APPENDIX G

RIVER IMPROVEMENT PLAN

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CHAPTER I FLOODING PROBLEMS

1.1 Potential Flood Areas

The Laoag River Basin suffers severe floods throughout the entire river reaches from the uppermost locations in the alluvial fan to the river mouth. The potential flood area for the design flood of a 25-year return period is estimated at 17,400 ha, and divided into 19 subdistrict areas as listed below. The boundary of these flood reaches are as shown in Fig. G.1.1.

	River	Bank	Area	Urban/Rural
1)	Laoag River	Left bank	Tangid, Laoag	Mixed
2)	- do -	Right bank	Suyo, Laoag	Rural
3)	- do -	- do -	Poblacion, Laoag	Urban
4)	- do -	- do -	Camanggaan, Laoag	Mixed
5)	- do -	Left bank	Poblacion, San Nicolas	Urban
6)	Laoag/Bongo R.	- do -	San Manuel, Sarrat	Rural
7)	Laoag River	- do -	San Felipe, Sarrat	Rural
8)	- do -	Right bank	Sto. Tomas, Sarrat	Rural
9)	- do -	Left bank	San Marcos, Sarrat	Rural
10)	- do -	Right bank	San Cristobal, Sarrat	Rural
11)	Laoag/Guisit R.	Right bank	Guisit River/Mandaloque	Rural
12)	Laoag River	Left bank	Suyo, Dingras	Mixed
13)	- do -	- do -	Poblacion, Dingras	Urban
14)	Cura/Labugaon R.	Both banks	Whole area along river	Rural
15)	Solsona R.	Both banks	- do -	Rural
16)	Madongan R.	Both banks	- do -	Rural
17)	Papa R.	Both banks	- do -	Rural
18)	Lower Bongo R.	Both banks	- do -	Rural
19)	Upper Bongo R.	Both banks	- do -	Rural

In the above table, Laoag River covers the river stretches between the river mouth and the confluence with Cura River. Lower Bongo covers the river sections between the confluence with Cura River and confluence with Papa River while the Upper Bongo is the stretch upstream from the confluence with Papa River.

1.2 Flood Characteristics in the Laoag River Basin

Floods of the Laoag River Basin are classified as follows:

(1) Overbanking floods of the Laoag and Lower Bongo River; and

(2) Floods caused by channel shifting and riverbed aggradation in the tributaries of the alluvial fan (Cura/Labugaon, Solsona, Madongan, Papa and Upper Bongo).

The Solsona, Madongan and Papa rivers are already confined by a diking system; however, they are still under the menace of floods with severe flood damage. The dikes are temporary ones with insufficient structural stability and exposed to breaching.

The entire stretch of Laoag River was affected by a large flood on July 24-26, 1996. The Study Team and the DPWH counterpart staff had the timely opportunity to observe this flood from hydrological and structural aspects. The flood probability was estimated at 15-year (see Appendix B, Climate and Hydrology) and the flooded areas along with main flood flow directions are shown in Fig. G.1.2. The experienced hydraulic flooding situations in the respective flood areas are as summarized below.

(1) Tangid Area

Floodwaters overflowed the left bank of Laoag River at Tangid and entered the small Buttong creek drainage basin after crossing the Laoag - Gabu road near the Gilbert Bridge.

(2) Suyo Area of Laoag

Floodwaters overflowed the right bank of Laoag River at Suyo. The flood water flowed into the San Mateo River after crossing the Laoag-La Paz road. It obstructed the drainage system in the city proper of Laoag.

(3) Poblacion Area of Laoag

Only the uppermost and lowermost fringes of Poblacion, Laoag were inundated because of the overbanking of Laoag River.

(4) Camangaan Area

The area expanding on the right bank of Laoag River upstream of the Poblacion of Laoag was also inundated due to overbanking.

(5) Poblacion Area of San Nicolas

Floodwaters overflowed the left bank of Laoag River at Poblacion, San Nicolas and flowed into the upstream section of Buttong Creek after crossing the Laoag-San Nicolas road (National Highway Route 3) near Gilbert Bridge.

(6) San Manuel, Sto. Tomas and San Marcos Areas of Sarrat

These areas were affected by the overbank flood of Laoag River.

(7) San Felipe Area of Sarrat

The area was inundated by overflow of the left bank of Laoag River.

(8) San Cristobal Area

The area is located at a big concave section of the right bank of Laoag River. The national road (Laoag - Piddig) in this section was rendered impassable because of the deep flooding of more than 2 m. This flood area is hydraulically deemed a part of the river channel although it is cultivated as farmland.

(9) Mandaloque Area/Guisit River

Mandaloque area is situated on the right bank of Laoag River between the mouths of the Guisit and Cura rivers. The area was affected by combined floodwaters from the overbank flow of Laoag, Guisit and Cura rivers.

Guisit River had overbank floods on both sides in the lower reaches due to backwater of the Laoag River.

(10) Suyo and Poblacion Areas of Dingras, and Lower Bongo River

Flooding of the left bank of Laoag/Lower Bongo River in Dingras was mainly caused by flood intrusion from Lower Bongo River at Barangay Medina. Flood intrusion extended over approximately 1 km in the upstream of Cauplasan Bridge. A part of the floodwater crossed the approach road of the bridge to the left bank of the river. The remaining portion flowed northwest across the National Road inundating the western part of Dingras, and returned to the river at the downstream of Poblacion, Dingras (at

Barangay Suyo). As the result, the Poblacion area of Dingras was isolated like an island in such a short time.

(11) Upper Bongo River

There was no overbank flood except in some very short distances. Many locations were affected by bank erosion.

(12) Solsona/Madongan/Papa Rivers

Some sections of the existing diking system in these rivers were breached by bank erosion, resulting in flooding and sediment deposition on the inner lands. However, overflow of dikes was not experienced during this flood event.

Breach of dikes mostly occurred at the sections of open levee, at the sites where drainage/intake was provided and at the concave section where flood water converged.

Local riverbed scouring of 3 m or more were observed in the downstream of the irrigation diversion dams. Further, a considerable volume of sediment deposition was observed in some river sections where the riverbed slope changes much. It caused shifting of the main flood stream within the channel, resulting in bank erosion.

(13) Cura/Labugaon River

Flood water of the Labugaon River flowed straight westward through the existing small channel, causing damage to agricultural lands and infrastructures. In the middle reaches of the Cura/Labugaon River, flood water overflowed and breached the existing concrete covered dikes on the right bank. It flooded extensively through small creeks.

Numerous flowing debris and driftwood were observed. Moreover, some houses were washed away due to strong flood current and bank erosion.

Experiences in this flood event gave useful guidelines to the engineering design of river improvement in the alluvial fan as described below.

(1) Diking system in the alluvial fan rivers is effective for fixing the river course and for preventing overbank flood if sufficient bank protection works are provided.

(2) Appropriately designed open dike is useful in river sections with steep slope. However, the open river section is liable to produce a complicated hydraulic phenomenon, resulting in the breach of neighboring dikes.

(3) Inlet/outlet structure installed through earth dike is a weak point and requires sufficient reinforcement works.

(4) Bank erosion easily occurs in every river section. Bank protection works are necessary for the entire reaches.

(5) Sudden change of river width and riverbed slope could cause shifting of the main stream, bed and bank erosion, and sediment deposition in the river channel that would result in dike breaching. Alignment and bed slope of river channel should be designed to adapt smoothly to channel shift.

1.3 Flooding Problems in the Urban Area of Laoag City

The urban area (Poblacion) of Laoag City is located on the right (north) bank of Laoag River 8 km upstream of the river mouth. It is more affected by local runoff especially in the low-lying areas (see Fig. G.1.3 for location).

Most of the urban area is drained by the Daorao creek. Only a small portion is drained directly to the Laoag River. Daorao creek runs through the northern outskirts of the poblacion from east to west and finally flows into the China Sea. The irrigation canal (Laoag-Vintar irrigation canal) serving the ricefields in the outskirts of the poblacion also drains local floods. This canal originates from the Vintar Dam located 3 km upstream of the town of Vintar and runs around the northern side of Laoag Poblacion.

Daorao creek is independent from the Laoag River. However, the low-lying outskirts of Laoag City is habitually inundated by local runoff due to the poor capacity of the existing drainage system including the creek. A wide area including the densely populated areas were also inundated in July, 1996 (typhoon Gloring).

Development in the city has been directed towards the northeast in the low-lying rice field along the national road. This urban development worsens the flood problems even more.

CHAPTER II DESIGN FLOOD DISCHARGE

2.1 Design Flood Discharge Probability of Major Rivers in the Philippines

The design flood probability of a river basin should well match its hydrological characteristics, socio-economic importance and financial capability. Further, it should be comparable with those of the other river basins in the country. Therefore, the design flood probabilities of major river basins in the Philippines were evaluated and compared prior to the determination of design flood probability of the Laoag River basin.

Since 1981, ten (10) major rivers and volcanoes in the Philippines have been studied by the DPWH with foreign technical and financial assistance. These are the eight rivers of Cagayan, Agno, Pampanga, Pasig, Panay, Agusan, Ilog-Hilabangan and Jaro/Iloilo and two volcanoes, Mt. Pinatubo and Mt. Mayon (refer to Fig. G.2.1). Various plans have been proposed and these are categorized into three (3) main stages: Framework Plan, Master Plan and Short-term Plan, as follows.

Framework Plan	:	The target year is indefinite and its implementation period is not specified. This plan was proposed for six (6) rivers.
Master Plan	:	The target year is 20 to 30 years and the proposed works are to be achieved within 20 to 30 years. This plan was proposed for seven (7) rivers and volcanoes.
Short-term Plan	:	This is a priority plan selected from the master plan and the proposed works are to be achieved within 10 years. The plan was proposed for nine (9) rivers and volcanoes.

Design flood discharge probabilities of the respective rivers are tabulated below. A 100-year probability is proposed for the Framework Plan. The Master Plan varies from 25-year to 100-year while the Short-term Plan is in the range of a 10-year and 30-year.

River/Volcano	Framework Plan	Master Plan	Short-term Plan
Cagayan R.	100-year	25-year	25-year
Agno R.	100-year	25-year	10-year
Pampanga R.	100-year	-	20-year
Mt. Pinatubo	-	-	20-year
Pasig R.	100-year	100-year	30-year
Mt. Mayon	-	50-year	-
Panay R.	100-year	25-year	10-year
Agusan R.	100-year	-	30-year
Ilog-Hilabangan R.	-	100-year	25-year
Jaro-Iloilo R.	-	50-year	20-year

Table G.2.1 summarizes the proposed design flood discharge probabilities of the plans of 10 major rivers and volcanoes and the salient features of their river basins. In addition, the Attachment presents the following statistics, estimates and information on the respective rivers and volcanoes.

(1) Project Area

(a) Drainage Basin Area
(b) Number of Cities/Municipalities in Drainage Basin
(c) Population of Drainage Basin
(d) GRDP of Drainage Basin
(e) Sectoral Structure of Drainage Basin
(f) Land Use of Drainage Basin

(2) Potential Flood Damage

(a) Flooded Area
(b) Affected Population
(c) Probable Flood Damage

(3) Probable Flood Discharge

(4) Design Flood Discharge Probability

(5) Project Cost

(6) Progress of Project

2.2 Socio-economy and Hydrological Characteristics of Laoag River Basin

The socio-economic situation and hydrological characteristics of the Laoag River basin are summarized in the same manner as described above as compared with the other river basins in Philippines.

(1) Project Area

1)	Drainage Basin	:	1,332 km^2
2)	Number of Cities/Municipalities of Drainage Basin	:	1 city & 10 municipalities
3)	Population of Drainage Basin (1995)		
	a) Total Population	:	196,900
	b) Population Density	:	148 persons/km^2
	c) Ratio of Urban Population to Total	:	29%
4)	GRDP of Drainage Basin (assumed as Region I average in 1996)		
	a) Per Capita	:	₱15,700
	b) Total	:	₱4,080,000,000
5)	Sectoral Structure of Drainage Basin (assumed as Region I average in 1996)		
	a) Agriculture		
	- By GRDP (%)	:	42
	- By Employment (%)	:	53
	b) Industry		
	- By GRDP (%)	:	15
	- By Employment (%)	:	9
	c) Service		
	- By GRDP (%)	:	43
	- By Employment (%)	:	38
6)	Land Use of Drainage Basin (1996)		
	a) Mountain Area	:	935.6 km^2 (70.2%)
	b) Cultivated Land	:	246.7 km^2 (18.5%)
	c) Residential Land	:	20.7 km^2 (1.5%)

d)	Low Land Tree Area	:	22.3 km^2 (1.7%)
e)	Devastated Area	:	36.9 km^2 (2.8%)
f)	River Bed Area	:	56.9 km^2 (4.3%)
g)	Other Area	:	13.0 km^2 (1.0%)
Total		:	1,332.1 km^2 (100%)

(2) Potential Flood Damage

1)	Flooded Area		
a)	25-year	:	17,400 ha
b)	100-year	:	20,220 ha
2)	Affected Population (1996)		
a)	25-year	:	66,118
b)	100-year	:	78,858
3)	Probable Flood Damage (1996 price)		
a)	25-year	:	696.1 million ₱
b)	100-year	:	913.8 million ₱

(3) Probable Flood Discharge At Gilbert Bridge of Laoag City (1,254.4 km^2)

1)	25-year	:	10,900 m^3/s
2)	100-year	:	13,700 m^3/s

The salient features of the Laoag River basin are compared with those of the major river basins in the Philippines in Table G.2.1.

2.3 Design Flood Discharge of the Laoag River System

The design flood discharge probability of the master plan of the Laoag River System is proposed to be 25-year, based on the following considerations:

(1) The Laoag River Basin is not so large and not much populated. Economic development is not so great compared with the other 10 major river basins in the Philippines.

(2) The potential flood area and affected population of the Laoag River Basin also are not much compared with the other 10 major rivers basins.

(3) In consideration of Items (1) and (2) above, the design flood discharge probability of the Laoag River should not exceed those of the other 10 major rivers.

(4) The largest flood of the Laoag River in the past (1967 Typhoon Gening) recorded the peak discharge with a 25-year probability.

The design flood discharge with a 25-year probability is estimated to be 10,900 m^3/s at Gilbert Bridge, Laoag City. Design discharge distribution of the Laoag River System is shown in Fig. G.2.2. Detailed estimation of the probable discharges is described in Appendix B, Climate and Hydrology.

CHAPTER III POSSIBLE STRUCTURAL MEASURES

3.1 Possible Flood Control Structural Measures

Generally, the possible flood control measures include: (1) dike to confine flood, (2) channel improvement works to increase flood carrying capacity, (3) dam/reservoir to regulate flood peak, (4) retarding basin to regulate flood peak, and (5) floodway to divert flood.

As evident from the discussions below (Section 3.2 toSection 3.6), diking system with small scale channel improvement is applicable for the flood control of the Basin in addition to the sediment control by sabo dam.

3.2 Dike

Diking system is commonly used in many rivers. This involves the construction of embankments on both sides of the river to confine the floodwater. This is applicable at any point in the river course of this basin.

3.3 Channel Improvement

Channel improvement works increase the flood carrying capacity of rivers and lower flood level, which in turn result in reduced dike height. The works include clearing of channel bed, enlarging of channel cross-section (dredging) and/or shortening of channel distance (shortcut).

(1) Clearing of Channel Bed

The flood carrying capacity of river channel is increased by removing bushes, trees, and other obstacles from the riverbed and flood plain (high water channel). It is applicable at any location of the Laoag River Basin, especially in the high water channel of the lower reaches of Laoag River.

However, excessive clearing of bushes in the high water channel may increase the flow velocity near the bank, resulting in bank erosion. Location of bush clearing should be carefully selected considering the above phenomenon.

(2) Dredging of Channel

Dredging of river channel is commonly used to increase the flood carrying capacity in many rivers. However, it is generally effective in rivers with no excessive sediment runoff. In river with much sediment transport, local dredging may not be effective as the dredged channel section will be easily filled if no periodic dredging is made.

River dredging generally entails a higher cost compared to dike construction. It may be economically justified only when large spoil banks are available in the vicinity or the dredged materials can be used as aggregate for construction.

(3) Shortcut of Channel

Shortening of the river channel can be obtained by cutting bends. This makes the riverbed slope steeper, resulting in the increase of flood carrying capacity. On the other hand, shortcut is liable to cause vertical erosion in the upstream and sediment deposition in the downstream. Sufficient bank protection works are necessary for the shortcut section and the upstream.

The applicability of channel improvement in the Laoag River Basin is discussed below.

(1) Dredging in Laoag River

The Laoag River floods 11 areas on both banks between the river mouth and the confluence with Cura River (approximately 30 km long). Approximately 30 million m^3 have to be dredged to lower the high water level by 1.5 m and solve the flooding problems. This dredging alternative is considered infeasible from the following aspects.

(a) No spoil bank to accommodate such a large quantity of sand/gravel is identified in the basin except the sea or sand dune seacoast.

(b) Dredging and hauling of the dredged materials to the sea or seacoast requires a tremendous cost of 4.5 to 5.0 billion pesos at 1996 prices.

(c) Dredging for aggregate production is uneconomical. Only aggregate production for export in the lowermost reaches may be feasible; however, its commercial profitability varies depending on the international market price. (See, Appendix I, Multipurpose Development of the Project.)

(d) Flooding will still occur in some areas even after completion of dredging.

(2) Dredging of Upper Tributaries

The Solsona, Madongan and Papa rivers are already provided with dikes. Large scale dredging is not necessary for these rivers.

Large scale dredging is not also necessary for the Bongo River since flooding along the river is limited to some small areas scattered here and there. Local diking system is clearly more economical than river dredging.

On the other hand, dredging in the Cura River is considered as an effective flood control measure. Dredging of approximately 7 million m^3 is required to lower the riverbed by 2.0 m. This alternative is also considered infeasible from the following aspects:

(a) No spoil bank to accommodate such a large volume of sand/gravel is identified in the surrounding areas.

(b) The required cost for dredging and hauling to the sea or seacoast is as high as 1.7 to1.8 billion pesos at 1996 prices.

(c) Dredging for aggregate production is also applicable. (See, Appendix-I, Multipurpose Development of the Project.)

(d) In addition to dredging, sabo works are still necessary to prevent the excessive sediment deposition around the fan apex during a big flood to avoid channel shifting.

(e) Periodic dredging is necessary, especially for the river mouth areas, to maintain the compulsory design bed.

(3) Shortcut of Laoag River

The Laoag River has a narrow section at San Cristobal, 23 km from the river mouth. Further, the river meanders much in the downstream of this section. The flood water is dammed up by about 1.0 m at this section, resulting in severe sediment deposition around the confluence with the Guisit River. This is considered as one of the major causes of flood in San Cristobal, San Felipe, Guisit river mouth area, Suyo and lower Mandaloque areas.

Shortening of this meandering section and widening of the narrow section are considered to be alternative measures to mitigate the flooding problems. The cutoff channel will shorten the river length from 7 km to 3 km; however, the project will require excavation of 13 million m^3 in a hill with a maximum height of 45 m above the riverbed. For location of the cutoff channel, see Fig. G. 3.1.

Economic unfeasibility of this project is obvious.

3.4 Dam and Reservoir

The Laoag River Basin is endowed with a few possible dam/reservoir sites due to its steep mountain valleys. Among them, DPWH studied three (3) dams: Cura Dam in Cura River, Tina Dam in Labugaon River and Gasgas Dam in Solsona River as components of the Tina-Gasgas-Cura Multipurpose Project in 1983 (for location, see Fig. G.3.1). The salient features of the proposed dams are shown below.

	Cura Dam	Tina Dam	Solsona Dam
River	Cura	Labugaon	Solsona
Drainage Area (km^2)	63.1	98.5	71.4
Dam Height (m)	59	74	52
Gross Storage Capacity (m^3)	13,200,000	34,250,000	1,640,000

The above dams are planned as multipurpose dams for hydropower, irrigation and flood control development. In this JICA study, their availability for flood control in the Basin is as verified below.

The Gasgas Dam in Solsona River is provided with only a small storage capacity, Thus, it is not available for flood control purposes.

On the other hand, the Cura and Tina dams have large catchment areas and storage capacities. Their effective storage capacities are estimated at 10.7 million m^3 for Cura Dam and 26.8 million m^3 for Tina Dam assuming that sediment deposits for 50 years are 2.5 million m^3 and 7.5 million m^3, respectively.

