110 m3/s
	S-6 + 120 m (R)	D,F,N	6.3	Water gate	10 x 5	58 m3/s
Old Dagupan R.	D-1 + 50 m (R)	F	-	Sluice way	1.5 x 1.5 - 1	
	D-1 + 350 m (L)	F	-	Sluice way	1.5 x 1.5 - 1	
	D-2 + 400 m (R)	D,F	1.7	Sluice way	2 x 2 - 1	
By-Pass	P-3 + 250 m (L)	D	1.1	Sluice way	1.5 x 1.5 - 1	
	P-5 + 400 m (L)	D	2.0	Sluice way	2 x 2 - 1	
	P-6 + 300 m (R)	M,F	-	Water gate	5 x 3 - 1	
Sinocalan R.	S-21 +550 m (L)	D	0.8	Sluice way	1.5 x 1.5 - 1	
	S-24 (L)	D	0.3	Sluice way	D = 0.8	
	S-24 +200 m (R)	D	0.5	Sluice way	D = 0.8	
	S-27 (R)	D	1.5	Sluice way	2 x 2 - 1	
	S-29 +120 m (L)	D	55.0	Water gate	15 x 4	72 m3/s
	S-34 +700 m (R)	D	0.1	Sluice way	D = 0.8	
	S-40 +100 m (L)	D	0.3	Sluice way	D = 0.8	
	S-46 +250 m (L)	D	1.2	Sluice way	1.5 x 1.5 - 1	
	S-55 (L)	D	1.6	Sluice way	2 x 2 - 1	

Note: R: Right Bank L: Left Bank
D: Drainage F: Intake for Fish Pond
N: Navigation M: Intake for Maintenance Flow

Table 3.10 (2/2) LIST OF NEW DRAINAGE AND INTAKE FACILITIES IN PANTAL SINOCALAN RIVER

Name of River	Location (Sta.)	Purpose	Drainage Area(km2)	Facility Type	Facility B x H - Pcs
Dagupan R.	D-4 + 400 m (L)	F	-	Sluice way	1.5 x 1.5 -1
	D-5 + 150 m (L)	F	-	Sluice way	1.5 x 1.5 -1
	D-5 + 250 m (L)	F	-	Sluice way	1.5 x 1.5 -1
	D-6 + 100 m (R)	D,F	2.4	Sluice way	2 x 2 - 1
	D-9 + 100 m (R)	D,F	6.0	Sluice way	2 x 2 - 3
	D-11 + 200 m (R)	F	-	Sluice way	1.5 x 1.5 -1
	D-11 + 200 m (L)	F	-	Sluice way	1.5 x 1.5 -1
	D-12B + 250 m (R)	F	-	Sluice way	1.5 x 1.5 -1
	D-12B + 250 m (L)	F,N	-	Water gate	5 x 3
	D-13A + 500 m (L)	F	-	Sluice way	1.5 x 1.5 -1
	D-14 + 250 m (R)	F	-	Sluice way	1.5 x 1.5 -1
	D-14 + 250 m (L)	D,F	3.1	Sluice way	2 x 2 - 2
	D-14 + 900 m (R)	D,F	10.0	Water gate	5 x 3 - 1
	D-15A + 150 m (L)	D,F	3.8	Sluice way	2 x 2 - 2
	D-15B + 250 m (R)	F	-	Sluice way	1.5 x 1.5 -1
	D-15B + 250 m (L)	F	-	Sluice way	1.5 x 1.5 -1
	D-15B + 400 m (R)	D	7.5	Sluice way	2 x 2 - 3
	D-16 + 350 m (L)	D	57.0	Water gate	15 x 4
	D-17 + 200 m (R)	F	-	Sluice way	1.5 x 1.5 -1
	D-17 + 750 m (R)	F	-	Sluice way	1.5 x 1.5 -1
	D-18 + 50 m (L)	F	-	Sluice way	1.5 x 1.5 -1
	D-18 + 550 m (R)	F	-	Sluice way	1.5 x 1.5 -1
	D-19 (L)	F	-	Sluice way	1.5 x 1.5 -1
	D-20 + 350 m (R)	D	0.5	Sluice way	D = 0.8
	D-22 + 250 m (R)	D	4.5	Sluice way	2 x 2 - 2
	D-22 + 350 m (L)	F	-	Sluice way	1.5 x 1.5 -1
	D-24 + 200 m (L)	D	3.0	Sluice way	2 x 2 - 2
	D-24 + 900 m (R)	D	2.6	Sluice way	2 x 2 - 2
Ingalera R.	I-2 + 500 m (R)	D	1.5	Sluice way	2 x 2 - 1
	I-3 + 400 m (L)	D	12.2	Water gate	5 x 3 - 1
	I-4 + 1900 m (R)	D	4.5	Sluice way	2 x 2 - 2

Note: R: Right Bank — L: Left Bank
D: Drainage — F: Intake for Fish Pond
N: Navigation — M: Intake for Maintenance Flow
B: Width (m) — H: Height (m)

Table 3.11 LIST OF BRIDGES CONSTRUCTED IN PANTAL-SINOCALAN RIVER

River	Name of Bridge	Location (Station)	Existing Bridge Type	Length (m)	Width (m)	Depth (m)	Necessity of Construction	Proposed Bridge Length (m)
Sinocalan R.	New Br.	P.2 + 200 m		- No Bridge -			To be constructed	220
	New Br.	P.5 + 250 m		- No Bridge -			To be constructed	220
	Gov.Estrada Br.	P.23	Cocrete	103.0	10.0	4.0	To be reconstructed	200
	Railway Br.	S.24	Steel	-	-	-	To be demolished	-
	Maramba Br.	S.39	Cocrete	62.0	9.0	4.1	To be reconstructed	200
	Foot Br.	S.40	Hanging	50.0	2.0	5.1	To be demolished	-
	Sinocalan Br.	S.43	Cocrete	55.0	11.0	4.8	To be reconstructed	200
	Foot Br.	S.45	Hanging	56.0	1.5	2.6	To be demolished	-
	Banaonang Br.	S.47	Bailey	74.0	3.8	4.6	To be demolished	-
Dagupan R.	Manat Br.	D.12B	Steel	190.0	6.0	4.3	To be heightend	190
	Foot Br.	D.18 +300 m	Wooden	82.0	1.0	1.5	To be demolished	-
	Colombayan Br.	D.20	Bailey	30.0	3.7	1.8	To be reconstructed	100
	Pang Pang Br.	D.22	Wooden	22.0	3.3	1.8	To be reconstructed	100
	Pangolan Br.	D.24 +300 m	Wooden	18.0	3.2	2.4	To be reconstructed	100
	Palalis Br.	D.26	Concreat	76.0	9.0	4.9	To be reconstructed	100
Ingarela R.	San pablo Br.	I.1	Concrete	48.0	7.5	2.4	To be reconstructed	120
	Longos Br.	I.3 + 400 m	Bailey	45.0	3.8	3.1	To be demolished	-
	New Br.	I.4		- No Bridge -			To be constructed	120
	Foot Br.	I.5	Bamboo	23.0	-	2.1	To be constructed	120
	Foot Br.	I.5 + 1.6 km	Bamboo	21.0	-	-	To be demolished	-
	Macabit Br.	I.7	Concrete	44.0	7.8	5.6	To be reconstructed	120

Note Depth : From the lowest ember to water level on July,1991.