However, the flood control effect of the above two dams to the Laoag River is not large. They can reduce the flood peak at Laoag City by 1,000 m^3/s or 9% of the design flood discharge (10,900 m^3/s) even if their entire effective storage capacities are used for flood control. It is because they can control only a total drainage area of 170 km^2, equivalent to 13% of the basin drainage area of 1,332 km^2. Even if these dams will be operated mainly for the flood control of Cura River, they must apply their entire effective storage capacities to solve the existing flooding problems of the Cura River. Besides, the total construction cost of the two dams is estimated to be 1.5 billion pesos at 1996 prices. Thus, the flood control of Cura River by dam is considered economically infeasible.

From the above discussion, it is presumed that flood control by dam is not economical also in the Madongan, Papa and Bongo rivers.

3.5 Retarding Basin

Similar to flood control by dam, a retarding basin with a large storage capacity is required to attain a significant reduction in the flood peak of the Laoag River. A storage capacity of approximately 50 million m^3 is necessary to reduce the flood peak at Laoag City by 1,000 m^3/s. For this purpose, a flood retarding area larger than 2,500 ha is necessary if the flooding depth in the retarding basin is assumed to be 2 m, but such a wide flood plain is not available in the Basin.

No flood retarding area is identified along the upper tributaries. Thus, flood control by retarding basin is also not applicable for the tributaries in the alluvial fan.

3.6 Floodway

A floodway would divert floodwater upstream of the protection area to other rivers or the sea. However, there is no possible site (route) in the Laoag River Basin except the Lower Cura River.

The Cura River flows towards the west in the alluvial fan and changes direction to the southwest at the middle reaches. It finally joins the Laoag River against its flow direction. Diversion of the Cura River to Malabanga creek which joins Laoag River around the river mouth of the Guisit River is conceived as an alternative flood control measure only from the river morphological aspect (for location, see Fig. G.3.1). Construction of a new floodway (diversion channel) with a length of 6.0 km will require a large investment, and this is obviously infeasible.

CHAPTER IV RIVER IMPROVEMENT PLAN

4.1 Laoag-Bongo River Improvement Plan

The main course of the Laoag River is called Laoag River in the lower reaches after the confluence with the Cura River 31.6 km upstream from the river mouth, and Bongo River in the middle and upstream reaches. The Laoag River is joined by the Guisit River 26.0 km upstream from the river mouth. The Bongo River is also joined by major tributaries: Cura/Labugaon, Solsona/Madongan (32.4 km upstream from the river mouth), and Papa (42.4 km). River improvement of the Laoag-Bongo River from the river mouth to Bongo Bridge, about 54 km long along the existing river course, is discussed in this section. Likewise for Guisit River.

The major design components of the river improvement are river alignment, longitudinal profile of riverbed, high water and dikes, and river width. These components are determined as follows.

(1) Alignment

The existing alignment of the river is comparatively smooth except the large U-shaped meandering in the section between the town of Sarrat and the confluence with Guisit River. Cutoff at this section is not feasible as discussed in Section 3.3. Further, the flooding of the Laoag-Bongo River is caused by overflow of the existing banks and flooded areas are limited to the narrow low-lying stretches along the river course.

Hence, the design river alignment is set at the present course and necessary dikes are designed along this alignment.

(2) Longitudinal Profile

Aggradation of the riverbed is considered not significant. The average annual aggradation rate in this river stretch is estimated at 0.5 cm/year in the Laoag River, 0.4 cm/year in Lower Bongo River and 1.6 cm/year in the Upper Bongo River.

In view of the above circumstances, the design high water level of the Laoag-Bongo River is determined using the non-uniform flow method based on the existing riverbed profile. Roughness coefficients used in design are 0.035 for Laoag and Lower Bongo, and 0.04 for the Upper Bongo River. Moreover, the mean sea high water level of EL.-0.018 is used at the river mouth. Cross-section surveys of Laoag and Bongo rivers taken in the dry season of 1996 were used. Design high water levels of the Laoag-Lower Bongo and Upper Bongo rivers are shown in Fig. G.4.1 and G.4.2, respectively.

(3) River Width

The width of the existing river channel is enough to carry the design flood discharge. Accordingly no widening of the river channel is necessary.

On the other hand, Bongo River is designed by the Regime Theory to secure the stability of river channel with steep bed slopes. This equation shows the relation between the river width and discharge.

$$B = (3.5 \text{ to } 7.0) \times Q^{1/2}$$

where,

B : river width (m)
Q : design discharge (m^3/s)

The proposed widths are:

River	Design Discharge (m^3/s)	Required River Width (m)	Proposed Width (m)
Lower Bongo	3,220	199 -397	400
Upper Bongo	2,000	157 - 313	310
	1,160	119 - 238	350
	750	96 -192	190

(4) Necessary River Structures

Dikes with a total length of 69.5 km are needed: 32.8 km in Laoag River, 6.9 km in Lower Guisit River, and 29.8 km in Bongo River. In the urban area of Laoag City (Poblacion of Laoag), a 1.5 km long concrete dike (floodwall) is proposed because a space to construct earth dikes is not available. On the other hand, the lower Guisit River is largely affected by backwater of the Laoag River, so backwater dikes should be provided up to 3.5 km upstream from the confluence.

The proposed structures for each potential flood area are shown in Table G.4.1, and their locations are shown in Fig. G.4.3.

4.2 Cura/Labugaon River Improvement Plan

At present, the Cura River flows in the northern part of the Cura/Labugaon Basin. The Labugaon River flows straight westward in the southern part of the basin and joins the Cura River in the middle reaches. These rivers spread 600 to 1,200 m wide right and left and flow into the Bongo River. It is, therefore, desirable to confine the river courses to appropriate locations.

(1) Alignment

The following four (4) alternative alignments are considered for the improvement of the Cura/Labugaon River.

Plan A : To join the Labugaon to Cura at the fan apex and to improve the existing Cura River.

Plan B : To separate the Labugaon and Cura rivers until the middle reaches and thereafter, to join Labugaon to Cura.

Plan C : To separate the Labugaon and Cura rivers until the confluence to the Bongo River.

The alternative river alignments are shown in Fig. G.4.3. The above alternatives are compared from hydraulic, socio-economic and construction aspects as show in Table G.4.2.

(a) Hydraulic aspects are evaluated in terms of topographical advantages and disadvantages of the river course and stability of the river channel.

Plan A has a big bend in the Lower Labugaon River. This stretch should be firmly protected. There are no remarkable topographical disadvantages in Plan B. Plan C has many bending portions which should be protected from flood flows. Hydraulically, the alignment of Plan A is the most preferable since it runs through the deepest valley of the Cura/Labugaon flood plain and it requires no river widening which make it different from the other plans.

(b) Social aspects include the assessment of impact on the neighboring communities and required land acquisition.

Plan C requires land acquisition of 65 ha to construct dikes compared with Plan A (1 ha) and Plan B (8 ha). Plans B and C create islands between Cura and Labugaon river. There exist 4 communities (about 110 houses) in the island of Plan B and 5 communities (130 houses) in the island of Plan C. These plans may therefore have some negative impacts on the inhabitants.

In the case of Plan A, there is no separation of communities and it requires less land acquisition because the Cura and Labugaon rivers join upstream and almost follow the existing course. The resettlement and land acquisition of Plan A are very small compared to the other alternatives.

(c) Construction aspects compare the required construction costs.

River improvement works of all alternative plans consist mainly of excavation, dike embankment, revetment and bridge improvement. Estimated construction costs are 324 million pesos for Plan A, 558 million pesos for Plan B (1.7 times of Plan A), and 821 million pesos for Plan C (2.5 times of Plan A). Plan A is the most economical.

From the above discussion, the alignment under Plan A is proposed.

(2) Longitudinal Profile

The Cura/Labugaon River is also annually affected by excessive sediment deposition. The average annual aggradation rate to the riverbed is estimated at 3.0 cm/year. The proposed sabo dams are expected to curb this aggradation rate to 0.7 cm/year. Riverbed aggradation will be further decreased by the ongoing reforestation projects and sieving effects of the sabo dams. Hence, in principle, the existing profile is adapted as the design riverbed profile.

Design high water levels are obtained from uniform flow calculation as shown in Fig. G.4.4. Water level of the downstream of Cura River is affected by the high water level of the Laoag River.

(3) River Widths

Regime Theory is also applied to determine the river widths (refer to previous Section).

River	Design Discharge (m^3/s)	River Width (m)
Cura	2,360	340
	850	200
Labugaon	1,260	250

(4) Necessary River Structures

Major improvement works are as follows (see Fig. G.4.4 for locations and Table G.4.1 for work quantities):

(a) Diking system of 21.9 km to confine the existing braided river flow;

(b) Revetment and toe protection of 22.2 km to protect dikes from erosion by rapid current;

(c) Twenty (20) spurdikes to regulate flow direction and protect dikes at concave alignments;

(d) Four (4) sluiceways crossing new dikes for intake or drainage;

(e) One (1) groundsill downstream of the existing Labugaon irrigation diversion dam to avoid remarkable riverbed fluctuation which might affect the stability of the diversion dam.

4.3 Solsona, Madongan and Papa River Improvement Plan

The Solsona, Madongan and Papa rivers flow from the alluvial fans into the Bongo River at the right bank. These rivers were improved under the Urgent Disaster Prevention Works (UDPW) in early 1991 to 1993. Since these rivers have similar river morphology, they can be discussed together.

(1) Alignment

River courses of the Solsona, Madongan and Papa were fixed on the present smooth and hydraulically reasonable alignments with diking system constructed by the UDPW. Therefore, design of alignment follows the present river course.

(2) Longitudinal Profile

These rivers are prone to excessive runoff every year. The average annual sediment depositions are estimated at 5.1 cm/year in the Solsona/Madongan rivers, and 4.8 cm/year in the Papa River.

On the other hand, the proposed sabo dams are expected to reduce the annual riverbed aggradation to 2.5 cm/year in the Solsona/Madongan rivers and 2.3 cm/year in the Papa River on average. These riverbed aggradations will be further decreased by the on-going reforestation projects and the sieving effects of the sabo dams.

As known from the above discussions, the Solsona, Madongan and Papa rivers will cause no significant riverbed aggradation in the future. Hence, the design high water levels of the above rivers are determined based on the existing riverbed profiles.

Proposed high water levels, as shown in Fig. G.4.5 (Solsona), Fig. G.4.6 (Madongan) and Fig. G.4.7 (Papa), are determined on the basis of the non-uniform cross-section survey in the dry season of 1996.

(3) River Width

The present river widths of these rivers are reviewed as follows using the regime equation to secure the stability of the river channel as stated in Section 4.2 above.

River	Design Discharge (m^3/s)	Required Width (m) (constant = 7.0)	Present River Width (m)
Lower Solsona	3,490	414	330
Middle Solsona	1,120	234	230
Upper Solsona	1,030	225	230
Madongan	1,970	311	300
Papa	690	184	223

The existing river widths of the Solsona and Madongan rivers fall within the range of the Regime Theory while the Papa River exceeds the range a little. However, this excess may not disturb the stability of the river channel. Therefore, no change of the existing river width is proposed in the design.

(4) Necessary River Structures

Major improvement works of these rivers are as follows (see Figs. G.4.5 to G.4.7 for locations and Table G.4.1 for work quantities):

(a) To strengthen the dikes by providing revetment and toe protection works since they are made of erosive sandy materials (43.6 km in total);

(b) To raise the existing dikes in some sections in accordance with the design high water level (15.0 km in total);

(c) To replace the existing intake/drainage structures which cause occasional dike breaching along the diking system, by gated sluiceway with sufficient cut-off walls (13 units); and

(d) To provide three (3) groundsills downstream of the existing irrigation diversion dams to avoid remarkable riverbed fluctuation which might affect the stability of the diversion dams.

4.4 Preliminary Structural Design

4.4.1 Dike and Floodwall

Dikes are made of riverbed materials available near construction sites to save in cost. Since riverbed materials consist mainly of sandy soils, the embankment would be permeable and easily eroded. Therefore, impermeable mountain soils will be used to cover the sandy embankment (see Fig. G.4.8 for details of dike structure).

In Laoag Proper, since there are no available spaces to construct an earth dike, a concrete floodwall is proposed (see Fig. G.4.8). This structure consists of concrete sheet piling for foundation, stone pitching grouted with concrete on slope, and concrete wall with the same height of freeboard (1.0 m).

Top of dike with crown width of 4.0 m is paved with gravel (2.5 m wide) to serve as maintenance road. A freeboard of 1.0 m is applied.

To protect dikes from erosion by rainfall or current, slopes of dike should be covered with sodding or revetment.

4.4.2 Revetment

Considering the material available in-situ, stone pitching grouted with concrete is applied as type of revetment (see Fig. G.4.9). Underneath stone pitching, thin concrete layer is provided to increase rigidity. Revetments are embedded appropriately into the riverbed. Toe of revetment is covered with concrete block or gabion mattress to avoid scouring by rapid current.

4.4.3 Spurdike

Spurdikes proposed as shown in Fig. G.4.10 are made by placing boulders available in-situ. This type of spurdike is popularly used in the Laoag River Basin, which performs well at places with mild current attack.

4.4.4 Groundsill

Construction of sabo dams may affect the riverbed elevations downstream of existing diversion dams. To maintain the existing riverbed elevation, groundsills are proposed downstream of diversion dams. Groundsill is designed as a structure flexible to riverbed fluctuation and made of reinforced concrete slab and concrete blocks, as shown in Fig. G.4.11.

4.4.5 Sluiceway

Sluiceway are built for irrigation water intake or drainage outlet at dike crossings. The sluiceway is composed of reinforced concrete box culvert(s) and steel sluice gate(s) (see Fig. G.4.12 for details of structure).

4.5 Cost Estimate

Construction cost is estimated on the following conditions:

(1) Construction works are to be executed on a contract basis.

(2) Price level is as of August, 1996.

(3) Exchange rates used to convert foreign currency into local currency are

US$1.0 = 26.0 Pesos = 105 Yen (1.0 Peso = 4.0 Yen).

(4) Main construction cost consists of cost for preparatory works, main civil works and miscellaneous works. Preparatory works cover the establishment of contractor's site offices; water, power supply and communication systems; topographic survey and soil investigation; transport of construction equipment; installation of concrete production plant; etc. This cost for preparatory works is estimated as 10% of cost of main civil works and miscellaneous works.

(5) Cost of main civil works (dike, revetment, spurdike, etc.) is estimated by multiplying work quantities by the respective unit costs.

(6) Miscellaneous works cover construction and maintenance of temporary roads, cofferdams and minor civil work items including waterstops inside of concrete, drainage pipes of dams, etc. Cost of miscellaneous works is estimated as 10% of cost of main civil works and preparatory works.

(7) Unit cost of work comprises direct costs of materials, labor and equipment, and indirect costs of contractor's expenses, overhead, profit, insurance, field supervision, tax, etc.

(8) Government administration cost is assumed at 5% of main construction cost.

(9) Cost of engineering services covering detailed design and construction supervision of the project is estimated as 10% of main construction cost.

(10) Physical contingency is assumed as 10% of main construction cost, administration cost and engineering services cost.

(11) In principle, major works will be executed as follows:

(a) Embankment works for dike construction using riverbed materials is executed by a combination of 0.6 m^3 class backhoe (excavation of riverbed material), 11-ton class dump truck (hauling) and 15-ton class bulldozer (spreading and compacting). Surface of embankment with sandy riverbed material is covered by impermeable mountain soil hauled by 11-ton class dump truck.

(b) Channel excavation work will be done using 0.6 m^3 class backhoe and excavated materials are hauled near sites by 11-ton dump truck.

(c) Revetment consisting of concrete foundation and concrete-grouted stone pitching is constructed using 0.6 m^3 class backhoe (structural excavation) and 0.2 m^3 class portable type concrete mixer. Stone pitching is manually executed.

(d) Spurdike is constructed by manually placing boulders one at a time. Construction of groundsill also needs equipment such as 0.6 m^3 class backhoe (structural excavation) and 15-ton class truck crane (pouring concrete).

Construction costs by flood potential area are estimated as shown in Table G.4.3.

TABLES

Table G.2.1 Design Flood Discharge Probability of Major Rivers in the Philippines

Item	Cagayan River	Agno River	Pampanga River	Mt. Pinatubo	Pasig River	Mt. Mayon	Panay River	Agusan River	Ilog-hilabagan River	Jaro-Iloilo River	Laoag River
1. Project Area											
River Drainage Basin(km^2)	27,300	7,640	10,503	322	4,678	699	2,181	1,140	2,162	505	1,332
Project Area(km^2)			3,200	1,296	981			199			
Nos. of Cities/Municipalities	107	83	12*	9*	17*	23	17	2*	4		11
Total Pop.(1,000)	2,136	2,324	1,792*	736*	5,926*	419	448	134*	347	310	197
Pop. Density(per km^2)	78	304	599*	568*	6,040*	599	187	673*	160	613	148
Ratio of Urban Pop. (%)	19	26		59*	mostly*	20	14	mostly*	20	mostly	29
GRDP of Agriculture(%)	47	37	37	24*	0*	52	38		32		42
GRDP of Industry/Service(%)	53	63	63	76*	100*	48	62		68		58
Developed Land Use(%)	20	30	40	53*	51*	65	49	69*	51		20
2. Potential Damage											
Flooded Area(km^2)	1,860	2,465	1,448*	393*	110*	184	338	79*	120	41	202
Affected Pop.(1,000)		1,457		205*	1,100*	70	121	115*	47	149	79
3. Design Probability											
Framework(year)	100	100	100		100		100	100			
Master Plan(year)	25	25			100	50	25		100	50	
Short-term(year)	25	10	20	20	30		10	30	25	20	
4. Implement. Period											
Framework(year)	not	not	not		not		not	not			
Master Plan(year)	20	20			30	10	30		20	20	
Short-term(year)	10	10	10	10	10		10	10	10	10	

Note : 1) * shows the figures for project area, while others are for drainage basin.
2) not" in implementation period means not specified".

Table G.4.1 Structures proposed in River Improvement Plans by Sub-project

Work Items	River Improvement Works										Compensation	
	Dike			Channel Excavation	Revetment		Spurdike	Sluiceway	Groundsill	Bridge Ext. /Reconst.	Land	House
	Length (m)		Volume (m3)	(m3)	Length (m)	Area (m2)	(units)	(units)	(units)	(m2)(nos.)	(ha)	(units)
(1) Tangid, Laoag	6,450		176,000	-	-	-	10	2	-	-	10	-
(2) Suyo, Laoag	2,100		73,300	-	-	-	-	2	-	-	4	-
(3) Poblacion, Laoag	1,500	*1	-	-	-	-	-	3	-	-	-	-
(4) Camangaan, Laoag	4,000		195,000	-	-	-	-	3	-	-	8	1
(5) Poblacion, San Nicolas	3,000		140,000	-	-	-	10	2	-	-	6	-
(6) San Manuel, Sarrat	3,600		86,000	-	-	-	-	2	-	-	5	20
(7) San Felipe, Sarrat	3,700		156,000	-	300	2,540	10	4	-	-	7	-
(8) Sto. Tomas, Sarrat	4,800		66,000	-	-	-	-	3	-	-	5	-
(9) San Marcos, Sarrat	2,250		36,000	-	-	-	-	3	-	-	3	-
(10) San Cristobal, Sarrat	1,850		78,000	-	1,850	19,000	-	2	-	-	3	-
(11) Guisit R./Mandaloque	18,300		978,000	-	700	3,700	10	20	-	-	36	1
(12) Suyo, Dingras	3,700		104,000	-	-	-	-	3	-	-	5	-
(13) Poblacion, Dingras	5,600		205,000	-	-	-	10	3	-	-	10	-
(14) Cura/Labugaoe River	21,900		350,000	1,532,000	22,200	206,500	20	4	1	315(1)	1	-
(15) Solsona River	10,950	*2	173,000	-	13,700	155,400	-	4	1	-	1	-
(16) Madongan River	4,000	*3	60,000	-	17,500	225,500	-	7	1	-	-	-
(17) Papa River	1,000	*3	14,500	-	12,400	132,000	-	2	1	-	-	-
(18) Lower Bongo River	17,750		636,000	-	-	-	20	-	-	-	10	-
(19) Upper Bongo River	19,300		293,000	-	19,300	192,900	-	5	1	2710(2)	3	-
Total	135,750 (New dike=120,750) (Heightening=15,000)		3,819,800	1,532,000	87,950	937,540	90	74	5	3,025(3)	117	22

Notes : *1; Floodwall.
*2; Heightening of existing dike = 10,000 m, and new dike = 950 m.
*3; Heightening of existing dikes only.

Table G.4.2 Comparison of Cura/Labugaon River Alignment

Aspect	Plan-A	Plan-B	Plan-C
Hydraulic	• River course following the deepest valley. • A large bank protection at fan apex of Labugaon River to be needed.	• No topographical disadvantages.	• 7 bending reaches to be protected.
Social	• No community separation by rivers. • Easy access to communities. • Land acquisition (1 ha). • House evacuation (1 house).	• 4 communities (110 houses) to be enclosed by 2 rivers. • Land acquisition (8 ha). • House evacuation (9 houses).	• 5 communities (130 houses) to be enclosed by 2 rivers. • Land acquisition (65 ha). • House evacuation (25 houses).
Construction	• Channel length of 15 km to be improved. • Cost; 324 million pesos. - Excavation; 1,500,000m3x 90P/m3=135m - Embankment; 350,000m3x120P/m3=42m - Revetment; 22kmx6.3million P/km=139m - Bridge; 1 br.(315m2) x 25,000P/m2=8 m	• Channel length of 20 km to be improved. • cost; 558 million pesos. - Excavation; 3,200,000m3x 90P/m3=288m - Embankment; 450,000m3x120P/m3=54m - Revetment; 33kmx6.3million P/km=208m - Bridge; 1 br.(315m2) x 25,000P/m2=8 m	• Channel length of 26 km to be improved. • Cost; 821 million pesos. - Excavation; 4,800,000m3x 90P/m3=432m - Embankment; 580,000m3x120P/m3=70m - Revetment; 45kmx6.3million P/km=284m - Bridge;2 br(1,400m2)x 25,000P/m2=35 m
Evaluation	• Recommendable.	• Much disadvantages of social and construction aspects.	• Much disadvantages of social and construction aspects.

Table G.4.3(1) Construction Cost of River Improvement by Sub-project

Unit : million pesos

Area	Civil Works	Compensation	Administration	Engineering	Physical Cont.	Total
(1) Tangid, Laoag	27.8	1.0	1.4	2.8	3.3	36.3
(2) Suyo, Laoag	11.7	0.0	0.6	1.2	1.4	14.9
(3) Poblacion, Laoag	48.1	0.0	2.4	4.8	5.5	60.8
(4) Camangaan, Laoag	27.3	1.0	1.4	2.7	3.2	35.6
(5) Poblacion, San Nicolas	22.2	0.6	1.1	2.2	2.6	28.7
(6) San Manuel, Sarrat	13.8	3.9	0.9	1.4	2.0	22.0
(7) San Felipe, Sarrat	32.0	0.7	1.6	3.2	3.8	41.3
(8) Sto. Tomas, Sarrat	13.3	0.5	0.7	1.3	1.6	17.4
(9) San Marcos, Sarrat	8.7	0.3	0.5	0.9	1.0	11.4
(10) San Cristobal, Sarrat	25.5	0.3	1.3	2.5	3.0	32.6
(11) Guisit R./Mandaloque, Dingras	161.5	3.8	8.3	16.2	19.0	208.8
(12) Suyo, Dingras	25.3	0.3	1.3	2.5	2.9	32.3
(13) Poblacion, Dingras	31.4	1.0	1.6	3.1	3.7	40.8
(14) Cura/Labugaon River	466.3	0.1	23.3	46.6	53.6	589.9
(15) Solsona River	211.7	0.1	10.6	21.2	24.4	268.0
(16) Madongan River	277.5	0.0	13.9	27.8	31.9	351.1
(17) Papa River	167.7	0.0	8.4	16.8	19.3	212.2
(18) Lower Bongo River	92.6	1.0	4.7	9.3	10.8	118.4
(19) Upper Bongo River	335.9	0.3	16.8	33.6	38.7	425.3
Total	2,000.3	14.9	100.8	200.1	231.7	2,547.8

Table G.4.3(2) Construction Cost of River Improvement by Sub-project

(1) Tangid, Laoag — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				27,804,711
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		2,527,701
1.2 Main Works				22,979,100
1.2.1 Earth Dike	m	6,450		18,979,100
(1) Clearing, Grubbing & Stripping	m2	98,000	23	2,254,000
(2) Embankment(sandy material)	m3	150,000	80	12,000,000
(3) Covering Soil (mountain clay soil)	m3	26,000	120	3,120,000
(4) Sodding	m2	88,000	12	1,056,000
(5) Gravel Maintenance Road	m3	3,230	170	549,100
1.2.2 Spurdike	pcs	10		2,000,000
(1) Hand Laid Boulder	m3	5,000	400	2,000,000
1.2.3 Sluiceway	pcs	2		2,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	2	1,000,000	2,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		2,297,910
2. COMPENSATION COST				1,000,000
2.1 Land Acquisition	ha	10		1,000,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	10	100,000	1,000,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	Houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		1,440,236
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		2,780,471
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		3,302,542
TOTAL				36,327,959

Table G.4.3(3) Construction Cost of River Improvement by Sub-project

(2) Suyo, Laoag — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				11,708,323
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		1,064,393
1.2 Main Works				9,676,300
1.2.1 Earth Dike	m	2,100		7,676,300
(1) Clearing, Grubbing & Stripping	m2	35,000	23	805,000
(2) Embankment(sandy material)	m3	62,000	80	4,960,000
(3) Covering Soil (mountain clay soil)	m3	11,300	120	1,356,000
(4) Sodding	m2	31,400	12	376,800
(5) Gravel Maintenance Road	m3	1,050	170	178,500
1.2.2 Sluiceway	pcs	2		2,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	2	1,000,000	2,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		967,630
2. COMPENSATION COST				40,000
2.1 Land Acquisition	ha	4		40,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	0	100,000	0
(3) Unused Area	ha	4	10,000	40,000
2.2 House Evacuation	Houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		587,416
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		1,170,832
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		1,350,657
TOTAL				14,857,229

Table G.4.3(4) Construction Cost of River Improvement by Sub-project

(3) Poblacion, Laoag — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				48,108,995
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		4,373,545
1.2 Main Works				39,759,500
1.2.1 Flood Wall	m	1,500		36,759,500
(1) Concrete Sheet Piling (L=5 m)	m	1,500	11,000	16,500,000
(2) Structural Excavation/Filling	m3	1,500	43	64,500
(3) Footing Concrete	m3	400	5,300	2,120,000
(4) Gravel Sublayer	m3	6,000	325	1,950,000
(5) Grouted Stone Pitching	m3	10,500	1,400	14,700,000
(6) Wall Concrete	m3	250	5,700	1,425,000
1.2.2 Sluiceway	pcs	3		3,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	3	1,000,000	3,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		3,975,950
2. COMPENSATION COST				0
2.1 Land Acquisition	ha	0		0
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	0	100,000	0
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		2,405,450
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		4,810,900
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		5,532,534
TOTAL				60,857,879

Table G.4.3(5) Construction Cost of River Improvement by Sub-project

(4) Camangaan, Laoag — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				27,321,558
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		2,483,778
1.2 Main Works				22,579,800
1.2.1 Earth Dike	m	4,000		19,579,800
(1) Clearing, Grubbing & Stripping	m2	77,000	23	1,771,000
(2) Embankment(sandy material)	m3	170,000	80	13,600,000
(3) Covering Soil (mountain clay soil)	m3	25,000	120	3,000,000
(4) Sodding	m2	72,400	12	868,800
(5) Gravel Maintenance Road	m3	2,000	170	340,000
1.2.2 Sluiceway	pcs	3		3,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	3	1,000,000	3,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		2,257,980
2. COMPENSATION COST				950,000
2.1 Land Acquisition	ha	8		800,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	8	100,000	800,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	1	150,000	150,000
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		1,413,578
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		2,732,156
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		3,241,729
TOTAL				35,659,021

Table G.4.3(6) Construction Cost of River Improvement by Sub-project

(5) Poblacion of San Nicolas — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				22,151,470
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		2,013,770
1.2 Main Works				18,307,000
1.2.1 Earth Dike	m	3,000		14,307,000
(1) Clearing, Grubbing & Stripping	m2	60,000	23	1,380,000
(2) Embankment(sandy material)	m3	120,000	80	9,600,000
(3) Covering Soil (mountain clay soil)	m3	20,000	120	2,400,000
(4) Sodding	m2	56,000	12	672,000
(5) Gravel Maintenance Road	m3	1,500	170	255,000
1.2.2 Spurdike	pcs	10		2,000,000
(1) Hand Laid Boulder	m3	5,000	400	2,000,000
1.2.3 Sluiceway	pcs	2		2,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	2	1,000,000	2,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		1,830,700
2. COMPENSATION COST				600,000
2.1 Land Acquisition	ha	6		600,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	6	100,000	600,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		1,137,574
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		2,215,147
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		2,610,419
TOTAL				28,714,610

Table G.4.3(7) Construction Cost of River Improvement by Sub-project

(6) San Manuel, Sarrat — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				13,772,220
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		1,252,020
1.2 Main Works				11,382,000
1.2.1 Earth Dike	m	3,600		9,382,000
(1) Clearing, Grubbing & Stripping	m2	48,000	23	1,104,000
(2) Embankment(sandy material)	m3	71,000	80	5,680,000
(3) Covering Soil (mountain clay soil)	m3	15,000	120	1,800,000
(4) Sodding	m2	41,000	12	492,000
(5) Gravel Maintenance Road	m3	1,800	170	306,000
1.2.2 Sluiceway	pcs	2		2,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	2	1,000,000	2,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		1,138,200
2. COMPENSATION COST				3,900,000
2.1 Land Acquisition	ha	5		900,000
(1) Residential Area	ha	1	500,000	500,000
(2) Agricultural Area	ha	4	100,000	400,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	20	150,000	3,000,000
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		883,611
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		1,377,222
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		1,993,305
TOTAL				21,926,358

Table G.4.3(8) Construction Cost of River Improvement by Sub-project

(7) San Felipe, Sarrat — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				32,047,213
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		2,913,383
1.2 Main Works				26,485,300
1.2.1 Earth Dike	m	3,700		15,861,600
(1) Clearing, Grubbing & Stripping	m2	65,000	23	1,495,000
(2) Embankment(sandy material)	m3	135,000	80	10,800,000
(3) Covering Soil (mountain clay soil)	m3	21,000	120	2,520,000
(4) Sodding	m2	60,300	12	723,600
(5) Gravel Maintenance Road	m3	1,900	170	323,000
1.2.2 Revetment	m	300		1,623,700
(1) Structural Excavation/Filling	m3	900	43	38,700
(2) Footing Concrete	m3	36	2,000	72,000
(3) Grouted Stone Pitching w/ Concrete Layer	m3	890	1,700	1,513,000
1.2.3 Spurdike	pcs	10		2,000,000
(1) Hand Laid Boulder	m3	5,000	400	2,000,000
1.2.4 Sluiceway	pcs	4		7,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	3	1,000,000	3,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	1	4,000,000	4,000,000
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		2,648,530
2. COMPENSATION COST				700,000
2.1 Land Acquisition	ha	7		700,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	7	100,000	700,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		1,637,361
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		3,204,721
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		3,758,929
TOTAL				41,348,224

Table G.4.3(9) Construction Cost of River Improvement by Sub-project

(8) Sto. Tomas, Sarrat — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				13,250,468
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		1,204,588
1.2 Main Works				10,950,800
1.2.1 Earth Dike	m	4,800		7,950,800
(1) Clearing, Grubbing & Stripping	m2	50,000	23	1,150,000
(2) Embankment(sandy material)	m3	50,000	80	4,000,000
(3) Covering Soil (mountain clay soil)	m3	16,000	120	1,920,000
(4) Sodding	m2	39,400	12	472,800
(5) Gravel Maintenance Road	m3	2,400	170	408,000
1.2.2 Sluiceway	pcs	3		3,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	3	1,000,000	3,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		1,095,080
2. COMPENSATION COST				500,000
2.1 Land Acquisition	ha	5		500,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	5	100,000	500,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		687,523
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		1,325,047
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		1,576,304
TOTAL				17,339,342

Table G.4.3(10) Construction Cost of River Improvement by Sub-project

(9) San Marcos, Sarrat — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				8,741,161
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		794,651
1.2 Main Works				7,224,100
1.2.1 Earth Dike	m	2,250		4,224,100
(1) Clearing, Grubbing & Stripping	m2	24,000	23	552,000
(2) Embankment(sandy material)	m3	27,000	80	2,160,000
(3) Covering Soil (mountain clay soil)	m3	9,000	120	1,080,000
(4) Sodding	m2	20,000	12	240,000
(5) Gravel Maintenance Road	m3	1,130	170	192,100
1.2.2 Sluiceway	pcs	3		3,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	3	1,000,000	3,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		722,410
2. COMPENSATION COST				300,000
2.1 Land Acquisition	ha	3		300,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	3	100,000	300,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		452,058
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		874,116
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		1,036,734
TOTAL				11,404,069

Table G.4.3(11) Construction Cost of River Improvement by Sub-project

(10) San Cristobal, Sarrat — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				25,469,290
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		2,315,390
1.2 Main Works				21,049,000
1.2.1 Earth Dike	m	1,850		7,883,000
(1) Clearing, Grubbing & Stripping	m2	33,000	23	759,000
(2) Embankment(sandy material)	m3	67,000	80	5,360,000
(3) Covering Soil (mountain clay soil)	m3	11,000	120	1,320,000
(4) Sodding	m2	31,000	12	372,000
(5) Gravel Maintenance Road	m3	900	80	72,000
1.2.2 Revetment	m	1,850		11,166,000
(1) Structural Excavation/Filling	m3	2,000	43	86,000
(2) Footing Concrete	m3	220	2,000	440,000
(3) Grouted Stone Pitching w/ Concrete Layer	m3	6,650	1,600	10,640,000
1.2.3 Sluiceway	pcs	2		2,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	2	1,000,000	2,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		2,104,900
2. COMPENSATION COST				300,000
2.1 Land Acquisition	ha	3		300,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	3	100,000	300,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		1,288,465
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		2,546,929
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		2,960,468
TOTAL				32,565,152

Table G.4.3(12) Construction Cost of River Improvement by Sub-project

(11) Gulsit River/Mandaloque, Dingras — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				160,922,619
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		14,629,329
1.2 Main Works				132,993,900
1.2.1 Earth Dike	m	18,300		96,203,800
(1) Clearing, Grubbing & Stripping	m2	362,600	23	8,339,800
(2) Embankment(sandy material)	m3	859,000	80	68,720,000
(3) Covering Soil (mountain clay soil)	m3	119,000	120	14,280,000
(4) Sodding	m2	344,000	12	4,128,000
(5) Gravel Maintenance Road	m3	9,200	80	736,000
1.2.2 Revetment	m	700		4,790,100
(1) Structural Excavation/Filling	m3	700	43	30,100
(2) Footing Concrete	m3	84	2,000	168,000
(3) Grouted Stone Pitching w/ Concrete Layer	m3	2,870	1,600	4,592,000
1.2.3 Spurdike	pcs	10		2,000,000
(1) Hand Laid Boulder	m3	5,000	400	2,000,000
1.2.4 Sluiceway	pcs	20		30,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	18	1,000,000	18,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	1	4,000,000	4,000,000
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	1	8,000,000	8,000,000
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		13,299,390
2. COMPENSATION COST				3,750,000
2.1 Land Acquisition	ha	36		3,600,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	36	100,000	3,600,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	1	150,000	150,000
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		8,233,631
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		16,092,262
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		18,899,851
TOTAL				207,898,363

Table G.4.3(13) Construction Cost of River Improvement by Sub-project

(12) Suyo, Dingras — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				25,331,350
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		2,302,850
1.2 Main Works				20,935,000
1.2.1 Earth Dike	m	3,700		10,935,000
(1) Clearing, Grubbing & Stripping	m2	53,000	23	1,219,000
(2) Embankment(sandy material)	m3	87,000	80	6,960,000
(3) Covering Soil (mountain clay soil)	m3	17,000	120	2,040,000
(4) Sodding	m2	47,000	12	564,000
(5) Gravel Maintenance Road	m3	1,900	80	152,000
1.2.2 Sluiceway	pcs	3		10,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	2	1,000,000	2,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	1	8,000,000	8,000,000
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		2,093,500
2. COMPENSATION COST				320,000
2.1 Land Acquisition	ha	5		320,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	3	100,000	300,000
(3) Unused Area	ha	2	10,000	20,000
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		1,282,568
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		2,533,135
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		2,946,705
TOTAL				32,413,758

Table G.4.3(14) Construction Cost of River Improvement by Sub-project

(13) Poblacion, Diagras — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				31,397,080
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		2,854,280
1.2 Main Works				25,948,000
1.2.1 Earth Dike	m	5,600		20,948,000
(1) Clearing, Grubbing & Stripping	m2	92,000	23	2,116,000
(2) Embankment(sandy material)	m3	175,000	80	14,000,000
(3) Covering Soil (mountain clay soil)	m3	30,000	120	3,600,000
(4) Sodding	m2	84,000	12	1,008,000
(5) Gravel Maintenance Road	m3	2,800	80	224,000
1.2.2 Spurdike	pcs	10		2,000,000
(1) Hand Laid Boulder	m3	5,000	400	2,000,000
1.2.3 Sluiceway	pcs	3		3,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	3	1,000,000	3,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		2,594,800
2. COMPENSATION COST				1,000,000
2.1 Land Acquisition	ha	10		1,000,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	10	100,000	1,000,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		1,619,854
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		3,139,708
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		3,715,664
TOTAL				40,872,306

Table G.4.3(15) Construction Cost of River Improvement by Sub-project

(14) Cura/Labugaon River | Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				466,307,985
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		42,391,635
1.2 Main Works				385,378,500
1.2.1 Earth Dike	m	21,900		40,957,000
(1) Clearing, Grubbing & Stripping	m2	263,000	23	6,049,000
(2) Embankment(sandy material)	m3	265,000	80	21,200,000
(3) Covering Soil (mountain clay soil)	m3	85,000	120	10,200,000
(4) Sodding	m2	219,000	12	2,628,000
(5) Gravel Maintenance Road	m3	11,000	80	880,000
1.2.2 Channel Excavation	m3	1,532,000		135,080,000
(1) Sand/Gravel	m3	560,000	85	47,600,000
(2) Gravel/Boulder	m3	972,000	90	87,480,000
1.2.3 Revetment	m	22,200		139,999,000
(1) Structural Excavation/Filling	m3	133,000	43	5,719,000
(2) Footing Concrete	m3	9,300	2,000	18,600,000
(3) Grouted Stone Pitching w/ Concrete Layer	m3	72,300	1,600	115,680,000
1.2.4 Toe Protection	m	22,200		39,327,000
(1) Structural Excavation/Backfill	m3	89,000	43	3,827,000
(2) Concerte Block	m3	0	2,000	0
(3) Gabion Mattress	m3	35,500	1,000	35,500,000
1.2.5 Spurdike	pcs	20		4,000,000
(1) Hand Laid Boulder	m3	10,000	400	4,000,000
1.2.6 Sluiceway	pcs	4		11,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	3	1,000,000	3,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	1	8,000,000	8,000,000
1.2.7 Groundsill	pcs	1		7,140,500
(1) Structural Excavation/Backfill (gravel,boulder)	m3	3,500	43	150,500
(2) Reinforced Concrete	m3	1,690	3,000	5,070,000
(3) Concrete Block	m3	960	2,000	1,920,000
1.2.8 Bridge Works	pcs	1		7,875,000
(1) Reconstruction/Extension	m2	315	25,000	7,875,000
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		38,537,850
2. COMPENSATION COST				100,000
2.1 Land Acquisition	ha	1		100,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	1	100,000	100,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		23,320,399
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		46,630,799
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		53,635,918
TOTAL				589,995,101