FIGURES

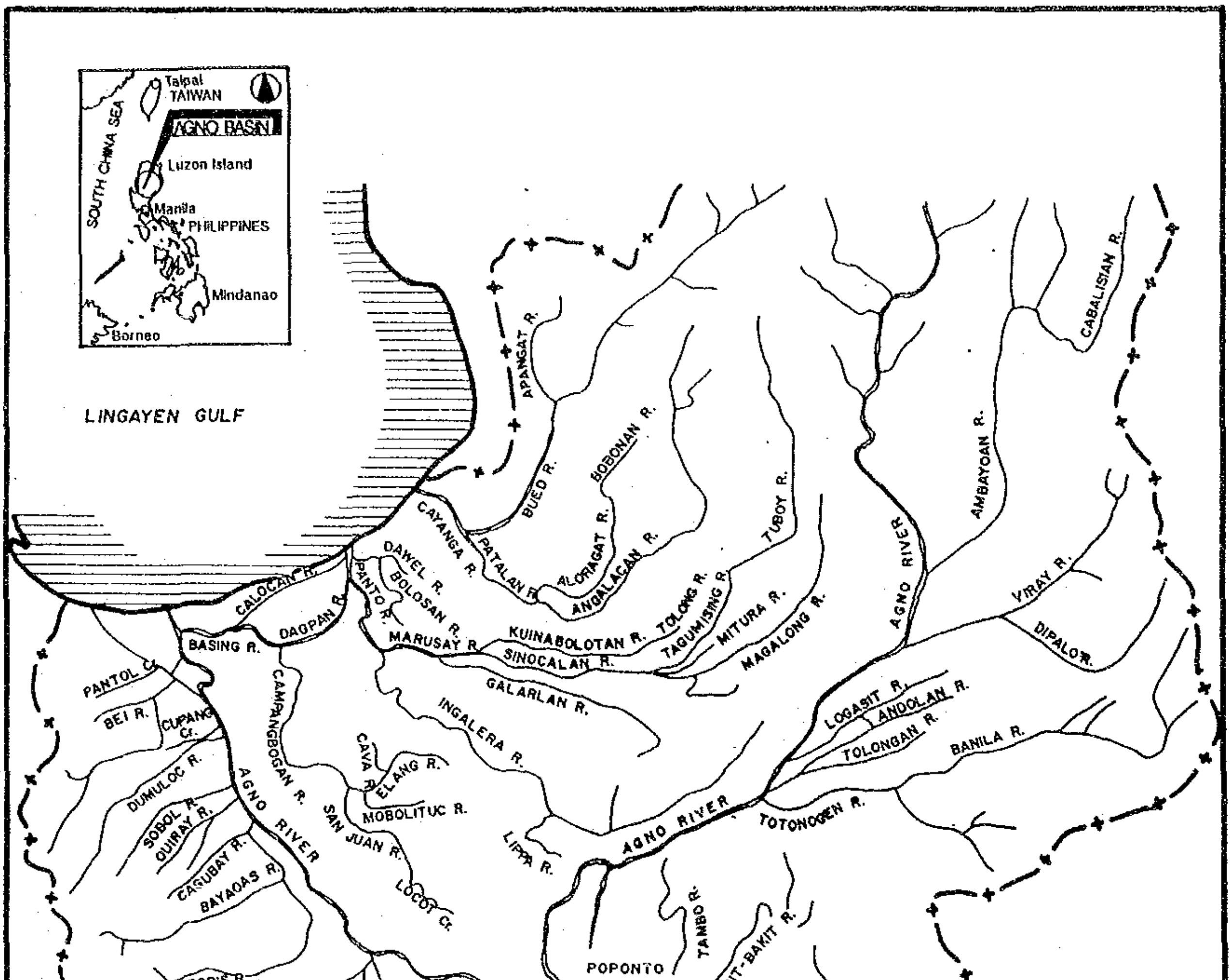
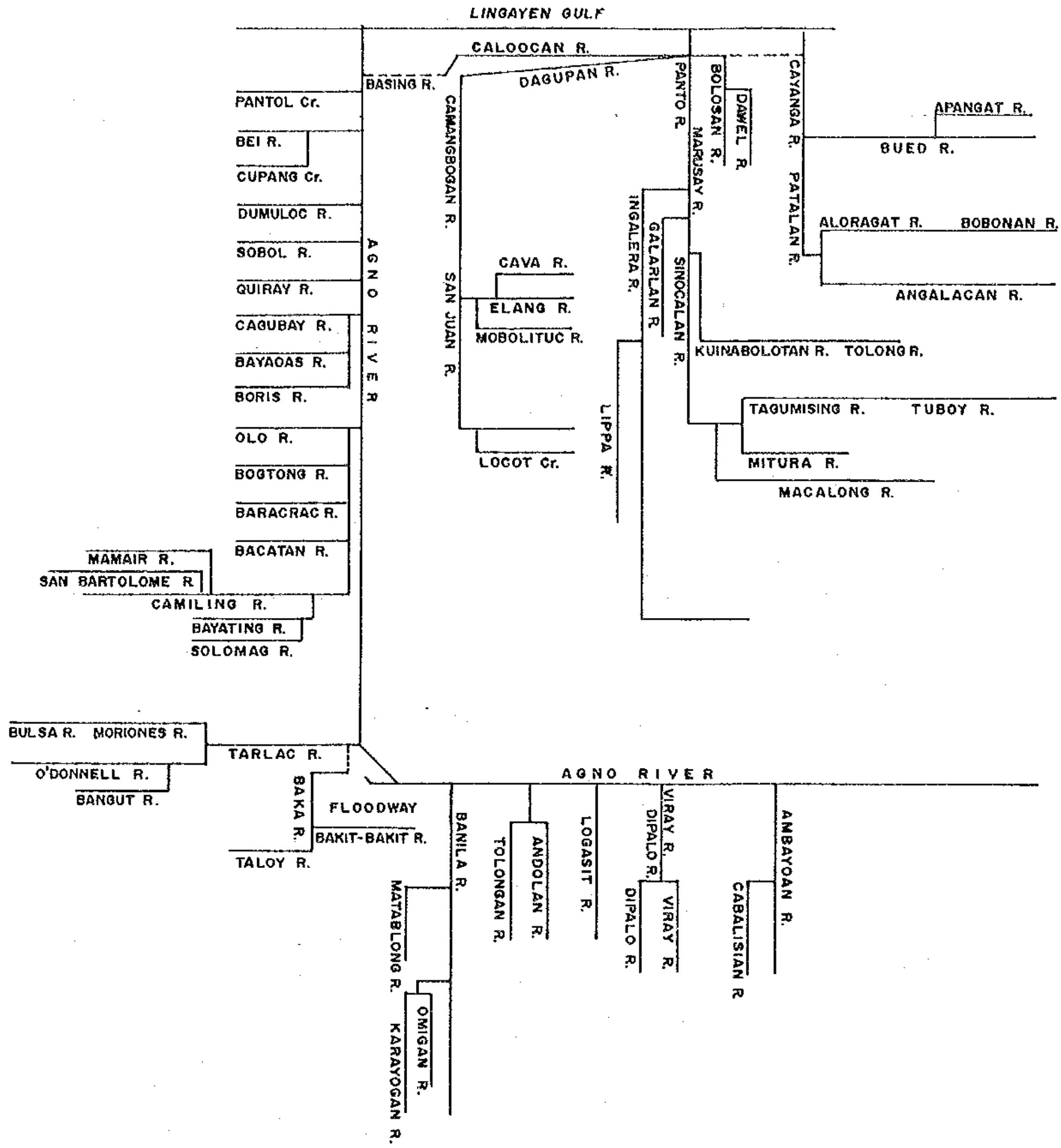


Fig. 2.1 RIVER BASIN MAP



AGNO RIVER BASIN

River	Basin Area (Km²)	River Length (Km)
AGNO RIVER		
Rivermouth	5860	165.00
Floodway Site	2477	119.00
AMBAYOAN RIVER	367	62.20
VIRAY - DIPALO RIVER	135	21.20
BANILA RIVER	309	39.00
TARLAC RIVER	1896	93.00
CAMILING RIVER	604	64.60

ALLIED RIVER BASIN

River	Area (Km²)	Length (Km)
CAYANGA - PATALAN R.		
(whole)	618	61.00
Angalacan R.	144	25.50
Aloragat R.	116	31.00
Bued R.	286	54.00
PANTO - SINOCALAN R.		
(whole)	1162	75.50
Tagumising R.	162	44.50
Mitura - Macalong R.	141	31.00
Ingalera R.	197	32.50
Dagupan R.	273	32.00

Fig. 2.2 RIVER SYSTEM DIAGRAM

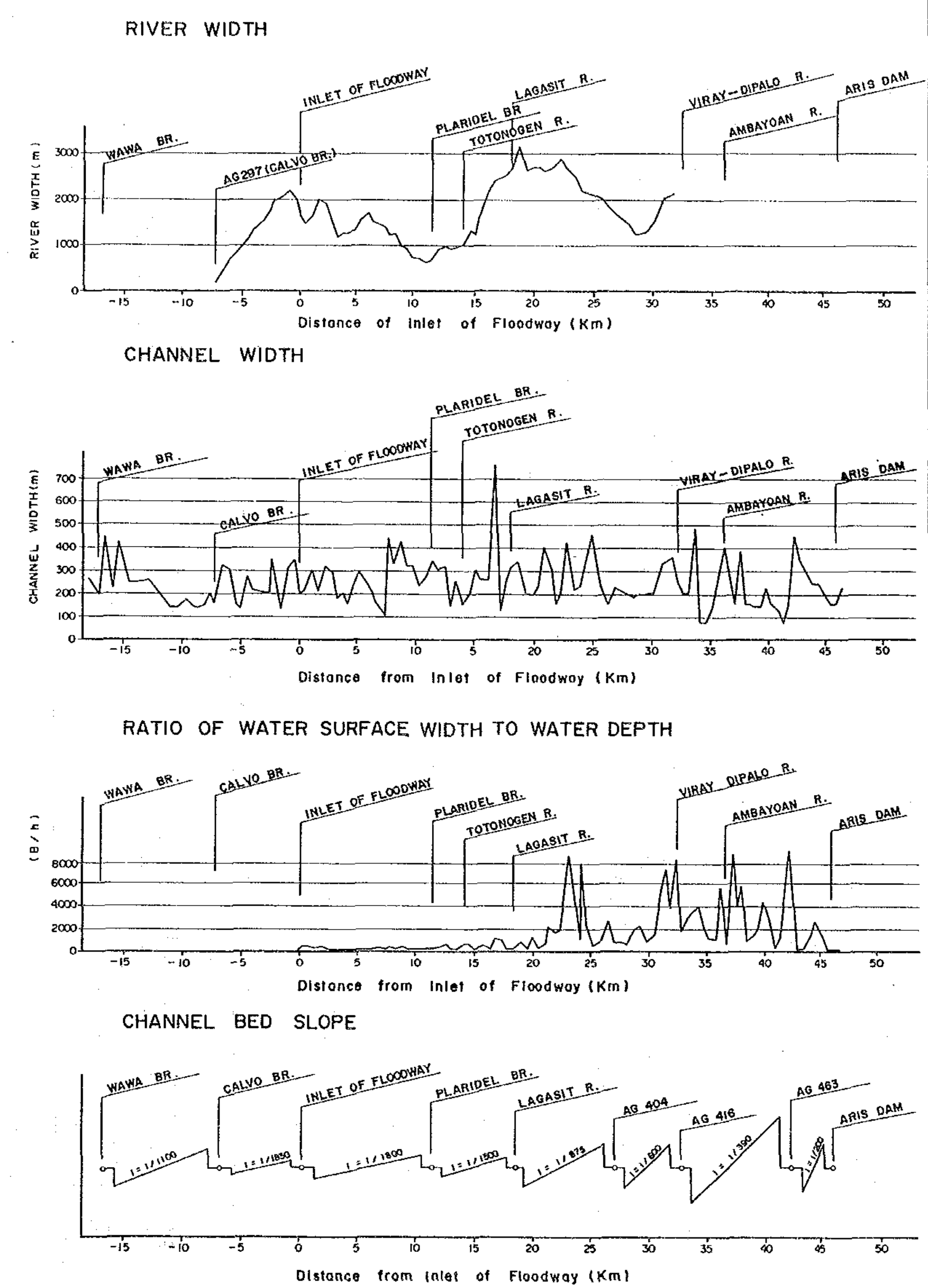


Fig. 2.3 EXISTING CHANNEL FEATURES OF UPPER AGNO RIVER

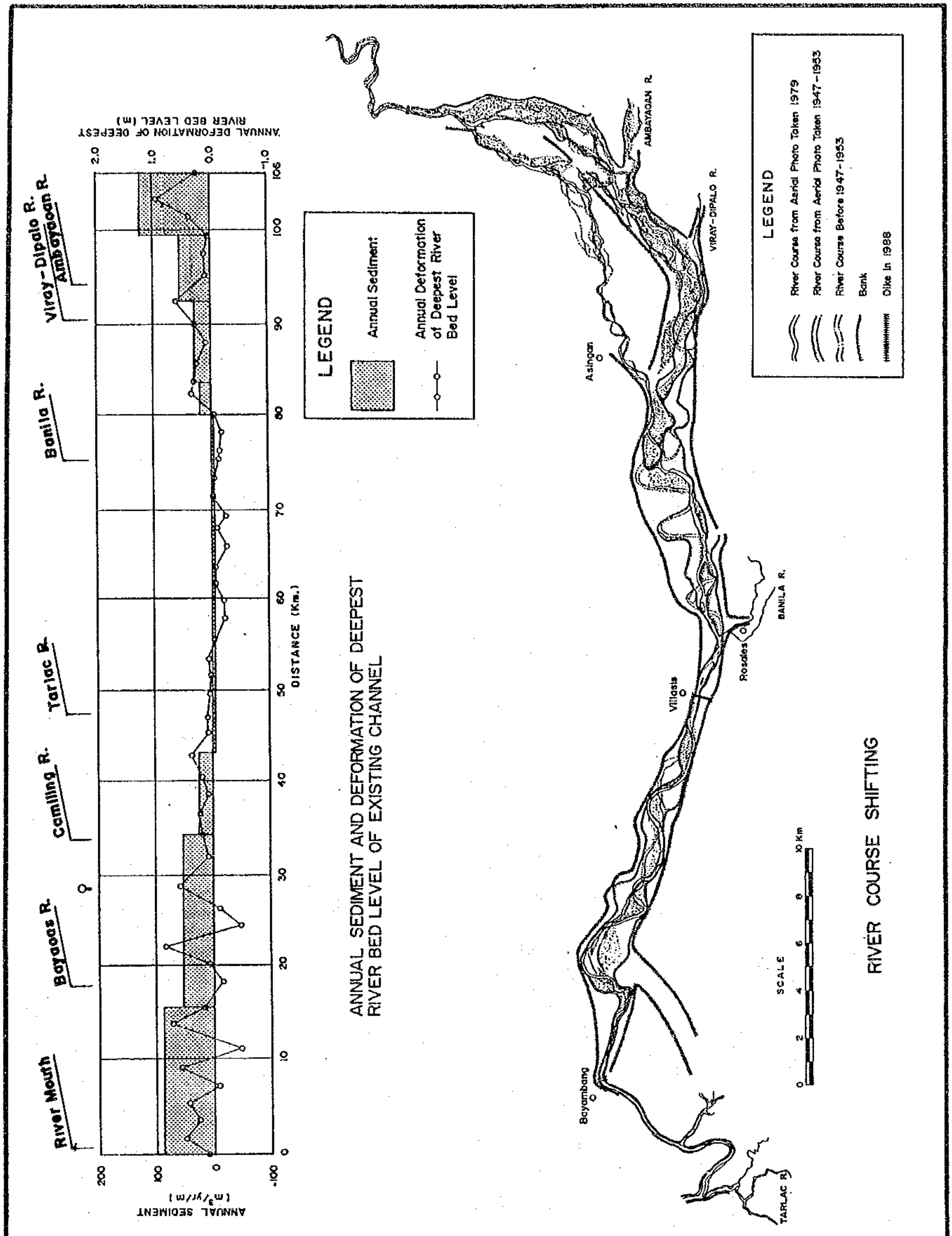


Fig. 2.4 RIVER COURSE SHIFTING AND CHANNEL BED FLUCTUATION OF UPPER AGNO RIVER