Table G.4.3(16) Construction Cost of River Improvement by Sub-project

(15) Solsona River — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				211,731,124
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		19,248,284
1.2 Main Works				174,984,400
1.2.1 Earth Dike	m	10,950		18,958,200
(1) Clearing, Grubbing & Stripping	m2	11,400	23	262,200
(2) Embankment(sandy material)	m3	111,000	80	8,880,000
(3) Covering Soil (mountain clay soil)	m3	62,000	120	7,440,000
(4) Sodding	m2	162,000	12	1,944,000
(5) Gravel Maintenance Road	m3	5,400	80	432,000
1.2.2 Revetment	m	13,700		105,692,000
(1) Structural Excavation/Filling	m3	164,000	43	7,052,000
(2) Footing Concrete	m3	5,800	2,000	11,600,000
(3) Grouted Stone Pitching w/ Concrete Layer	m3	54,400	1,600	87,040,000
1.2.3 Toe Protection	m	13,700		34,899,000
(1) Structural Excavation/Backfill	m3	93,000	43	3,999,000
(2) Concerte Block	m3	5,600	2,000	11,200,000
(3) Gabion Mattress	m3	19,700	1,000	19,700,000
1.2.4 Sluiceway	pcs	4		4,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	4	1,000,000	4,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.2.5 Groundsill	pcs	1		11,435,200
(1) Structural Excavation/Backfill (gravel/boulder)	m3	6,400	43	275,200
(2) Concrete	m3	2,600	3,000	7,800,000
(3) Concrete Block	m3	1,680	2,000	3,360,000
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		17,498,440
2. COMPENSATION COST				100,000
2.1 Land Acquisition	ha	1		100,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	1	100,000	100,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		10,591,556
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		21,173,112
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		24,359,579
TOTAL				267,955,372

Table G.4.3(17) Construction Cost of River Improvement by Sub-project

(16) Madongan River — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				277,538,547
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		25,230,777
1.2 Main Works				229,370,700
1.2.1 Earth Dike	m	4,000		7,312,000
(1) Clearing, Grubbing & Stripping	m2	60,000	23	1,380,000
(2) Embankment(sandy material)	m3	42,000	80	3,360,000
(3) Covering Soil (mountain clay soil)	m3	18,000	120	2,160,000
(4) Sodding	m2	21,000	12	252,000
(5) Gravel Maintenance Road	m3	2,000	80	160,000
1.2.2 Revetment	m	17,500		149,870,000
(1) Structural Excavation/Filling	m3	210,000	43	9,030,000
(2) Footing Concrete	m3	7,300	2,000	14,600,000
(3) Grouted Stone Pitching w/ Concrete Layer	m3	78,900	1,600	126,240,000
1.2.3 Toe Protection	m	17,500		48,651,800
(1) Structural Excavation/Backfill	m3	182,600	43	7,851,800
(2) Concerte Block	m3	8,000	2,000	16,000,000
(3) Gabion Mattress	m3	24,800	1,000	24,800,000
1.2.4 Sluiceway	pcs	7		7,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	7	1,000,000	7,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.2.5 Groundsill	pcs	1		16,536,900
(1) Structural Excavation/Backfill (gravel/boulder)	m3	8,300	43	356,900
(2) Reinforced Concrete	m3	3,900	3,000	11,700,000
(3) Concrete Block	m3	2,240	2,000	4,480,000
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		22,937,070
2. COMPENSATION COST				0
2.1 Land Acquisition	ha	0		0
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	0	100,000	0
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		13,876,927
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		27,753,855
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		31,916,933
TOTAL				351,086,262

Table G.4.3(18) Construction Cost of River Improvement by Sub-project

(17) Papa River — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				167,676,355
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		15,243,305
1.2 Main Works				138,575,500
1.2.1 Earth Dike	m	1,000		1,791,000
(1) Clearing, Grubbing & Stripping	m2	15,000	23	345,000
(2) Embankment(sandy material)	m3	10,000	80	800,000
(3) Covering Soil (mountain clay soil)	m3	4,500	120	540,000
(4) Sodding	m2	5,500	12	66,000
(5) Gravel Maintenance Road	m3	500	80	40,000
1.2.2 Revetment	m	12,400		90,770,000
(1) Structural Excavation/Filling	m3	150,000	43	6,450,000
(2) Footing Concrete	m3	5,200	2,000	10,400,000
(3) Grouted Stone Pitching w/ Concrete Layer	m3	46,200	1,600	73,920,000
1.2.3 Toe Protection	m	12,400		33,098,000
(1) Structural Excavation/Backfill	m3	86,000	43	3,698,000
(2) Concerte Block	m3	6,000	2,000	12,000,000
(3) Gabion Mattress	m3	17,400	1,000	17,400,000
1.2.4 Sluiceway	pcs	2		2,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	2	1,000,000	2,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.2.5 Groundsill	pcs	1		10,916,500
(1) Structural Excavation/Backfill (gravel/boulder)	m3	5,500	43	236,500
(2) Reinforced Concrete	m3	2,600	3,000	7,800,000
(3) Concrete Block	m3	1,440	2,000	2,880,000
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		13,857,550
2. COMPENSATION COST				0
2.1 Land Acquisition	ha	0		0
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	0	100,000	0
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		8,383,818
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		16,767,636
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		19,282,781
TOTAL				212,110,589

Table G.4.3(19) Construction Cost of River Improvement by Sub-project

(18) Lower Bongo River — Unit : Pesos

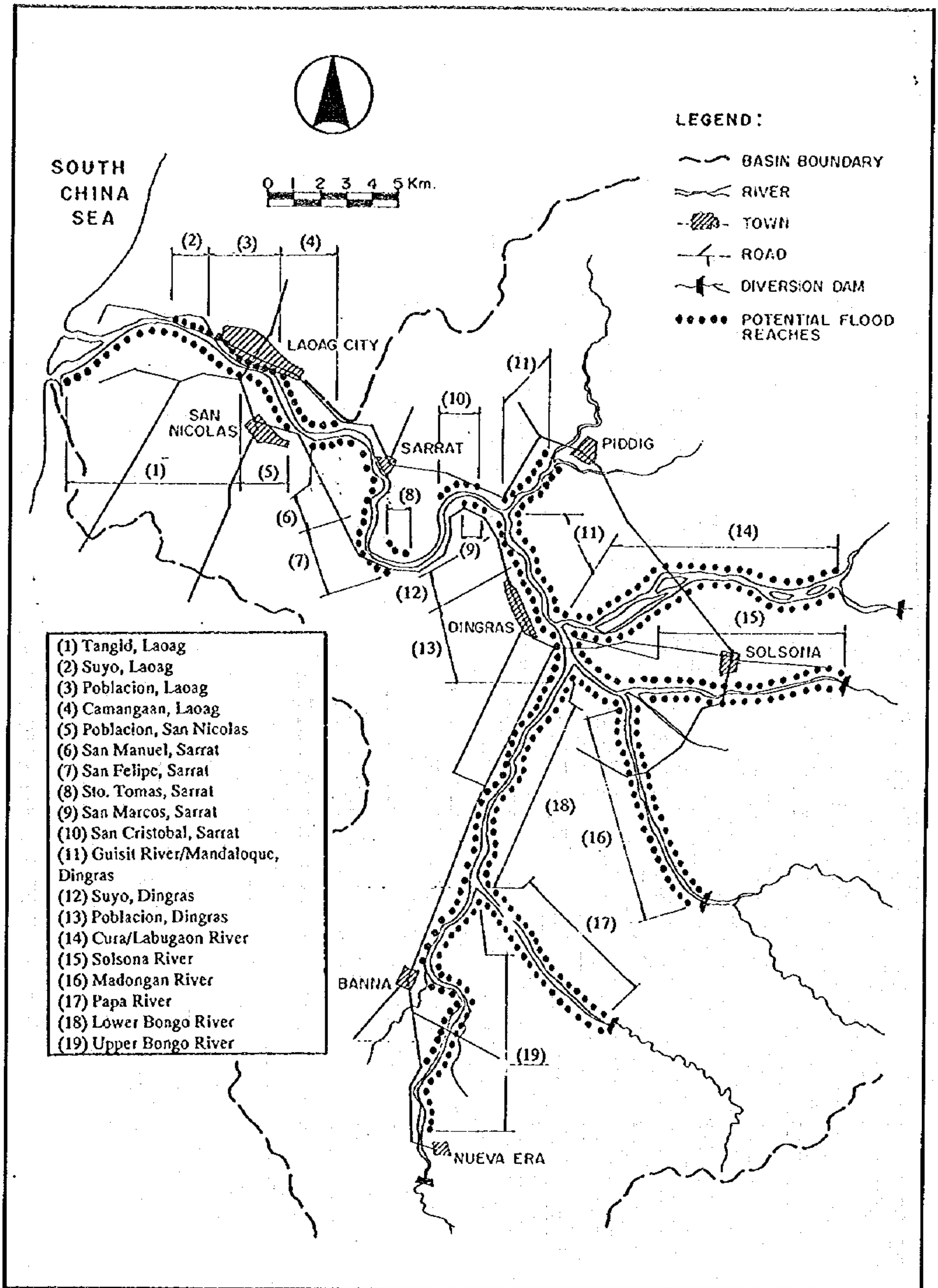
Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				92,620,660
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		8,420,060
1.2 Main Works				76,546,000
1.2.1 Earth Dike	m	17,750		72,546,000
(1) Clearing, Grubbing & Stripping	m2	590,000	23	13,570,000
(2) Embankment(sandy material)	m3	536,000	80	42,880,000
(3) Covering Soil (mountain clay soil)	m3	100,000	120	12,000,000
(4) Sodding	m2	282,000	12	3,384,000
(5) Gravel Maintenance Road	m3	8,900	80	712,000
1.2.2 Spurdike	pcs	20		4,000,000
(1) Hand Laid Boulder	m3	10,000	400	4,000,000
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		7,654,600
2. COMPENSATION COST				1,000,000
2.1 Land Acquisition	ha	10		1,000,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	10	100,000	1,000,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		4,681,033
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		9,262,066
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		10,756,376
TOTAL				118,320,135

Table G.4.3(20) Construction Cost of River Improvement by Sub-project

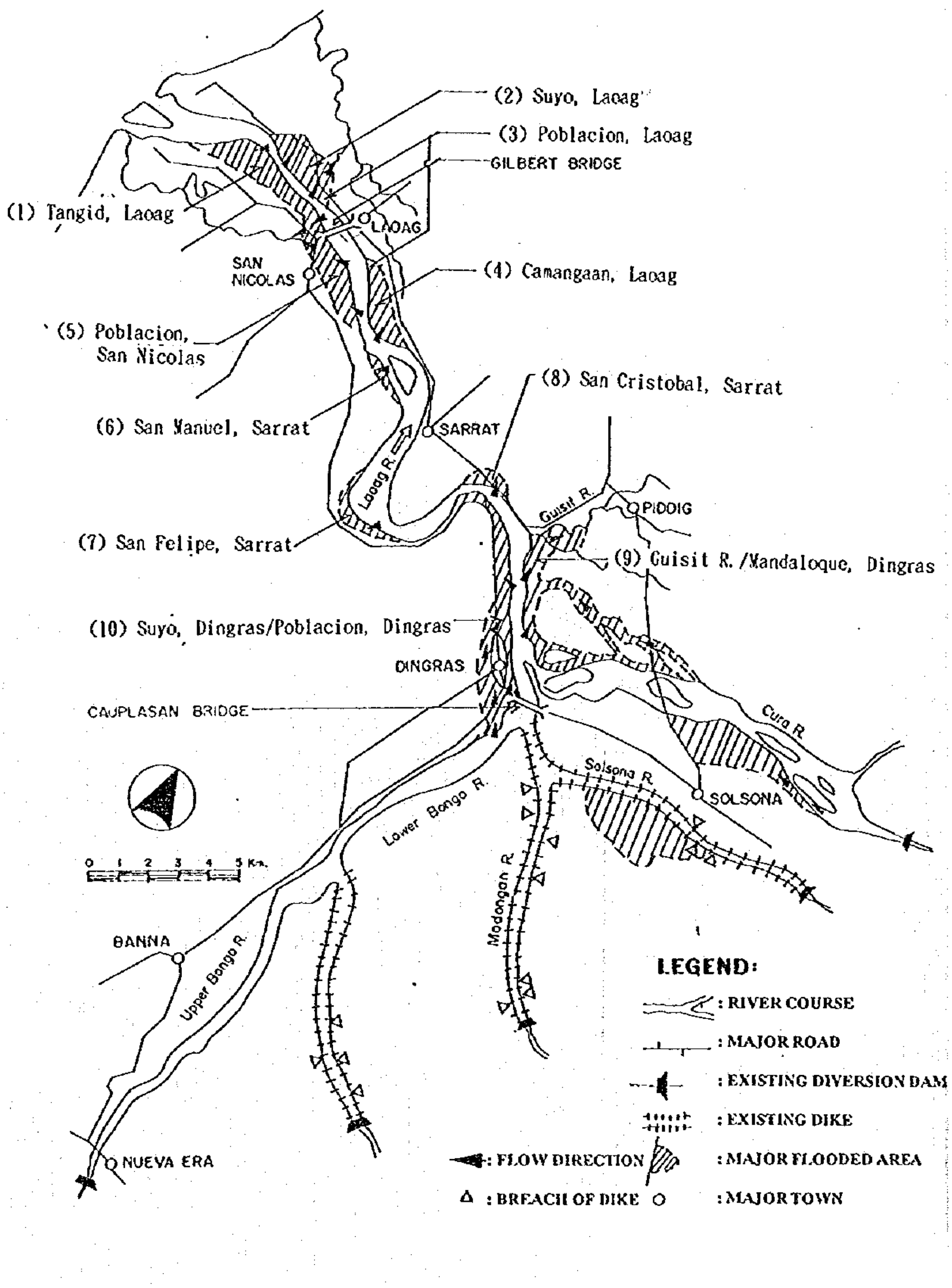
(19) Upper Bongo River — Unit : Pesos

Work Item	Unit	Quantity	Unit Cost	Amount
1. MAIN CONSTRUCTION COST				335,944,400
1.1 Preparatory Works (10% of 1.2 + 1.3)	l.s	1		30,540,400
1.2 Main Works				277,640,000
1.2.1 Earth Dike	m	19,300		38,858,000
(1) Clearing, Grubbing & Stripping	m2	270,000	23	6,210,000
(2) Embankment(sandy material)	m3	179,000	80	14,320,000
(3) Covering Soil (mountain clay soil)	m3	114,000	120	13,680,000
(4) Sodding	m2	323,000	12	3,876,000
(5) Gravel Maintenance Road	m3	9,650	80	772,000
1.2.2 Revetment	m	19,300		127,511,000
(1) Structural Excavation/Filling	m3	77,000	43	3,311,000
(2) Footing Concrete	m3	8,100	2,000	16,200,000
(3) Grouted Stone Pitching w/ Concrete Layer	m3	67,500	1,600	108,000,000
1.2.3 Toe Protection	m	19,300		35,888,000
(1) Structural Excavation/Backfill	m3	116,000	43	4,988,000
(2) Concerte Block	m3	0	2,000	0
(3) Gabion Mattress	m3	30,900	1,000	30,900,000
1.2.4 Sluiceway	pcs	5		5,000,000
(1) Type A (1 box;1.5 m wide x 1.5 m high)	pcs	5	1,000,000	5,000,000
(2) Type B (1 box;3.0 m wide x 3.0 m high)	pcs	0	4,000,000	0
(3) Type C (2 boxes;3.0 m wide x 3.0 m high)	pcs	0	8,000,000	0
1.2.5 Groundsill	pcs	1		2,633,000
(1) Structural Excavation/Backfill (gravel,boulder)	m3	1,000	43	43,000
(2) Concrete	m3	650	3,000	1,950,000
(3) Riverbed Protection	m3	320	2,000	640,000
1.2.6 Bridge Works	pcs	2		67,750,000
(1) Reconstruction/Extension	m2	2,710	25,000	67,750,000
1.3 Miscellaneous Works (10% of 1.2)	l.s	1		27,764,000
2. COMPENSATION COST				300,000
2.1 Land Acquisition	ha	3		300,000
(1) Residential Area	ha	0	500,000	0
(2) Agricultural Area	ha	3	100,000	300,000
(3) Unused Area	ha	0	10,000	0
2.2 House Evacuation	houses	0	150,000	0
3. ADMINISTRATION COST (5% of 1.+ 2.)	l.s	1		16,812,220
4. ENGINEERING SERVICES COST (10% of 1.)	l.s	1		33,594,440
5. PHYSICAL CONTINGENCY (10% of 1., 2., 3. & 4.)	l.s	1		38,665,106
TOTAL				425,316,166

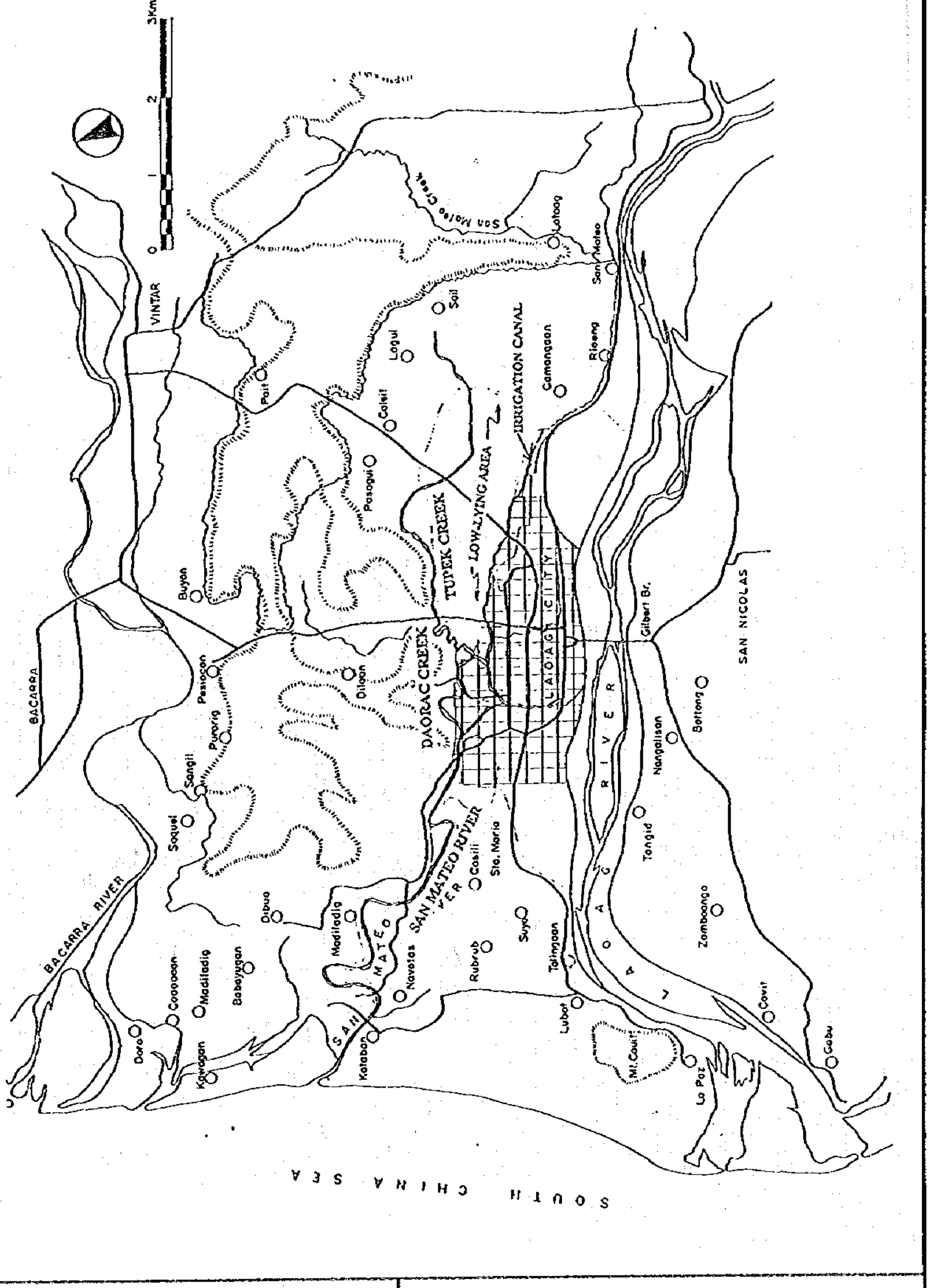
FIGURES



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. G.1.1** **Potential Flood Reaches in Laoag River Basin**