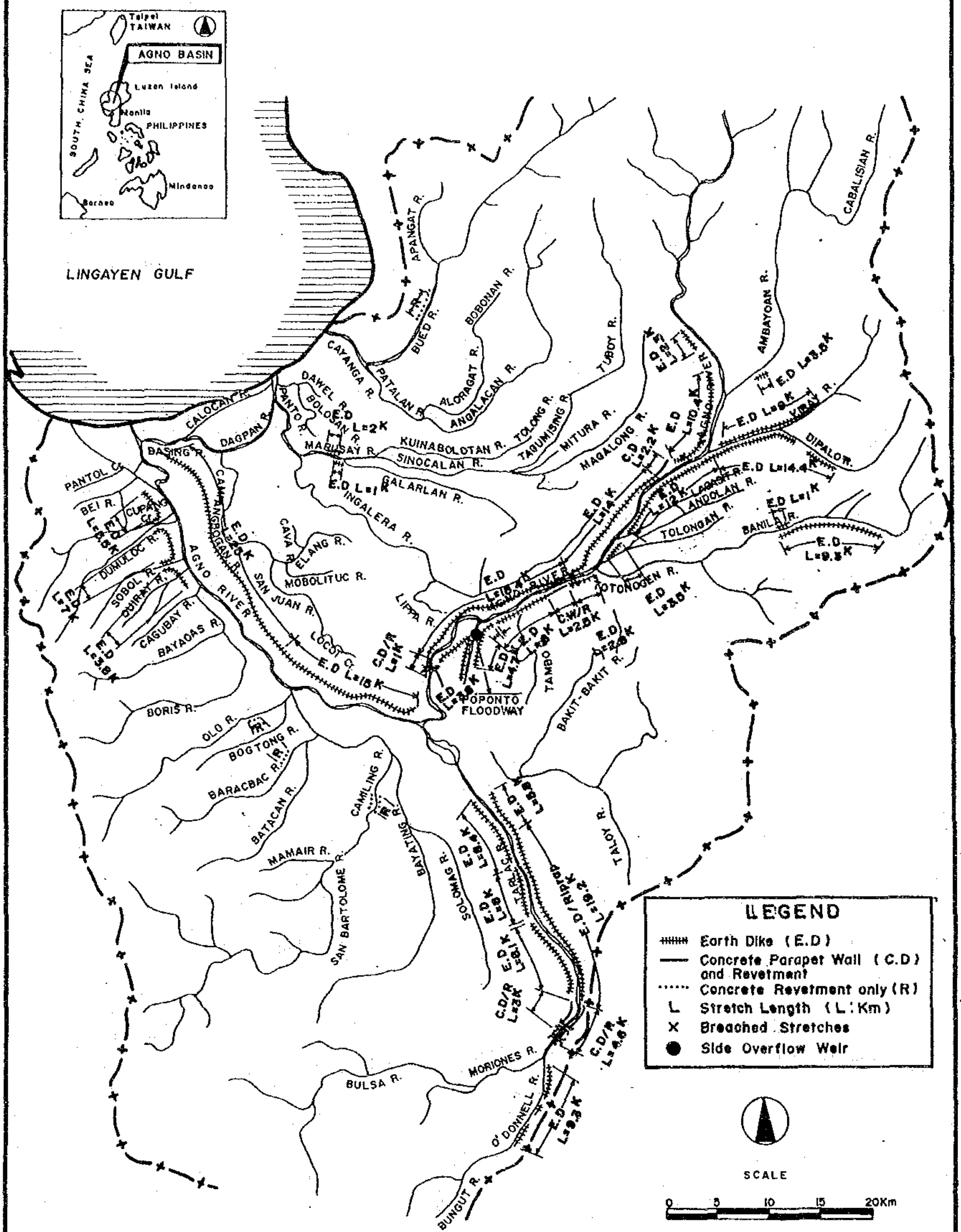


Fig. 2.5 LOCATION OF EXISTING FLOOD CONTROL FACILITIES

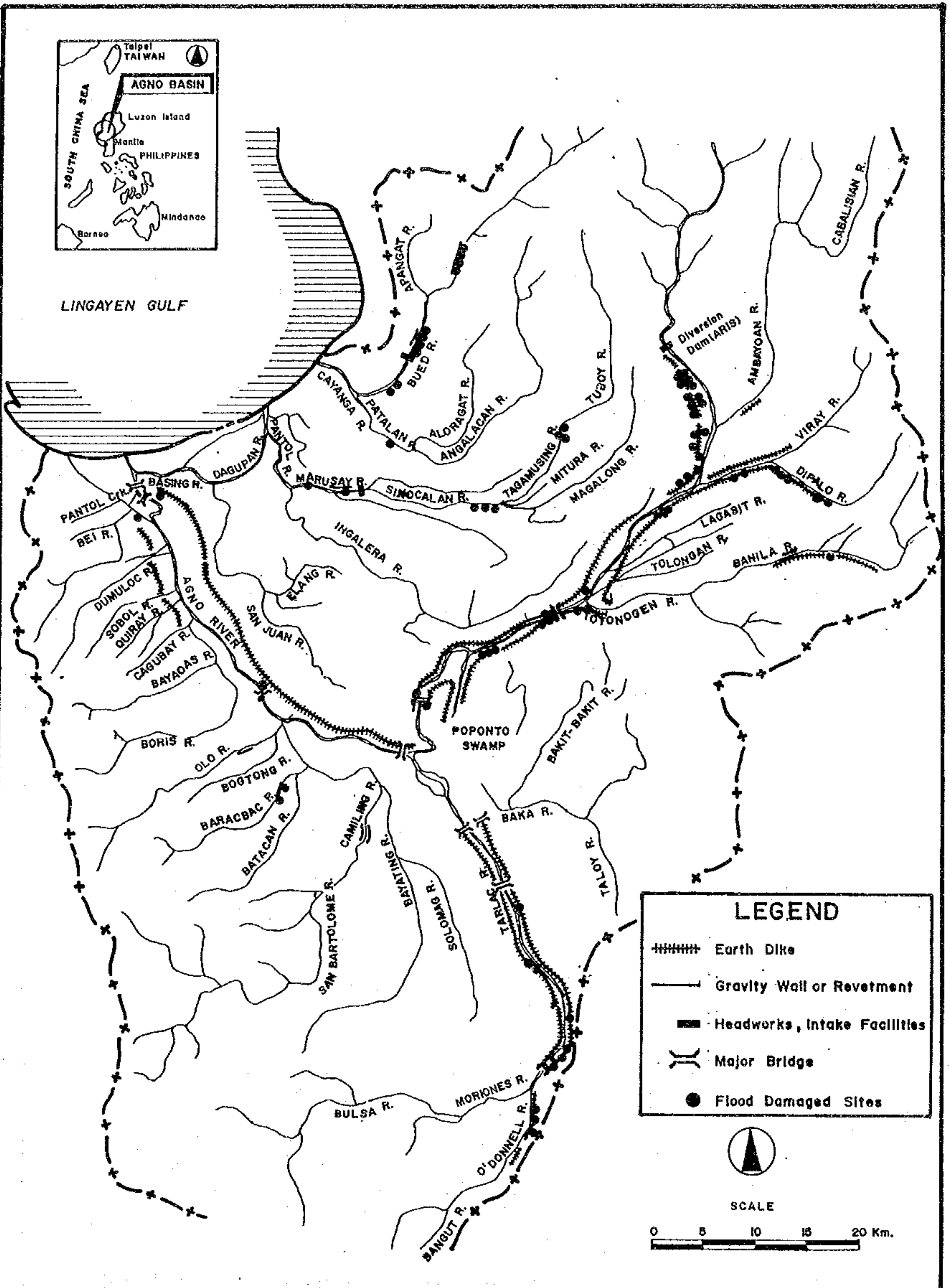


Fig. 2.6 LOCATION OF BEACHES/GAPS AND SCOURS CAUSED BY FLOODS (1984-1988)