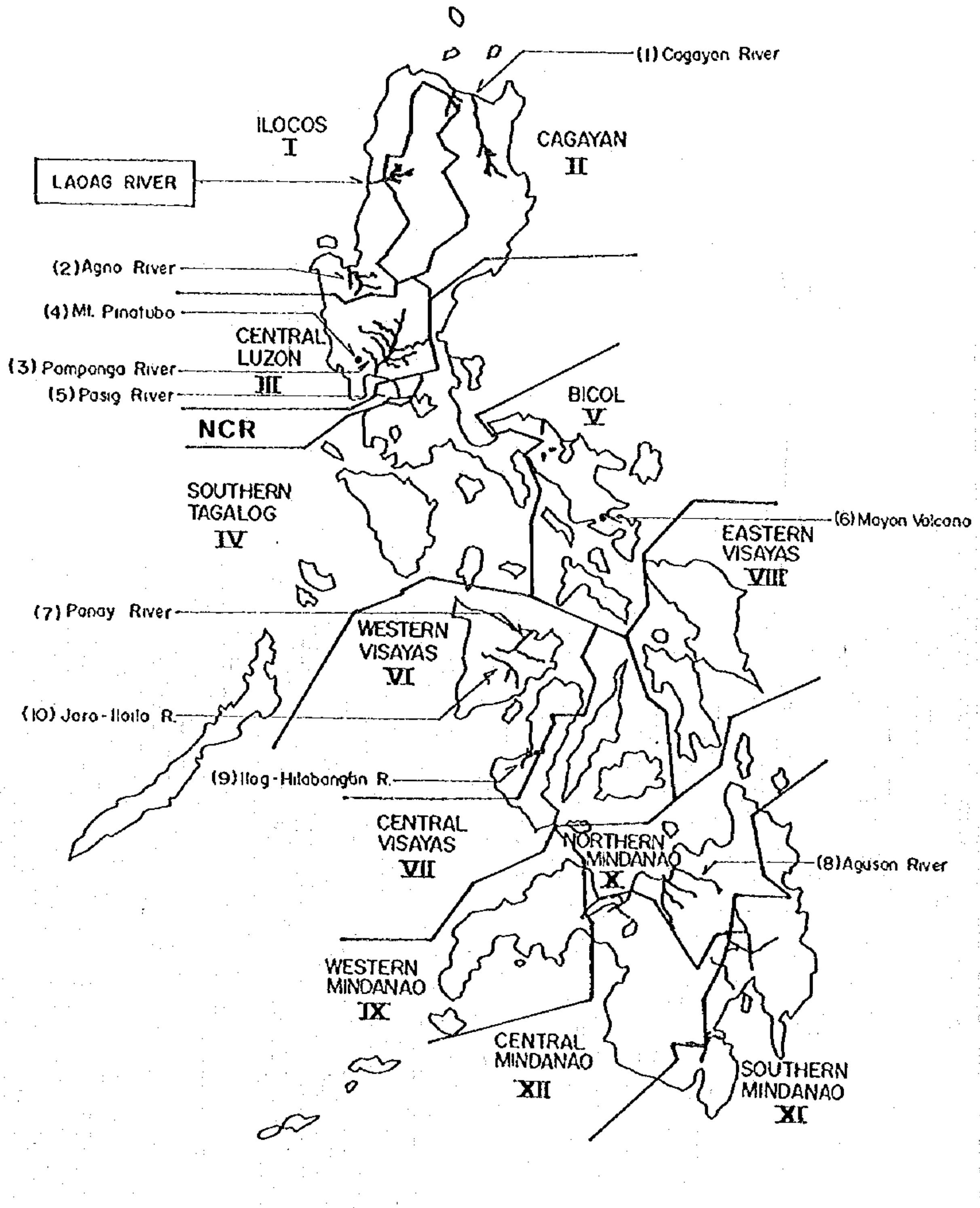
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. G.1.2** **Hydraulic Situations of 1996 Flood**



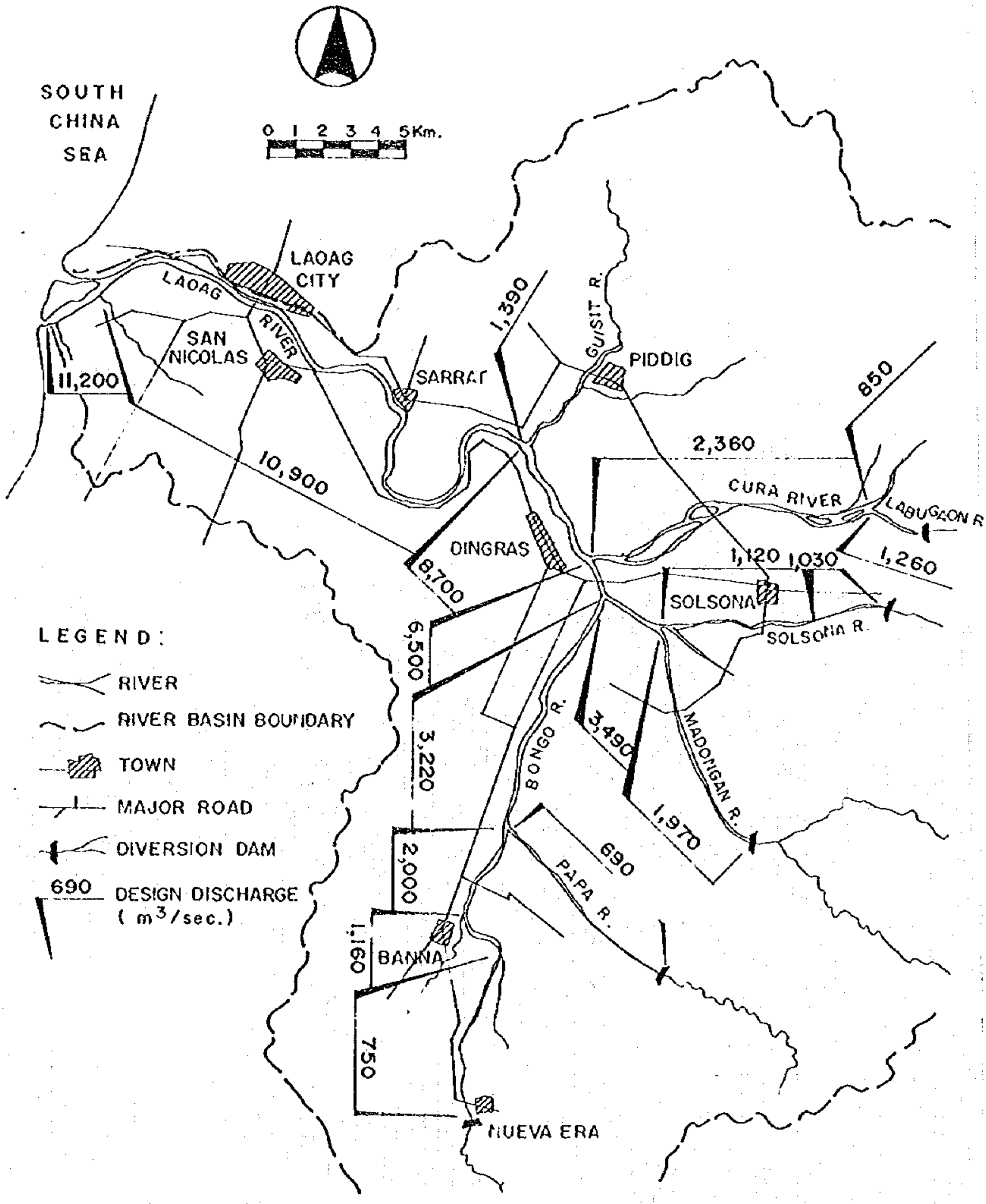
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

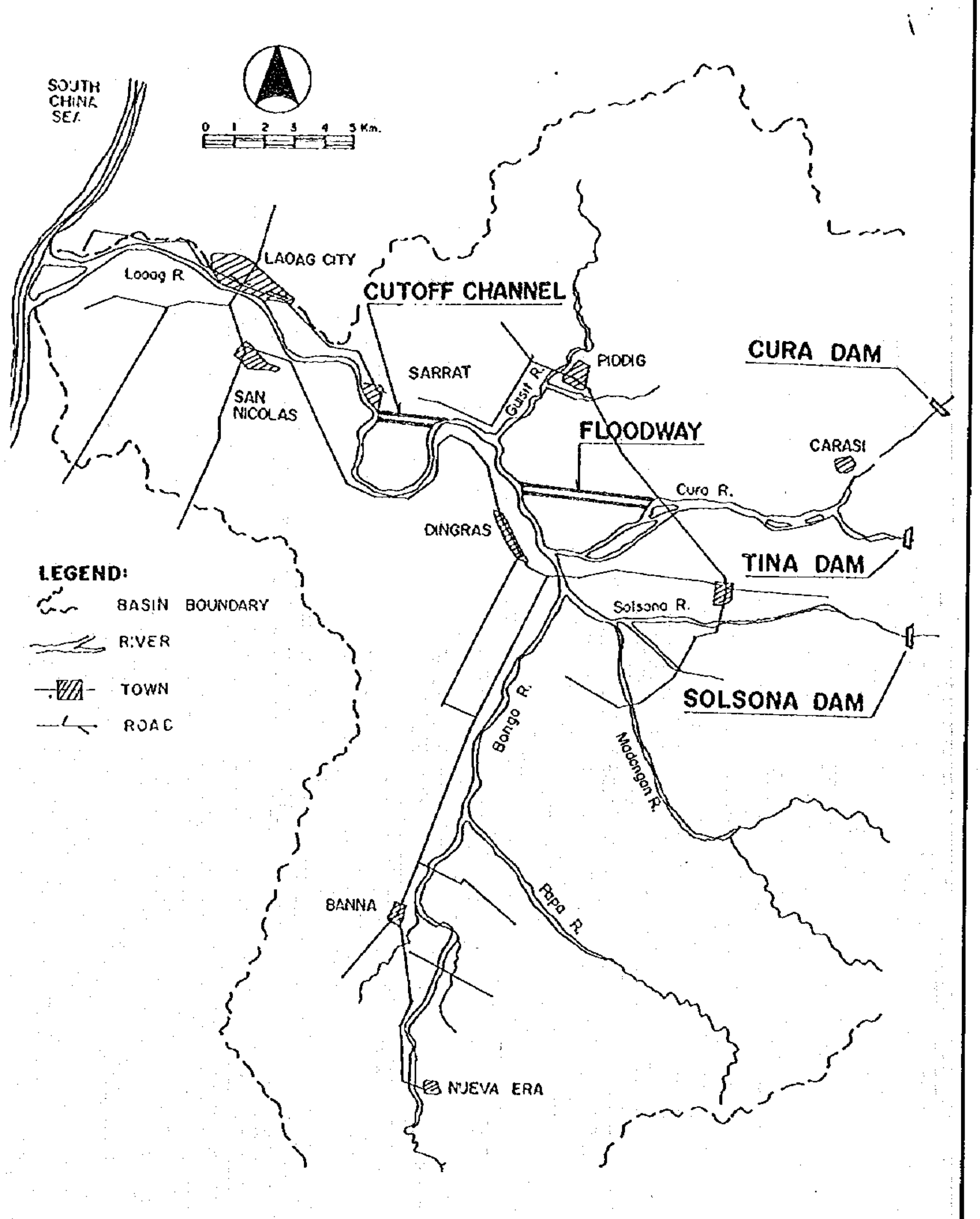
Fig. G.1.3
Existing Drainage System of Laoag City



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. G.2.1** **Major Flood Control Projects in the Philippines**



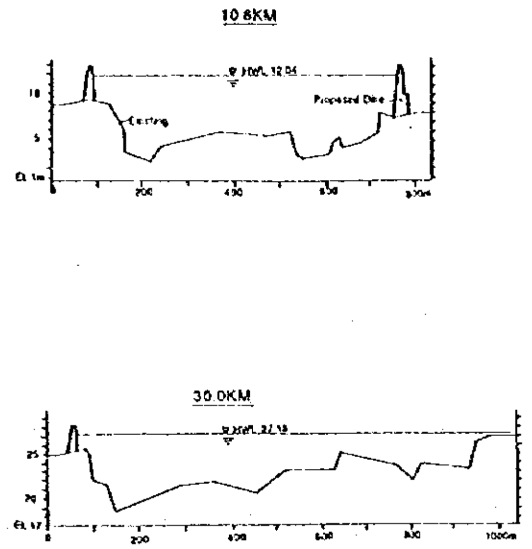
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. G.2.2** **Design Flood Discharge Distribution**

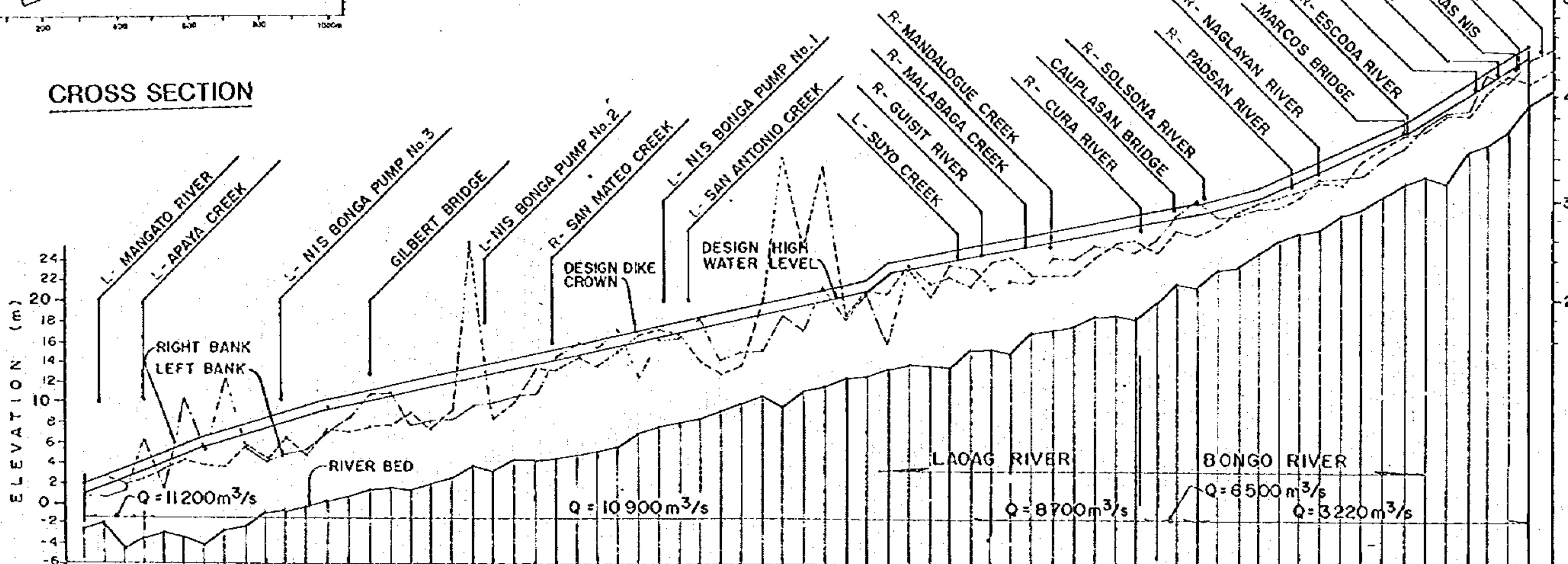


THE STUDY ON SABO AND FLOOD CONTROL
IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. G.3.1
Possibility of Cutoff Channel, Floodway and Dams



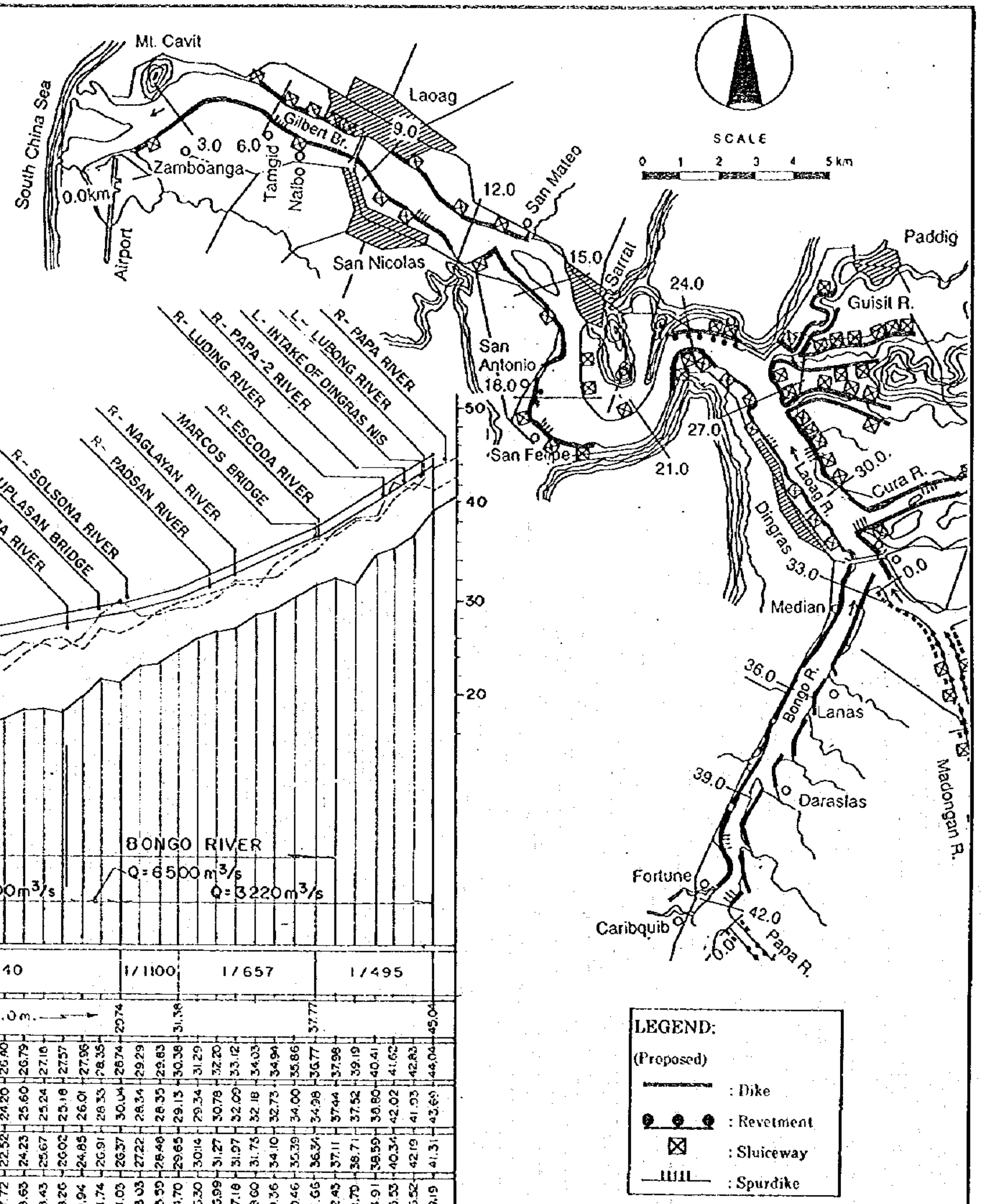


Gradient of H.W.L.	From (m)	To (m)
1/750	0	3600
1/1020	3600	7200
1/1316	7200	22800
1/345	22800	23400
1/1540	23400	32400
1/1100	32400	34200
1/657	34200	38400
1/495	38400	42000