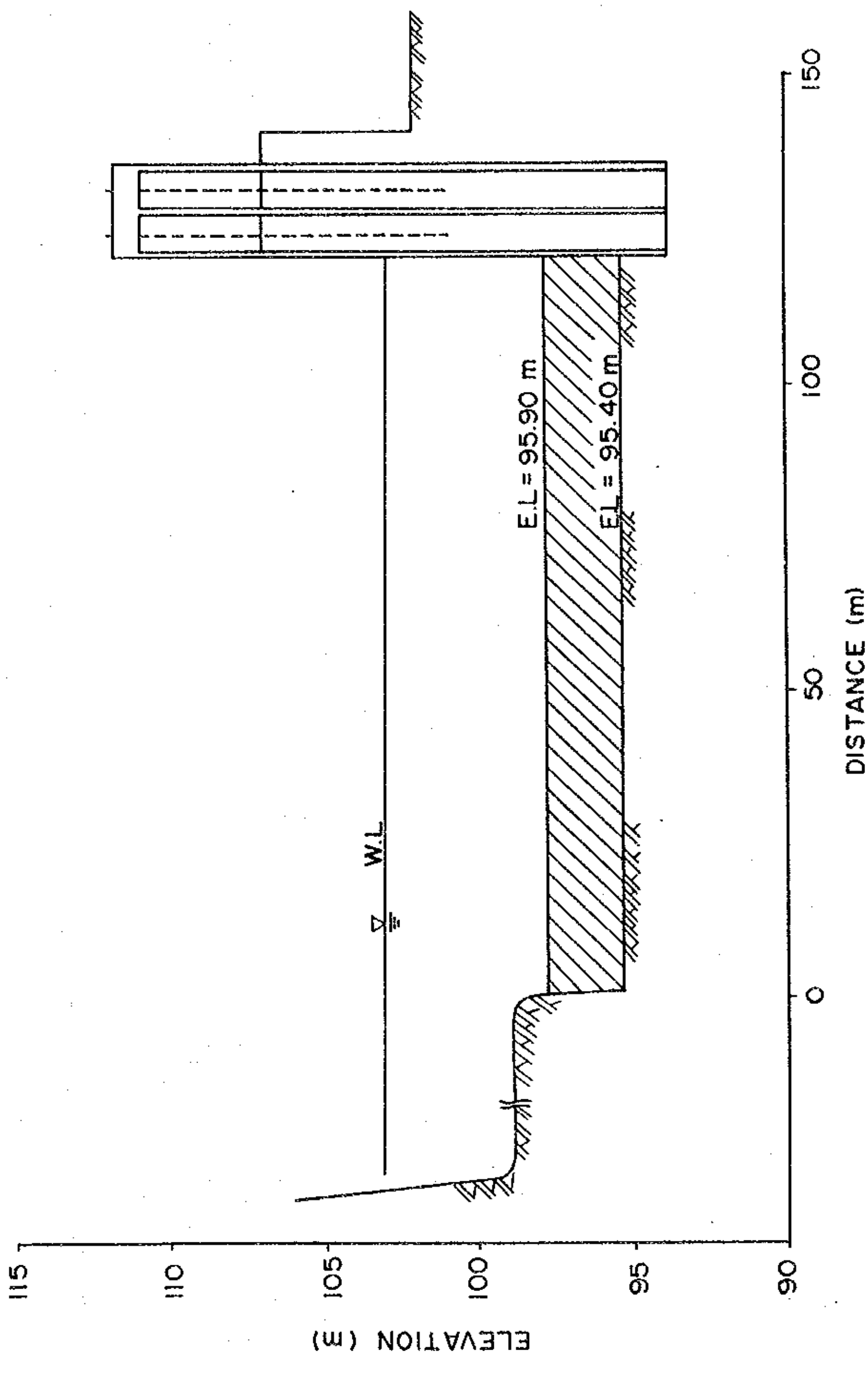


Fig. 2.7 EXISTING INTAKE DAM OF THE AGNO RIVER IRRIGATION SYSTEM

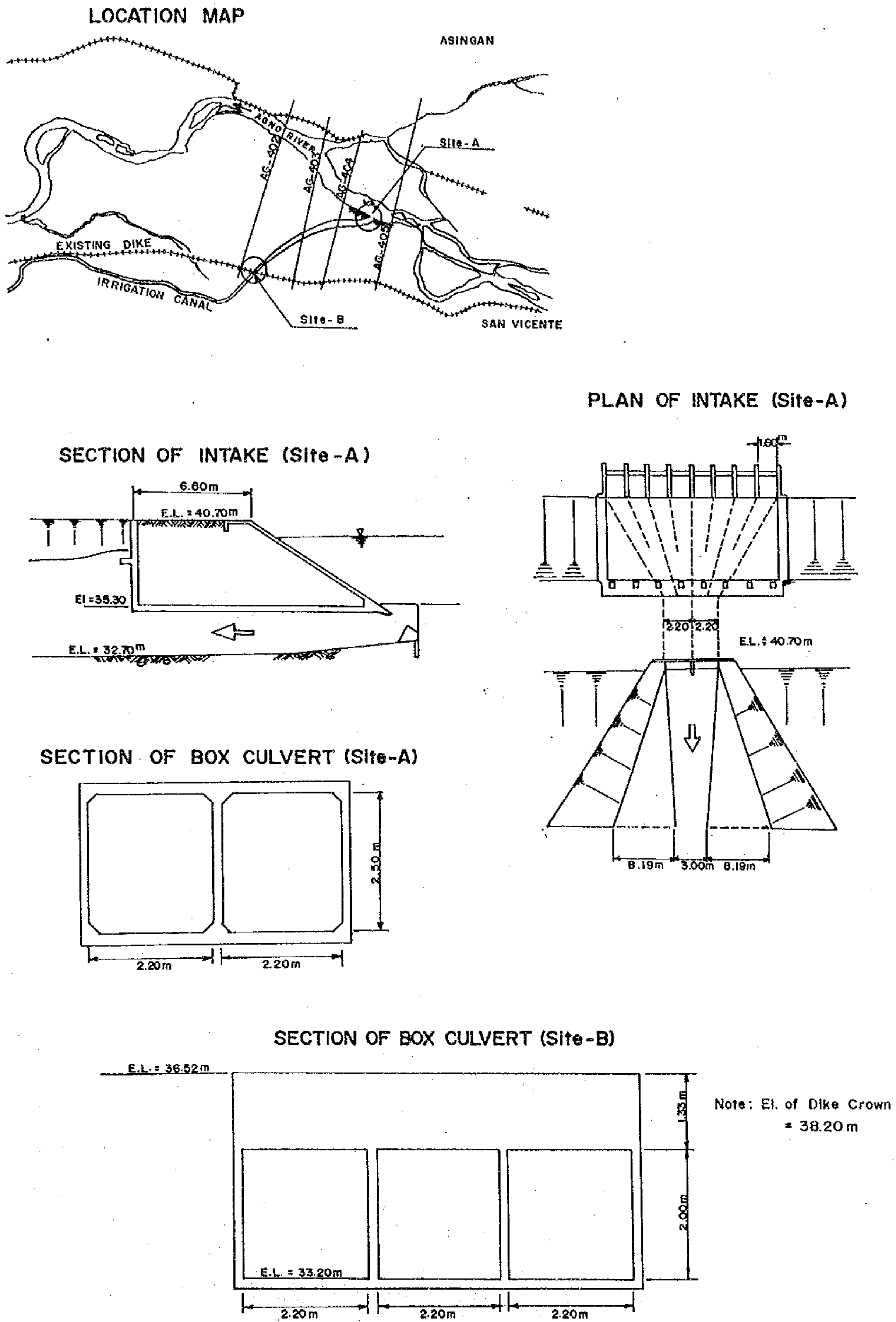
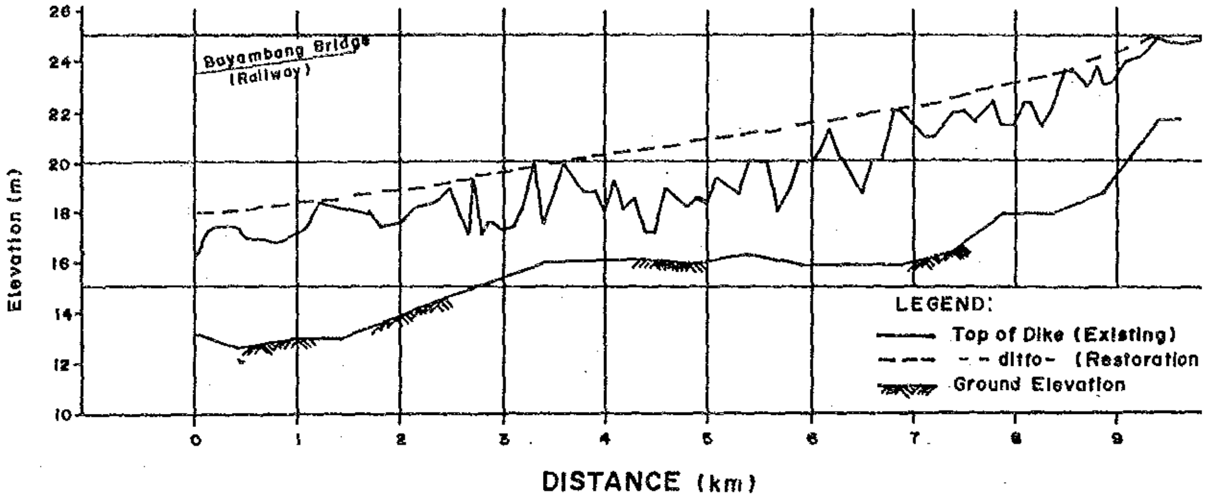


Fig. 2.8 EXISTING INTAKE FACILITY OF THE LOWER AGNO IRRIGATION SYSTEM

PROFILE ALONG THE CENTER OF DAMAGED EARTHDIKE
(Bayambang-Carmen Br.)