Cummulative Distance (m)	Design Dike Crown El. (m)	Design High Water Level (m)	Right Bank Elevation (m)	Left Bank Elevation (m)	River Bed Elevation (m)
0	2.05	1.05	3.82	2.12	-3.01
600		1.64	0.79	2.88	-1.99
1200		2.64	1.43	2.20	-4.50
1800		3.44	6.32	2.61	-3.26
2400		4.24	1.90	3.65	-2.72
3000		5.04	10.06	4.42	-3.22
3600	6.84	5.84	5.61	3.96	-4.04
4200		6.43	12.06	3.94	-2.77
4800		7.02	5.49	5.66	-1.99
5400		7.60	4.51	4.78	-0.74
6000		8.19	4.90	6.66	-0.75
6600		8.79	5.56	4.98	-0.04
7200	10.70	9.30	7.26	7.45	0.31
7800	H.W.L. + 1.0 m	9.76	8.62	7.11	0.94
8400		10.22	10.54	7.73	1.40
9000		10.67	10.44	7.85	1.76
9600		11.13	7.71	9.16	1.61
10200		11.58	8.33	7.87	2.09
10800		12.04	8.05	9.01	2.52
11400		12.49	9.85	25.58	3.96
12000		12.95	9.93	8.44	3.51
12600		13.41	10.07	9.95	4.45
13200		13.86	10.58	13.27	4.37
13800		14.32	14.33	13.00	4.62
14400		14.77	15.76	14.18	4.97
15000		15.23	15.39	13.43	5.06
15600		15.69	16.95	14.87	5.55
16200		16.14	12.34	16.45	7.08
16800		16.60	16.04	17.00	7.65
17400		17.05	16.16	16.62	8.00
18000		17.51	18.23	13.97	8.22
18600		17.97	14.09	12.67	9.23
19200		18.42	14.95	13.17	9.95
19800		18.88	15.10	19.64	10.69
20400		19.33	18.20	33.81	9.78
21000		19.79	17.07	25.21	10.96
21600		20.25	21.40	33.09	11.64
22200		20.70	18.12	18.58	12.56
22800	22.16	21.16	23.49	20.52	12.53
23400	23.90	22.90	15.54	20.46	13.19
24000	H.W.L. + 1.0 m.	23.29	23.04	23.08	13.47
24600		23.68	20.07	21.81	13.71
25200		24.07	23.53	22.00	13.25
25800		24.45	23.19	21.32	14.93
26400		24.84	21.12	23.85	15.17
27000		25.23	21.84	24.35	14.91
27600		25.62	21.70	22.38	16.83
28200		26.01	24.02	22.23	17.04
28800		26.40	24.20	22.52	17.72
29400		26.79	25.60	24.23	18.63
30000		27.18	25.24	25.67	18.43
30600		27.57	25.18	26.02	18.26
31200		27.96	26.01	24.85	19.94
31800		28.35	28.33	26.91	21.74
32400	29.74	28.74	30.04	26.37	21.03
33000		29.29	28.34	27.22	23.03
33600		29.83	28.35	28.48	23.59
34200	31.38	30.38	29.13	29.65	24.70
34800		31.29	29.34	30.14	26.30
35400		32.20	30.78	31.27	26.99
36000		33.12	32.09	31.97	27.18
36600		34.03	32.18	31.73	28.60
37200		34.94	32.73	34.10	29.36
37800		35.86	34.00	35.39	30.46
38400	37.77	36.77	34.98	36.34	31.66
39000		37.98	37.44	37.11	32.45
39600		39.19	37.52	38.71	31.70
40200		40.41	38.80	38.59	34.91
40800		41.62	42.02	40.34	35.53
41400		42.83	41.93	42.19	36.52
42000	45.04	44.04	43.69	41.31	39.19

DISTANCE (m): 0 — DISTANCE BETWEEN SECTIONS = 600 METERS ON CENTERS

LONGITUDINAL PROFILE

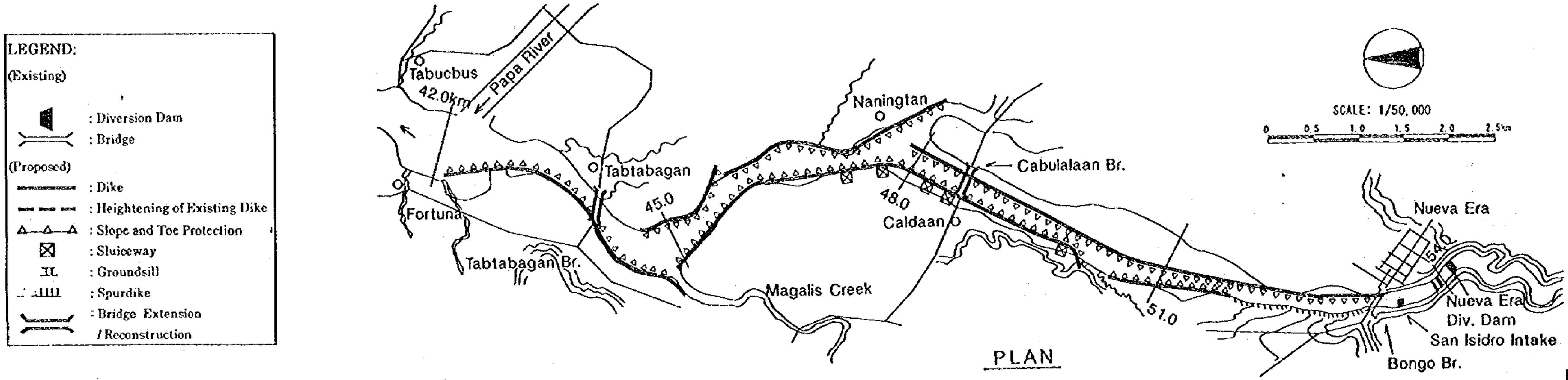


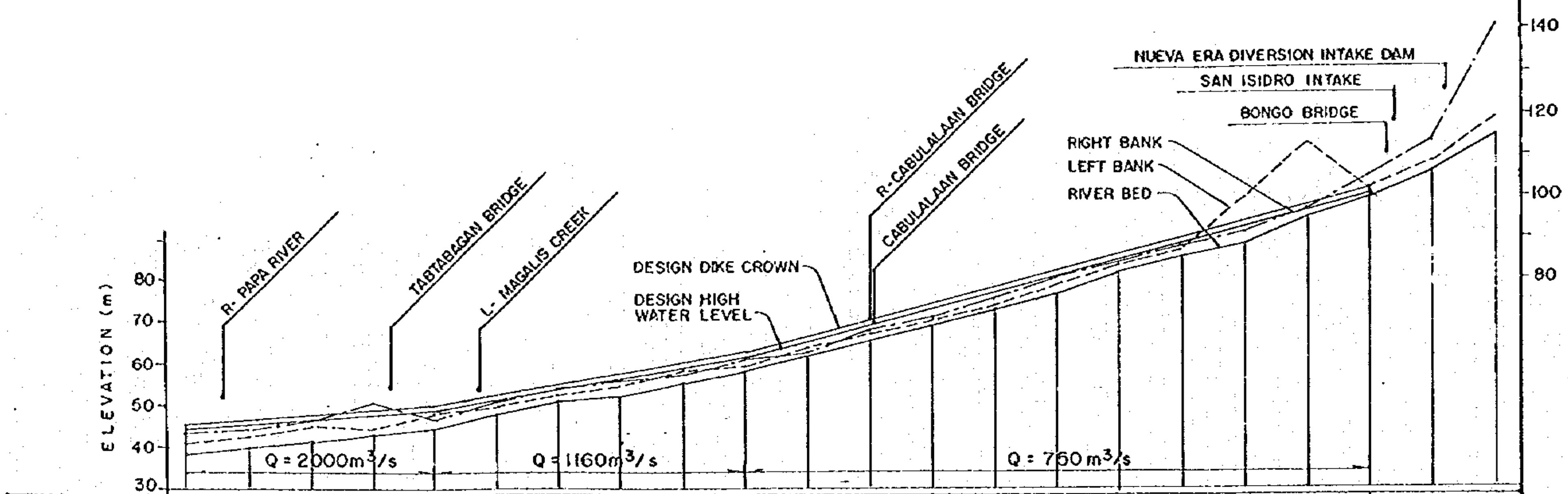
PLAN

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. G.4.1
Laoag-Lower Bongo River Improvement Plan





GRADIENT OF H.W.L.	1 / 495				1 / 238					1 / 150	
DESIGN DIKE CROWN EL. (m)	45.04				49.89					62.50	
DESIGN HIGH WATER LEVEL (m)	44.04	45.25	46.47	47.68	48.89	51.41	53.93	56.45	58.97	61.50	65.50
RIGHT BANK ELEVATION (m)	43.96	44.07	46.65	51.57	47.26	50.83	54.40	56.25	58.02	61.02	63.40
LEFT BANK ELEVATION (m)	41.31	42.56	45.18	44.79	48.42	50.30	52.81	55.03	58.42	60.13	63.46
RIVER BED ELEVATION (m)	39.19	40.05	41.48	43.52	44.76	48.51	51.24	52.16	55.69	58.38	62.48
ACCUMULATED DISTANCE (m)	42000	42600	43200	43800	44400	45000	45600	46200	46800	47400	48000
DISTANCE (m)	0	600	600	600	600	600	600	600	600	600	600

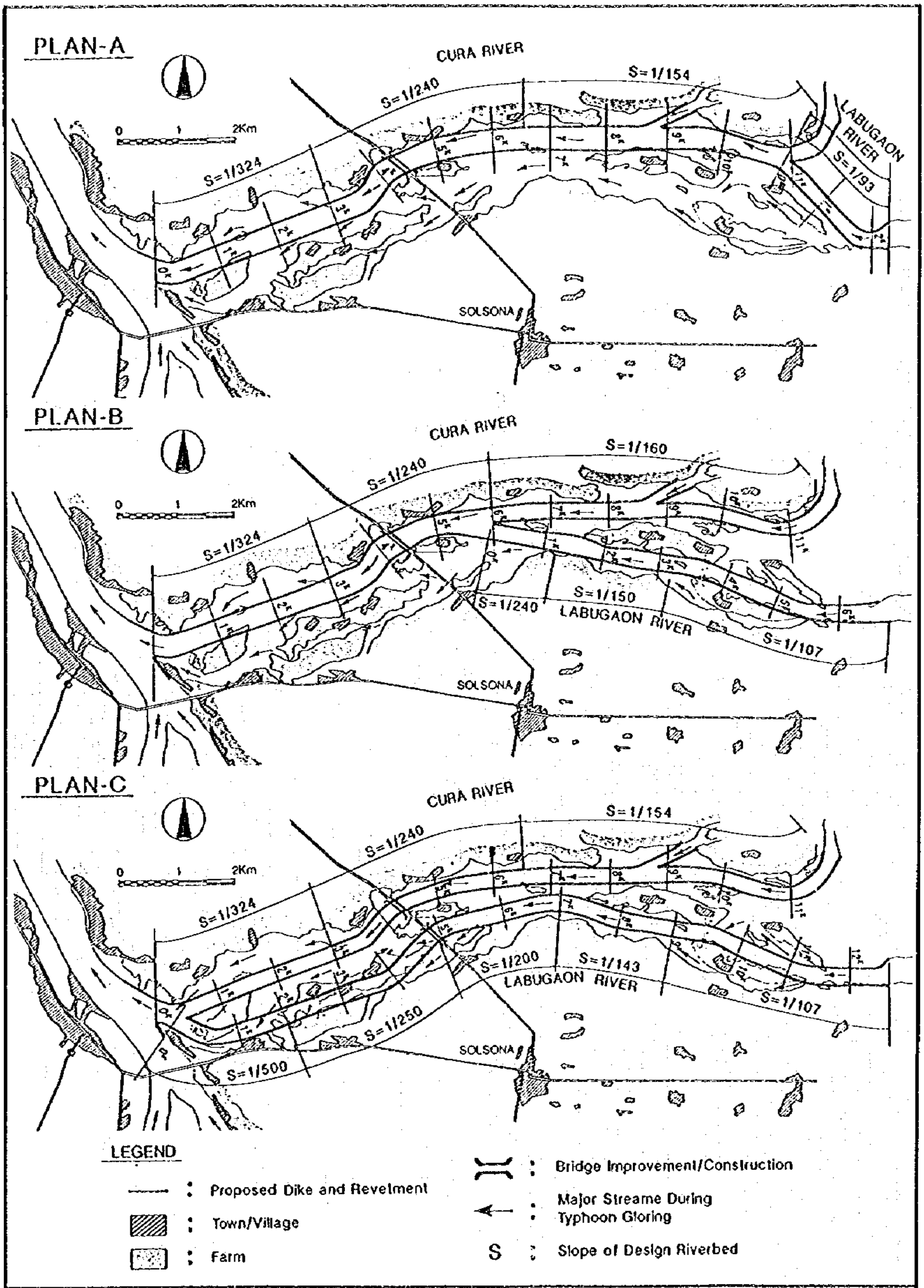
GRADIENT OF H.W.L.	1 / 150										
DESIGN DIKE CROWN EL. (m)	H.W.L. + 1.0 m.								102.50		
DESIGN HIGH WATER LEVEL (m)	69.50	73.50	77.50	81.50	85.50	89.50	93.50	97.50	101.50		
RIGHT BANK ELEVATION (m)	67.86	71.21	76.07	81.31	84.67	88.70	92.93	97.81	105.41	114.14	141.56
LEFT BANK ELEVATION (m)	67.52	71.04	74.37	79.55	84.13	88.56	100.22	113.61	102.38	108.84	119.44
RIVER BED ELEVATION (m)	65.90	69.85	73.81	77.27	82.81	85.24	89.73	96.03	100.05	105.03	114.67
ACCUMULATED DISTANCE (m)	48600	49200	49800	50400	51 000	51600	52200	52800	53400	54000	54 600
DISTANCE (m)	600	600	600	600	600	600	600	600	600	600	600

LONGITUDINAL PROFILE

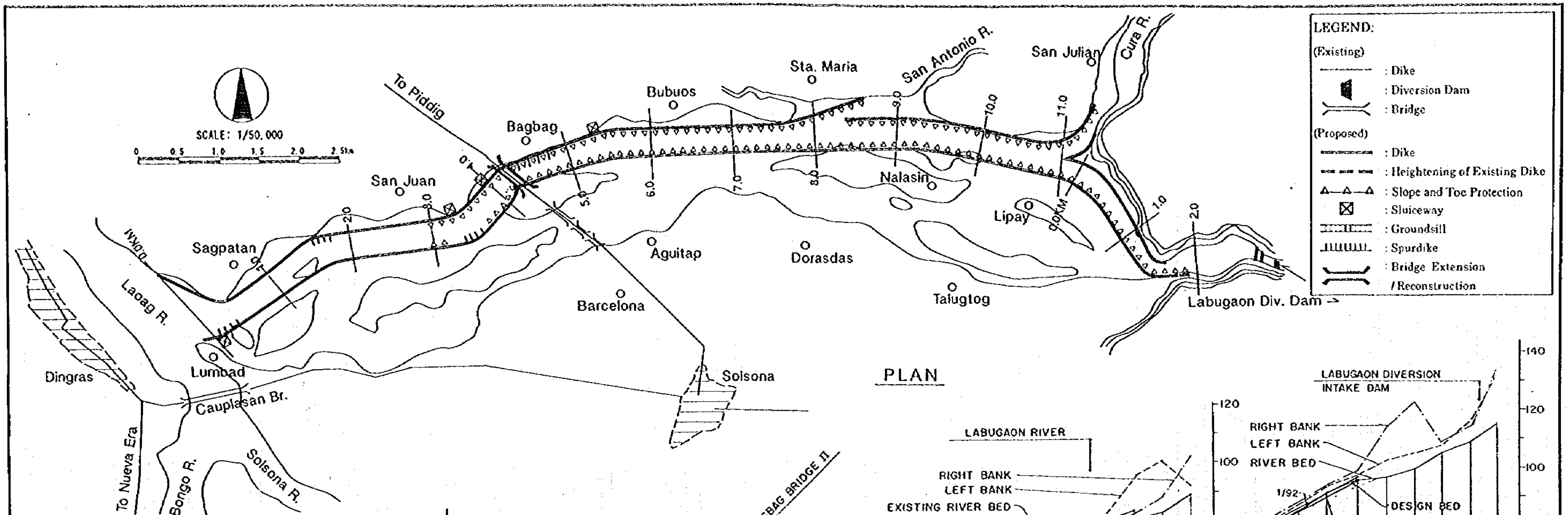
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

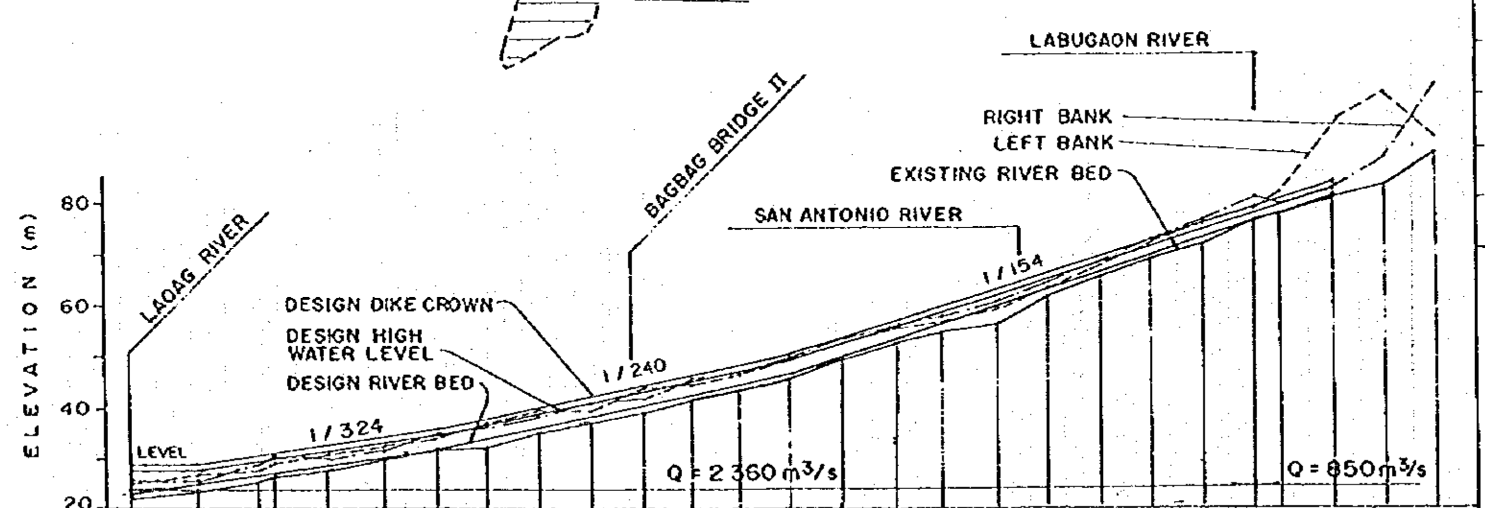
JAPAN INTERNATIONAL COOPERATION AGENCY

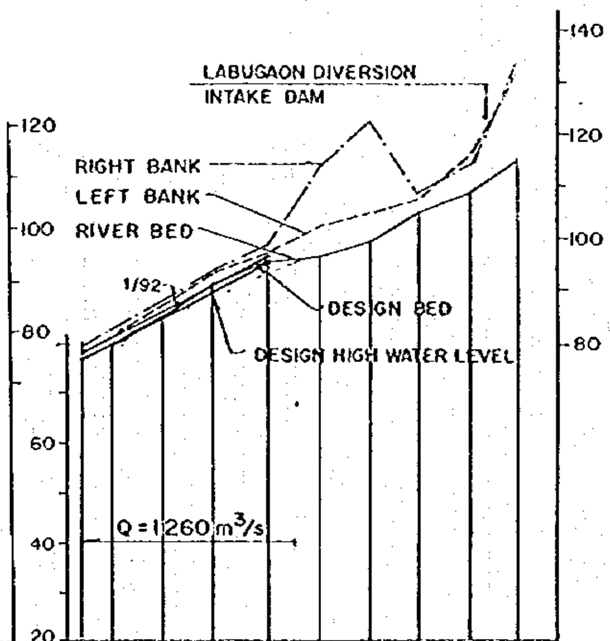
Fig. G.4.2
Upper Bongo River Improvement Plan



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN / JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. G.4.3 Alignment Alternatives of Cura/Labugaon River**