CROSS SECTION OF DAMAGED EARTHDIKE

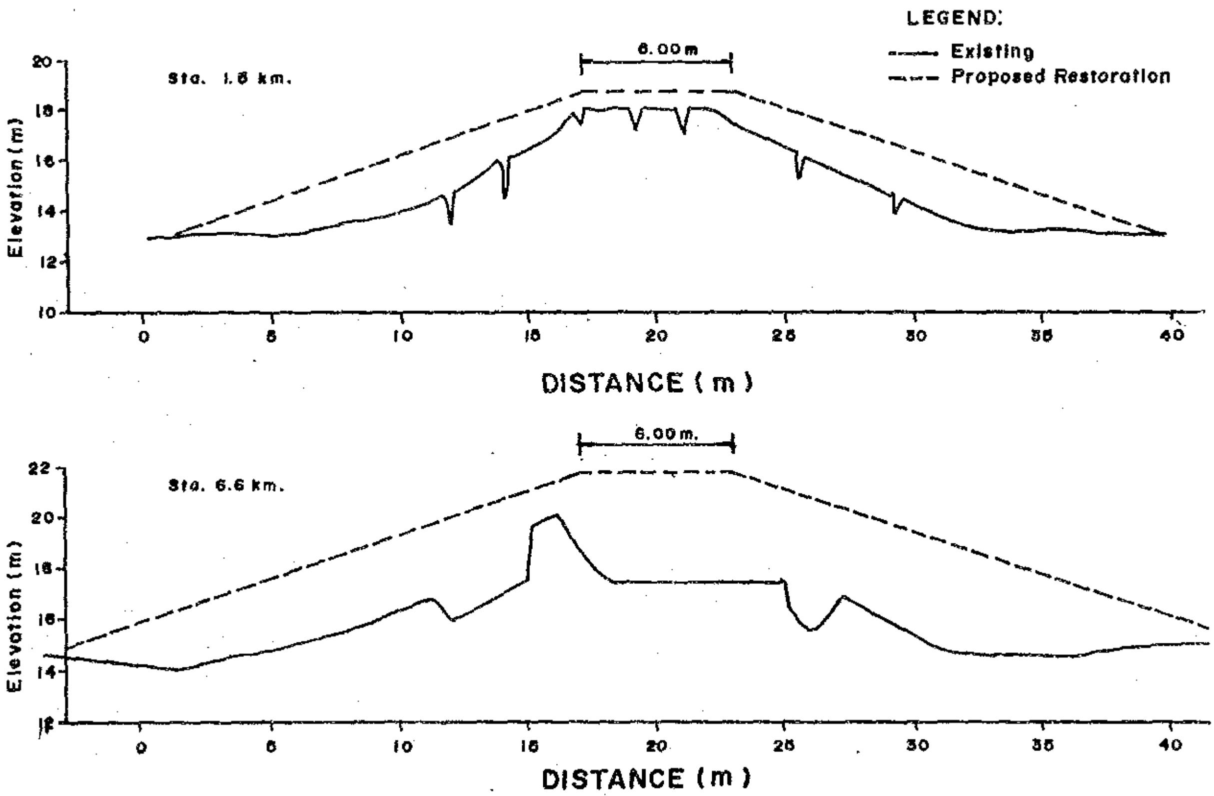
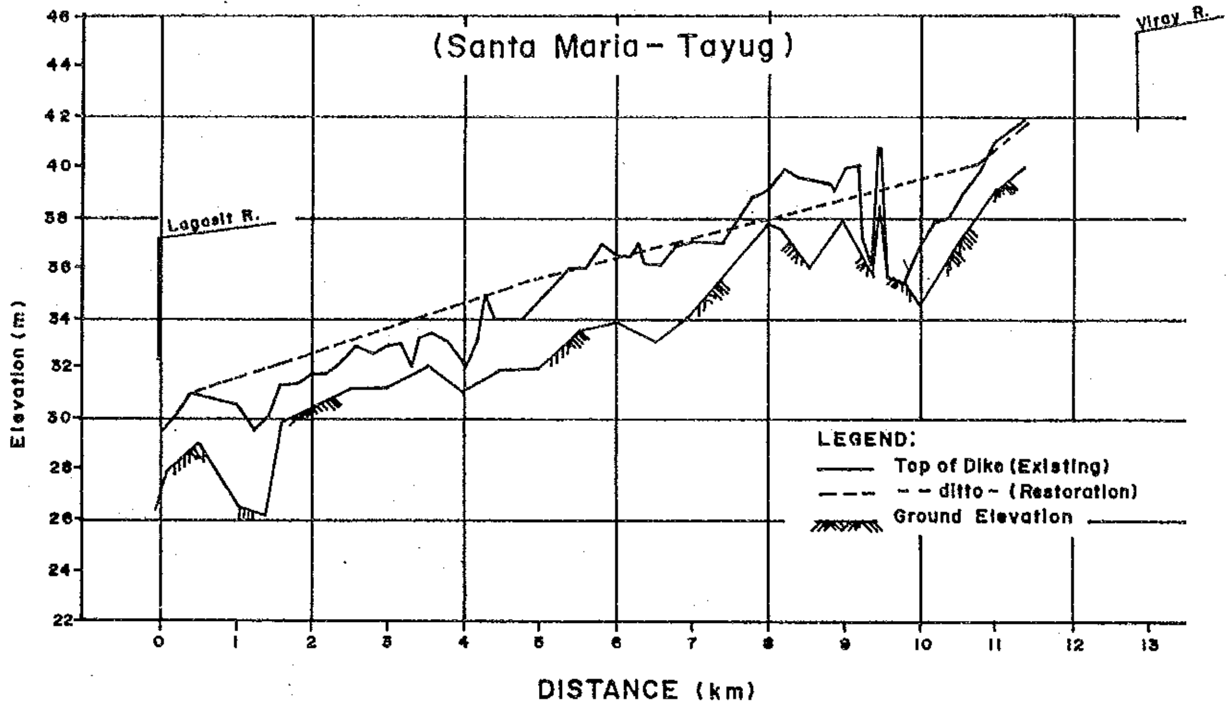


Fig. 2.9 (1/2) DAMAGE CONDITION OF EARTH DIKE IN THE MAJOR STRETCHES

PROFILE ALONG THE CENTER OF DAMAGED EARTHDIKE



CROSS SECTION OF DAMAGED EARTHDIKE

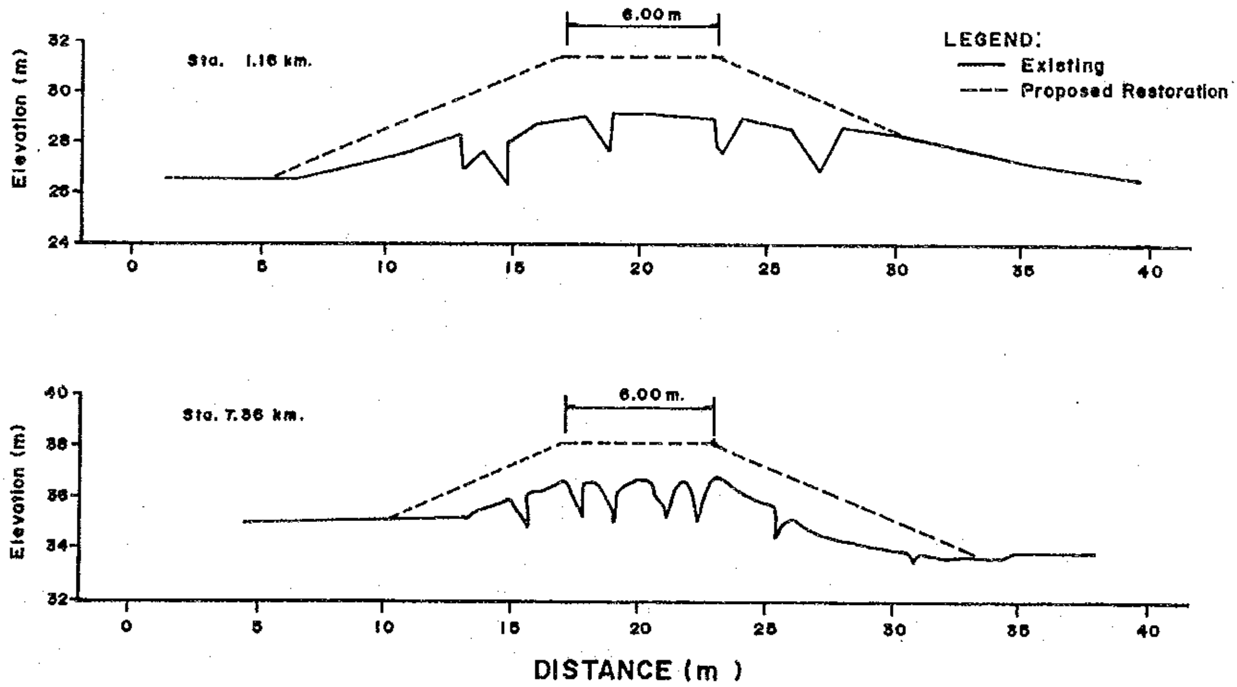


Fig. 2.9 (2/2) DAMAGE CONDITION OF EARTH DIKE IN THE MAJOR STRETCHES

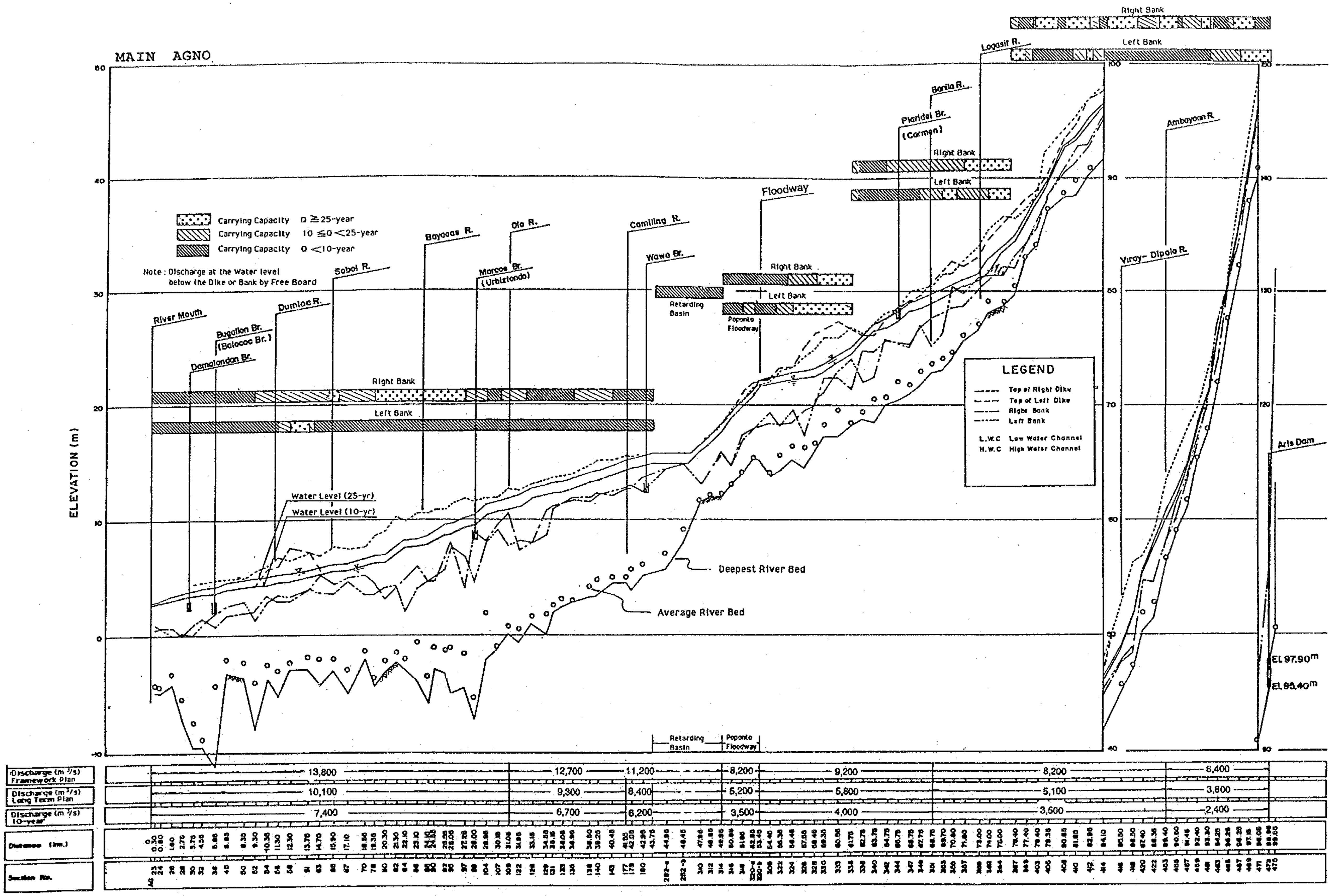


Fig. 2.10 EXISTING CARRYING CAPACITY OF THE AGNO RIVER