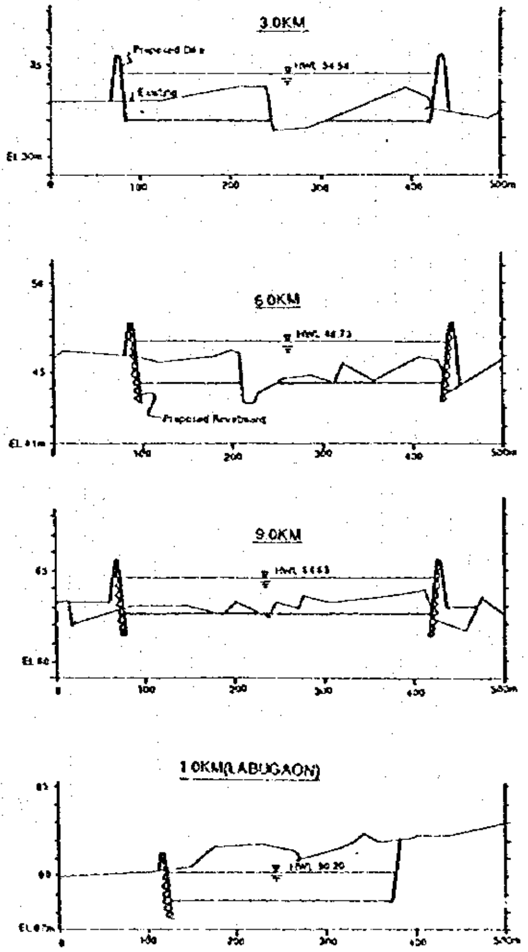




ACCUMULATED DISTANCE (m)	DISTANCE (m)	DESIGN DIKE CROWN EL. (m)	DESIGN HIGH WATER LEVEL (m)	DESIGN RIVER BED EL. (m)	RIGHT BANK ELEVATION (m)	LEFT BANK ELEVATION (m)	RIVER BED ELEVATION (m)
0	0	28.96	27.96	22.87	24.97	24.95	22.15
650	650	28.96	77.96	24.87	25.92	26.93	23.12
1 250	600		29.35	26.72	27.80	27.70	24.82
1 400	150		29.61	27.18	29.26	28.49	25.94
1 920	520		31.41	28.78	30.05	30.27	27.47
2 430	510		32.98	30.35	31.82	32.29	29.55
2 930	500	35.52	34.52	31.89	34.28	33.88	31.41
3 460	530		36.72	34.30	36.65	36.93	32.10
3 960	500		38.81	36.39	38.00	39.87	35.05
4 460	500		40.87	38.47	40.54	39.34	37.02
4 960	500		42.97	40.55	41.74	43.48	39.00
5 460	500		45.06	42.64	45.78	44.10	41.03
5 910	450		46.93	44.51	46.75	46.28	43.21
6 430	520	50.10	49.10	46.68	49.24	49.00	45.55
6 930	500	H.W.L. + 1.0 m.	52.35	50.25	52.29	51.84	40.80
7 430	500		55.59	53.49	55.56	55.36	52.52
7 880	450		58.51	56.41	57.71	56.55	54.58
8 420	540		62.02	59.92	60.51	58.82	56.06
8 900	480		65.14	63.04	64.27	63.26	61.49
9 420	520		68.51	66.41	68.30	68.09	65.13
9 930	510		71.83	69.73	71.81	71.72	68.21
10 430	500		75.07	72.97	75.92	75.23	71.56
10 930	500		78.32	76.22	80.43	78.90	76.59
11 180	250		79.94	77.84	79.23	81.39	77.13
11 680	500	84.19	83.19	81.09	82.87	96.33	80.92
12 180	500				88.61	100.69	82.17
12 680	500				102.13	91.96	89.45

ACCUMULATED DISTANCE (m)	DISTANCE (m)	DESIGN DIKE CROWN EL. (m)	DESIGN HIGH WATER LEVEL (m)	DESIGN RIVER BED EL. (m)	RIGHT BANK ELEVATION (m)	LEFT BANK ELEVATION (m)	RIVER BED ELEVATION (m)
-300	300	79.32	78.32	76.22	80.43	78.90	76.59
0	0	H.W.L. + 1.0 m.	81.07	79.45	81.88	81.75	79.57
500	500		86.44	84.82	87.70	87.34	85.02
1000	500		91.82	90.20	93.41	93.23	91.43
1500	500	98.19	97.19	95.57	98.69	97.30	95.62
2 000	500				114.05	102.58	96.51
2 500	500				122.03	104.63	99.70
3 000	500				108.90	107.58	105.44
3 500	500				114.31	115.68	108.76
4 000	500				133.65	132.65	115.20

LONGITUDINAL PROFILE



CROSS SECTION

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

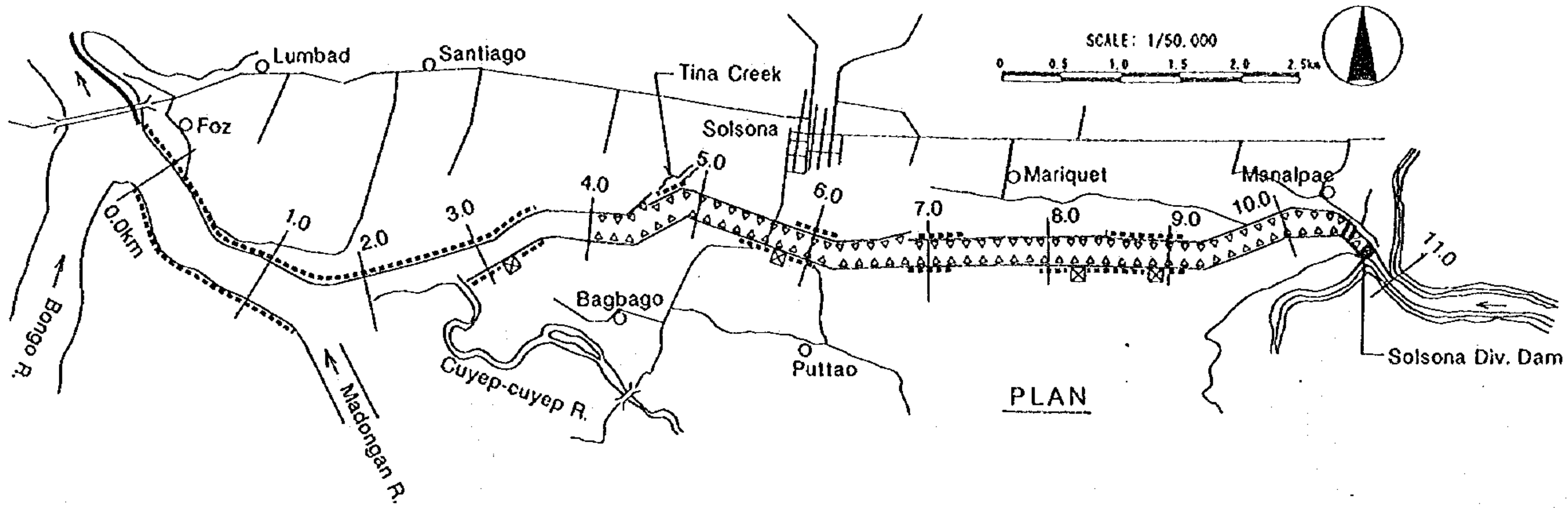
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. G.4.4
Cura/Labugaon River Improvement Plan

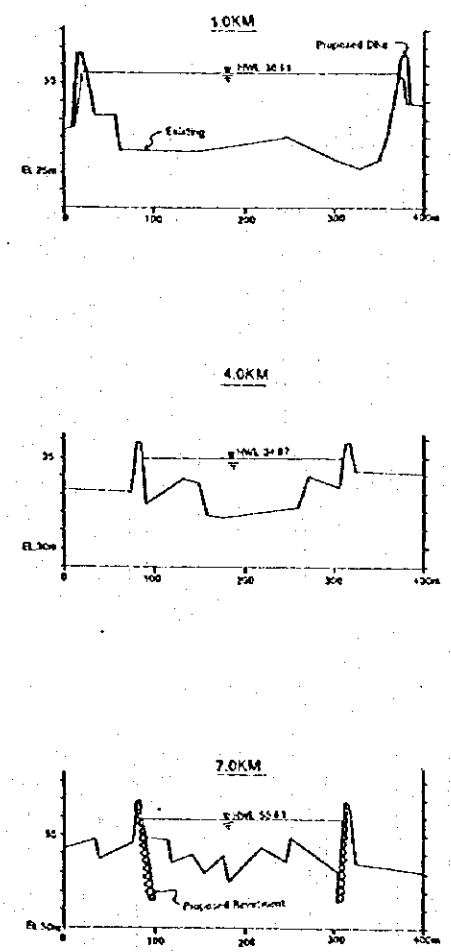
LEGEND:

(Existing)
- : Dike
- : Diversion Dam
- : Bridge

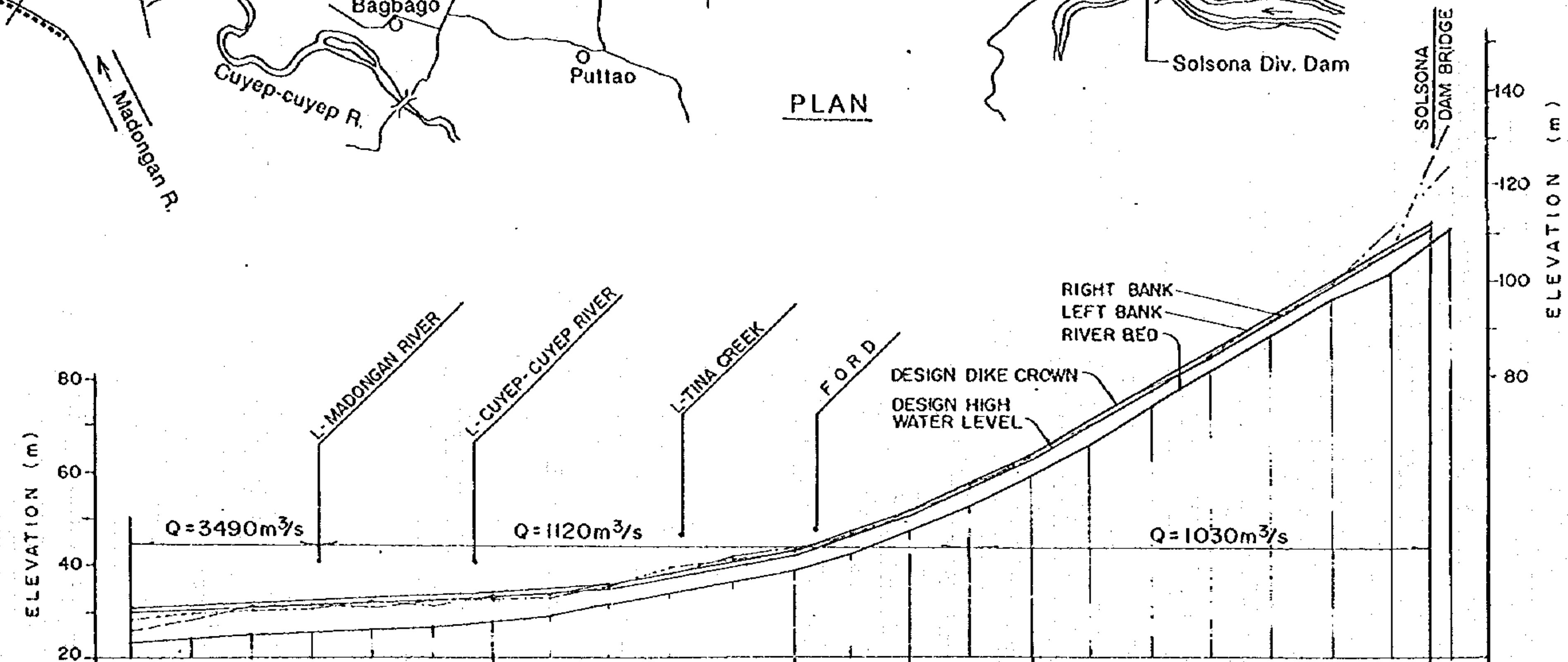
(Proposed)
- : Dike
- : Heightening of Existing Dike
- : Slope and Toe Protection
- : Sluiceway
- : Groundsill
- : Spurdike
- : Bridge Extension / Reconstruction



PLAN



CROSS SECTION



GRADIENT OF H.W.L.	1/1100						1/410		1/195			1/130
DESIGN DIKE CROWN EL. (m)	30.70	31.15	31.61	32.05	32.52	32.97	33.43	34.65	35.87	38.43	40.99	43.56
DESIGN HIGH WATER LEVEL (m)	29.70	30.15	30.61	31.06	31.52	31.97	32.43	33.65	34.87	37.43	39.99	42.56
RIGHT BANK ELEVATION (m.)	28.60	29.93	30.25	30.58	31.37	31.34	32.97	33.76	35.96	38.05	41.28	43.43
LEFT BANK ELEVATION (m.)	26.49	28.72	30.78	31.32	30.78	32.62	32.79	33.56	35.91	39.25	40.92	43.38
RIVER BED ELEVATION (m.)	23.24	24.14	25.12	25.30	26.25	27.16	28.37	29.64	31.70	34.32	36.68	38.70
ACCUMULATED DISTANCE (m.)	0	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500
DISTANCE (m.)	0	500	500	500	500	500	500	500	500	500	500	500

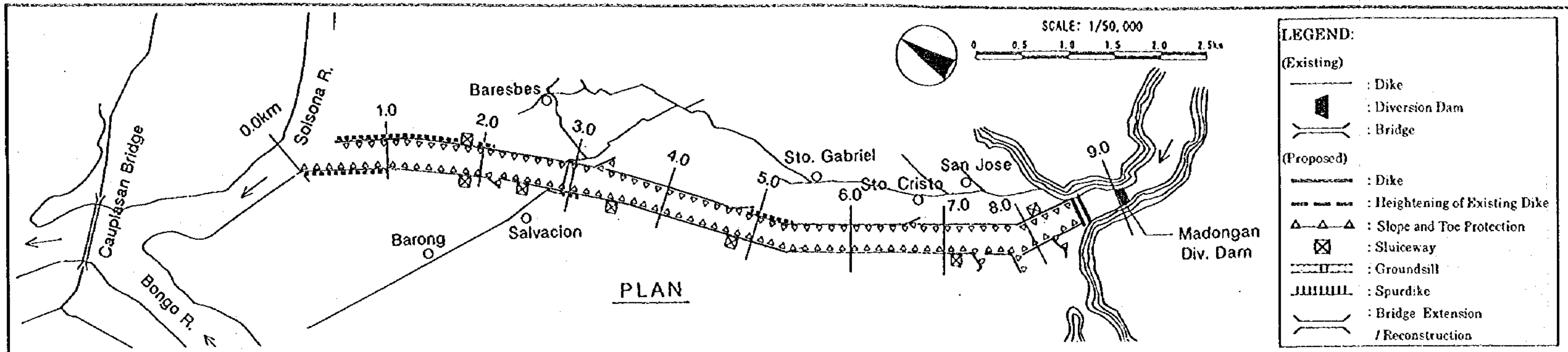
GRADIENT OF H.W.L.		1/90		1/67							
DESIGN DIKE CROWN EL. (m)	47.40	51.25	56.81	62.36	69.92	77.29	84.75	92.21	99.68	107.14	
DESIGN HIGH WATER LEVEL (m)	46.40	50.25	55.81	61.36	68.82	76.29	83.75	91.21	98.68	106.14	
RIGHT BANK ELEVATION (m.)	46.32	51.74	56.65	62.75	70.14	77.26	84.41	92.24	99.95	110.89	123.61
LEFT BANK ELEVATION (m.)	46.77	51.74	56.47	62.96	69.59	76.44	84.54	92.51	100.15	106.72	132.44
RIVER BED ELEVATION (m.)	42.54	47.59	52.46	58.06	65.69	73.22	80.78	88.93	96.47	101.93	110.75
ACCUMULATED DISTANCE (m.)	6000	6500	7000	7500	8000	8500	9000	9500	10000	10500	11500
DISTANCE (m.)	500	500	500	500	500	500	500	500	500	500	500

LONGITUDINAL PROFILE

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

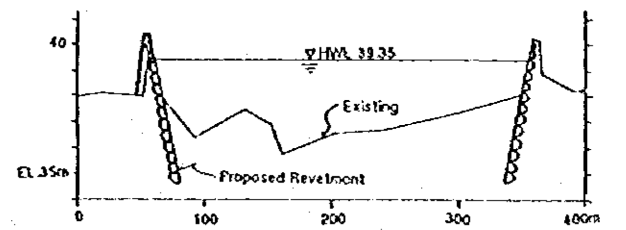
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. G.4.5
Solsona River Improvement Plan

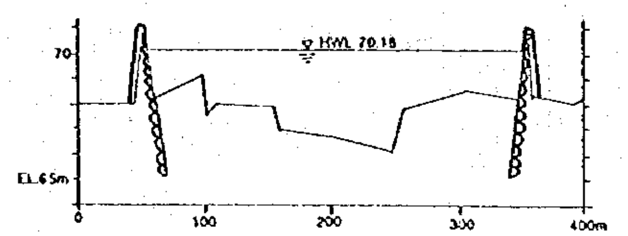


PLAN

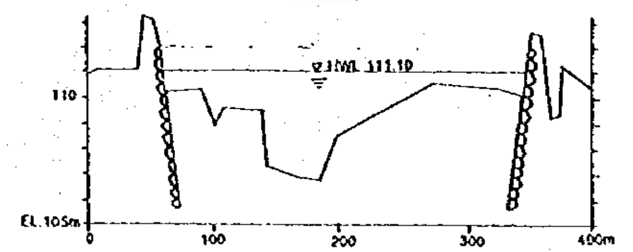
2.0KM



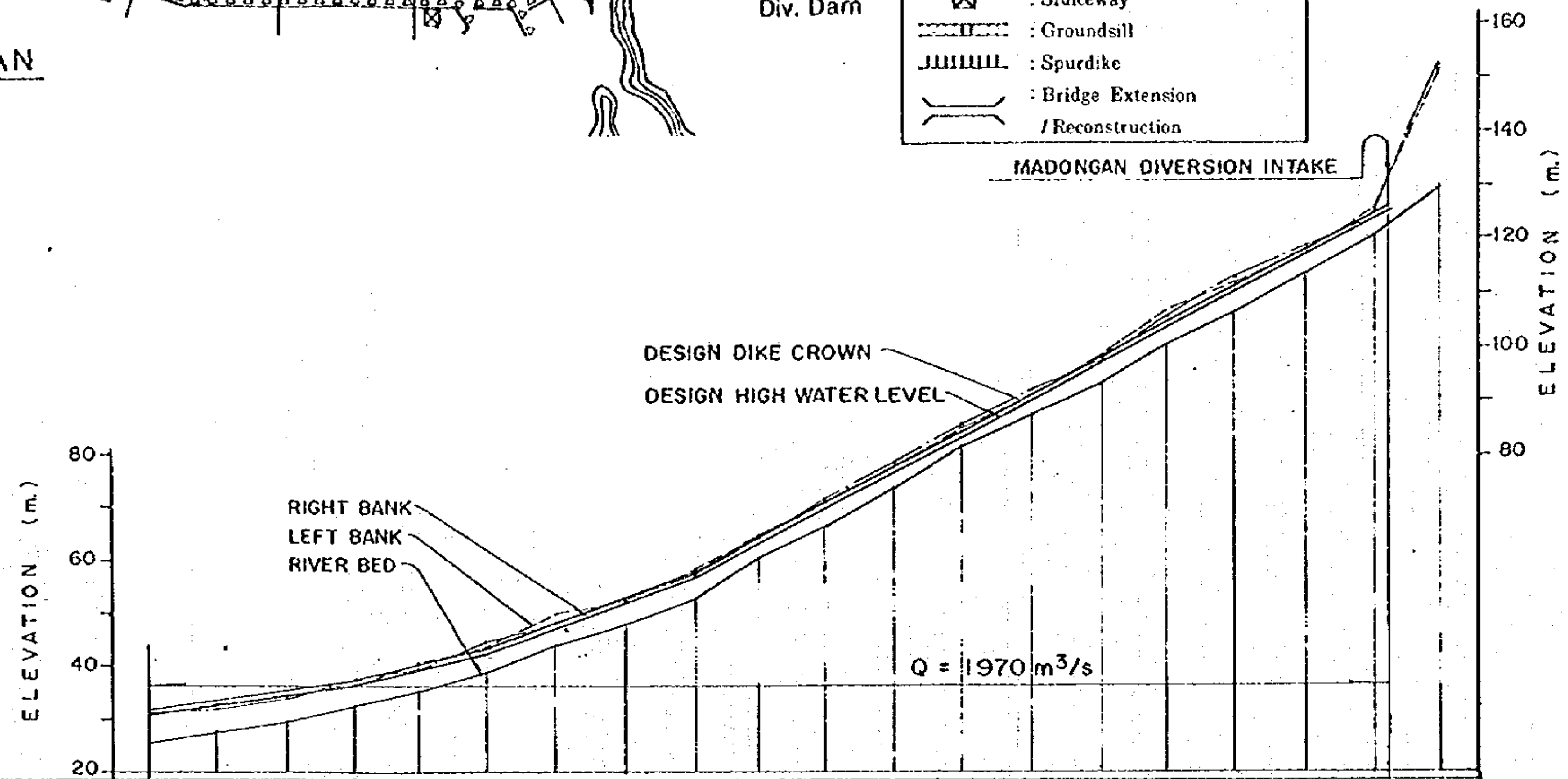
5.0KM



8.0KM



CROSS SECTION



GRADIENT OF H.W.L.	1/285			1/165		1/105			1/74	
DESIGN DIKE CROWN EL. (m)	32.06	33.81	35.57	37.32	40.35	43.38	48.15	52.91	57.67	64.43
DESIGN HIGH WATER LEVEL (m)	31.06	32.81	34.57	36.32	39.35	42.38	47.15	51.91	56.67	63.43
RIGHT BANK ELEVATION (m.)	30.83	32.59	34.63	36.85	40.40	43.63	49.89	52.90	58.04	64.43
LEFT BANK ELEVATION (m.)	30.95	31.93	34.61	37.44	39.55	44.54	47.98	52.96	58.01	64.22
RIVER BED ELEVATION (m.)	25.36	27.60	29.89	32.85	35.84	39.23	44.00	48.13	53.14	60.54
ACCUMULATED DISTANCE (m.)	0	500	1000	1500	2000	2500	3000	3500	4000	4500
DISTANCE (m.)	0	500	500	500	500	500	500	500	500	500