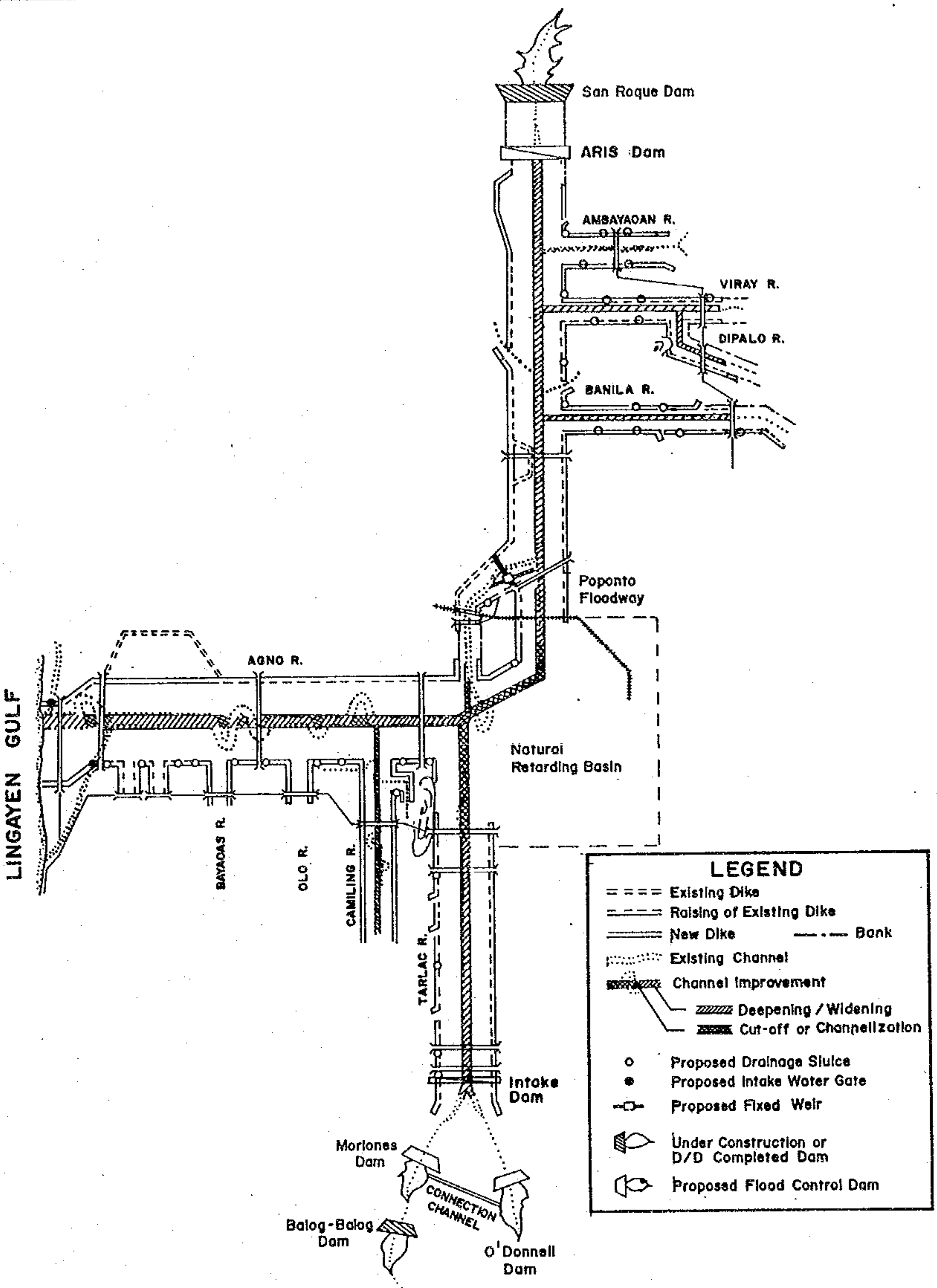


Fig. 2.11 GENERAL LAYOUT OF THE AGNO RIVER IMPROVEMENT PROJECT FOR THE FRAMEWORK PLAN

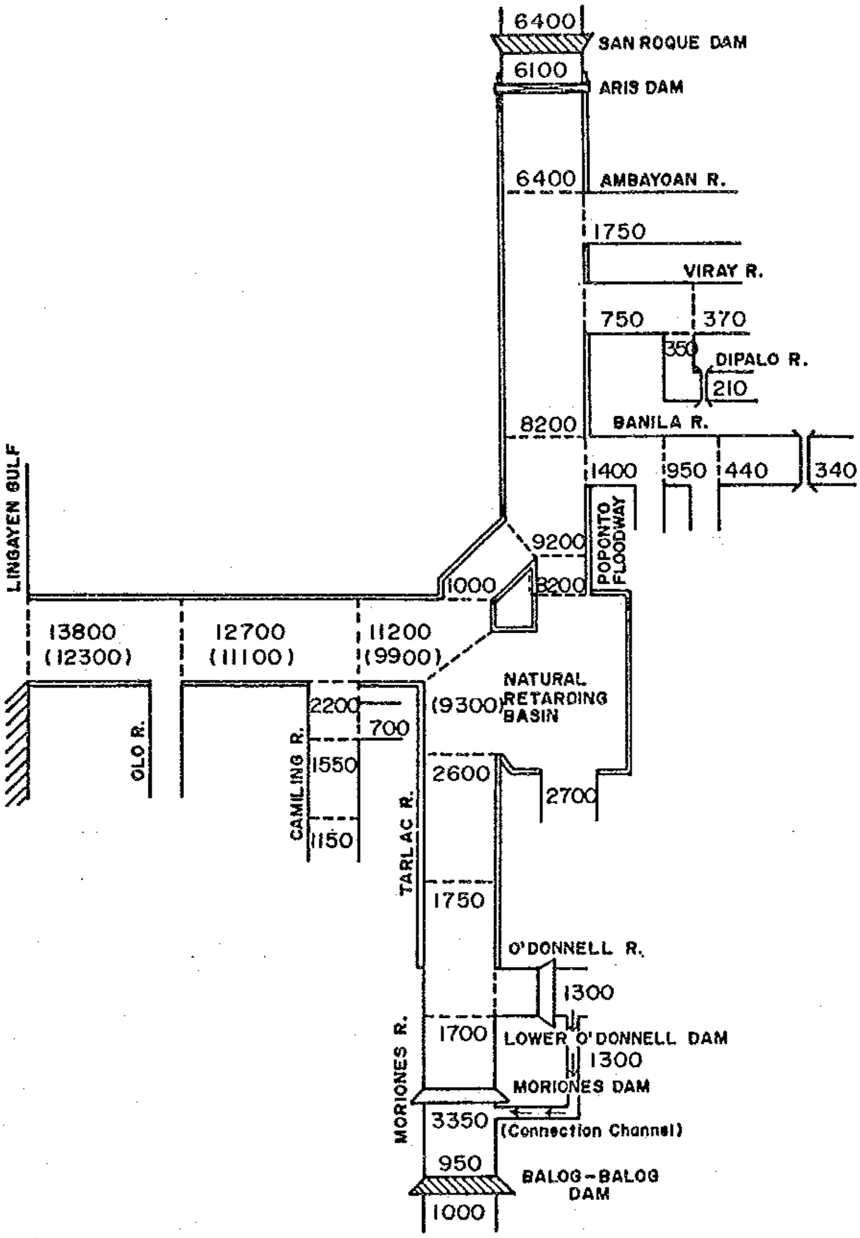


Fig. 2.12 DESIGN FLOOD DISCHARGE DISTRIBUTION OF FRAMEWORK PLAN IN THE AGNO RIVER

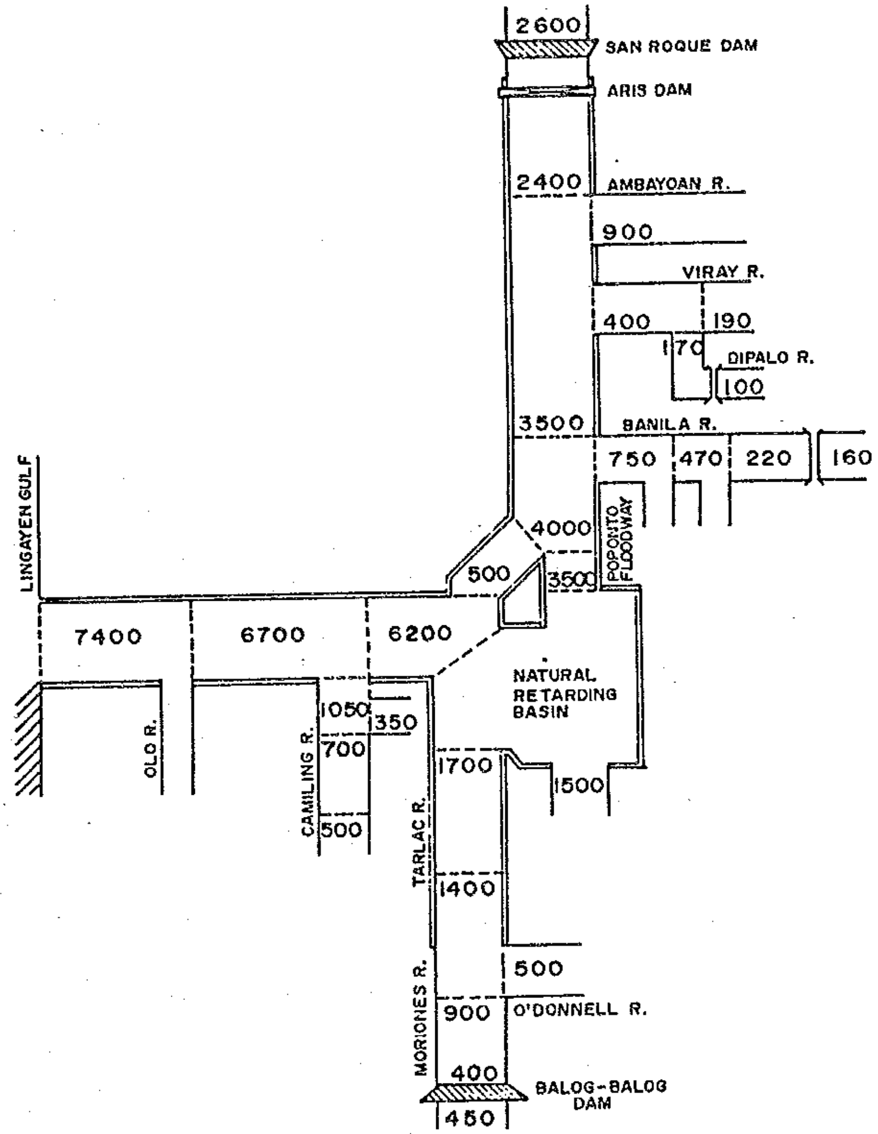


Fig. 2.13 **DESIGN FLOOD DISCHARGE DISTRIBUTION OF PRIORITY PROJECT STUDY IN UPPER AGNO RIVER**