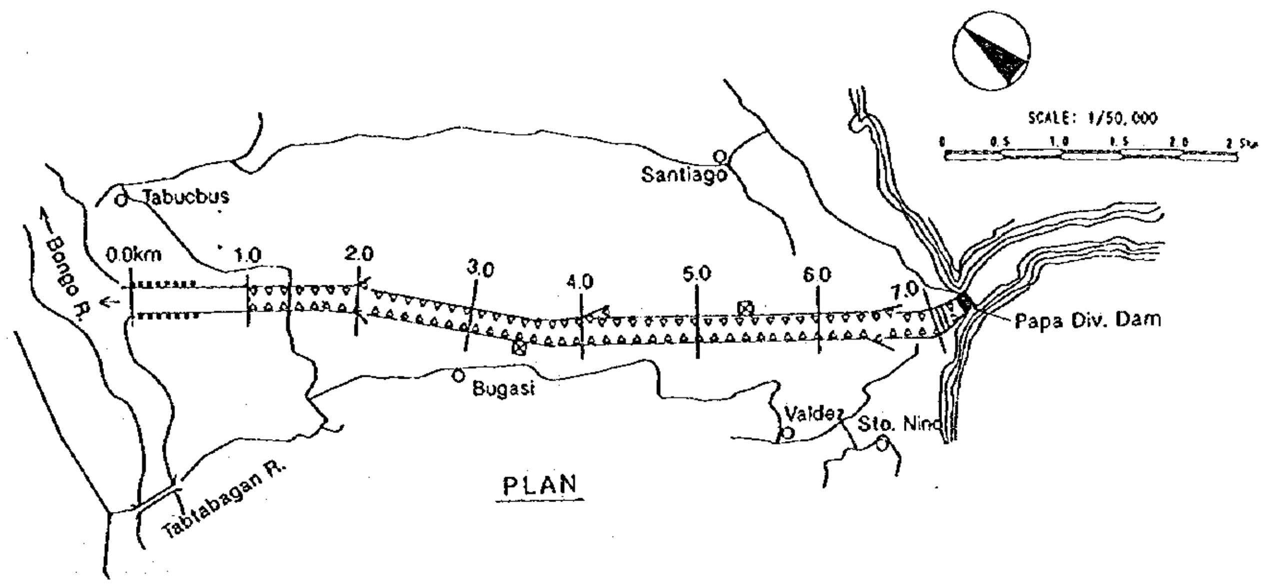
GRADIENT OF H.W.L.					1/72					
DESIGN DIKE CROWN EL. (m)	71.18	77.94	84.70	91.45	98.21	105.15	112.10	119.04	125.99	
DESIGN HIGH WATER LEVEL (m)	70.18	76.94	83.70	90.45	97.21	104.15	111.10	118.04	124.99	
RIGHT BANK ELEVATION (m.)	70.37	77.89	85.00	91.51	99.39	106.67	112.74	118.20	125.47	151.91
LEFT BANK ELEVATION (m.)	70.86	78.12	85.04	91.74	99.30	105.52	113.29	119.30	125.43	152.25
RIVER BED ELEVATION (m.)	66.24	73.51	80.81	87.27	93.72	100.56	106.78	114.00	120.32	129.99
ACCUMULATED DISTANCE (m.)	5000	5500	6000	6500	7000	7500	8000	8500	9000	9500
DISTANCE (m.)	500	500	500	500	500	500	500	500	500	500

LNOGITUDINAL PROFILE

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. G.4.6
Madongan River Improvement Plan

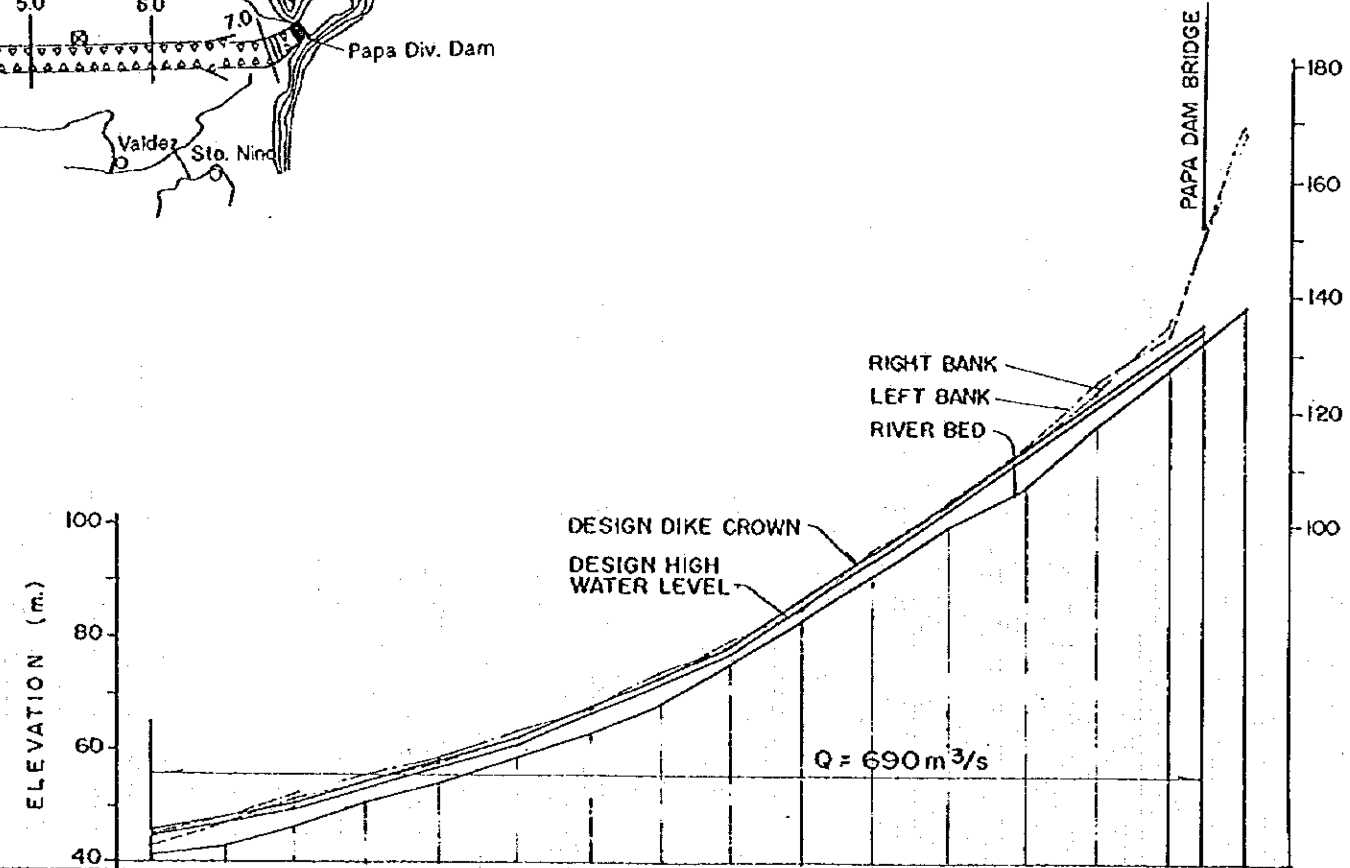


PLAN

LEGEND:

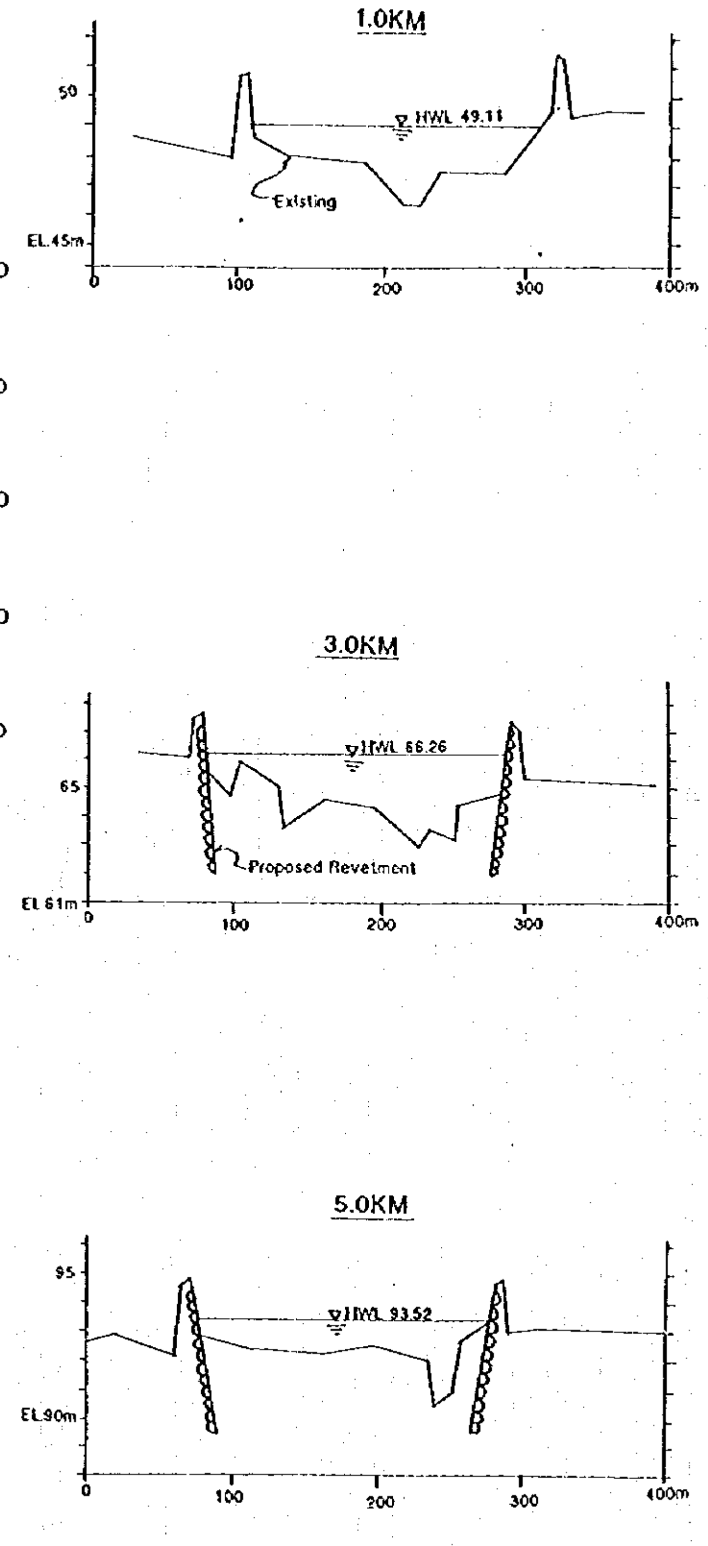
(Existing)
- : Dike
- : Diversion Dam
- : Bridge

(Proposed)
- : Dike
- : Heightening of Existing Dike
- : Slope and Toe Protection
- : Sluiceway
- : Groundsill
- : Spurdike
- : Bridge Extension / Reconstruction



GRADIENT OF H.W.L.		1/230			1/128			1/92		1/61			1/55			
DESIGN DIKE CROWN EL. (m)	45.76	47.93	50.11	54.01	58.92	61.83	67.26	72.70	78.13	86.33	94.52	103.62	112.71	121.80	130.29	
DESIGN HIGH WATER LEVEL (m)	44.76	46.93	49.11	53.01	57.92	60.83	66.26	71.70	77.13	85.33	93.52	102.62	111.71	120.80	129.89	
RIGHT BANK ELEVATION (m.)	45.12	47.86	51.59	55.14	58.53	62.77	67.64	73.65	78.54	86.64	94.85	103.58	113.21	123.65	134.56	168.13
LEFT BANK ELEVATION (m.)	42.88	47.26	50.82	54.79	58.09	62.27	67.75	72.91	79.65	84.99	94.92	103.65	113.77	125.11	133.16	169.14
RIVER BED ELEVATION (m.)	41.00	43.31	46.21	50.65	54.30	58.70	63.10	68.49	75.08	82.87	90.50	99.95	106.29	117.78	127.30	138.15
ACCUMULATED DISTANCE (m.)	0	500	1000	1 500	2 000	2 500	3000	3 500	4000	4500	5000	5500	6000	6500	7000	7 500
DISTANCE (m.)	0	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500

LONGITUDINAL PROFILE

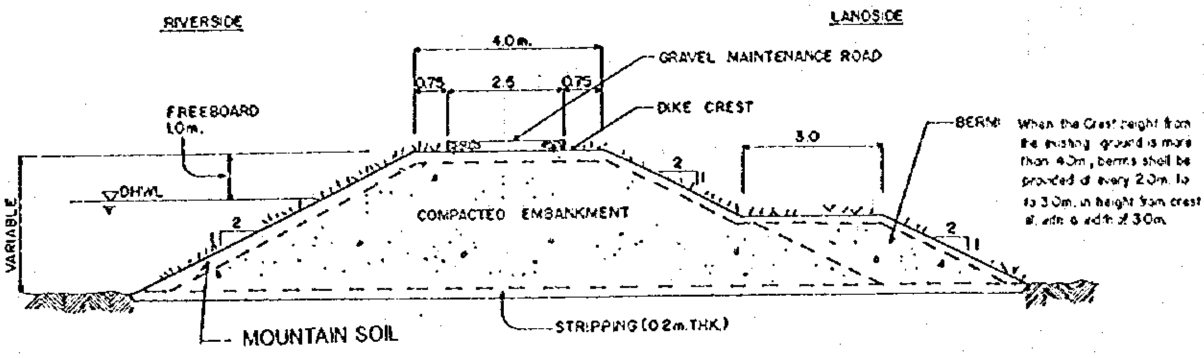


CROSS SECTION

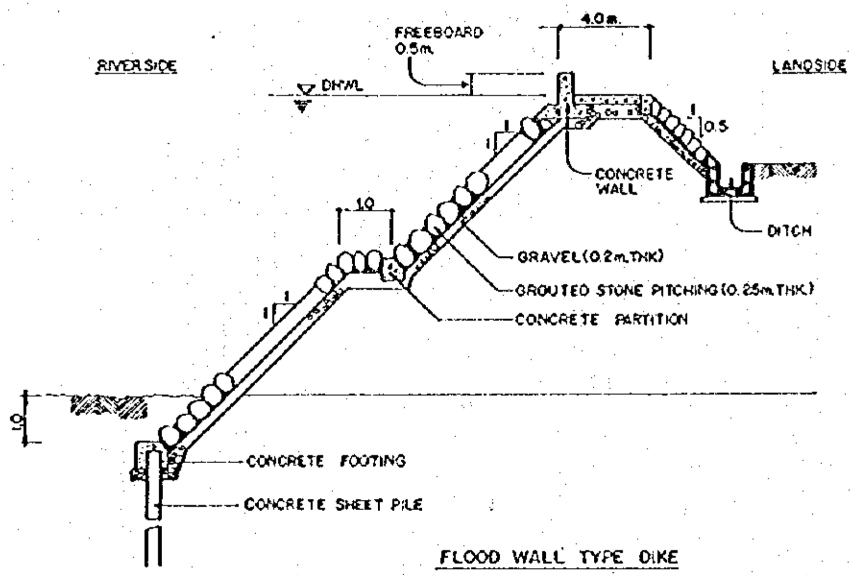
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. G.4.7
Papa River Improvement Plan

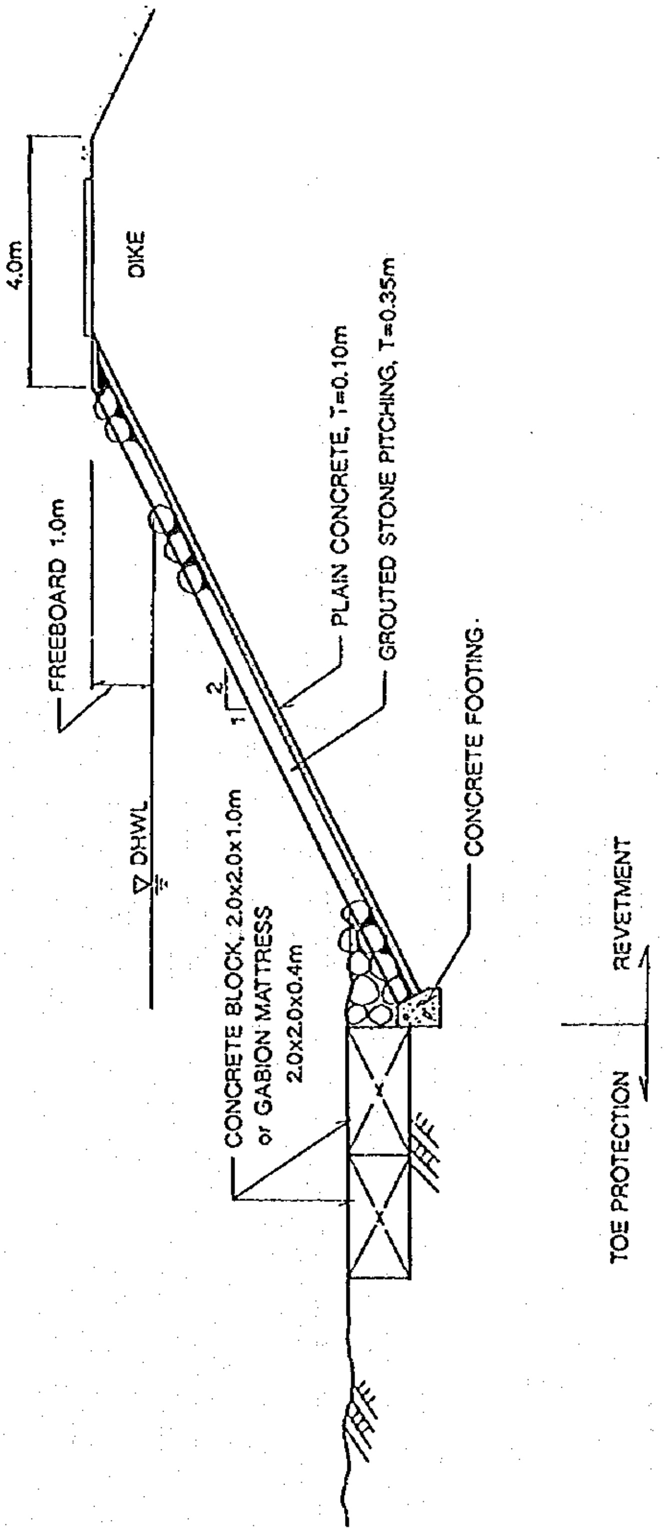


EARTH TYPE DIKE

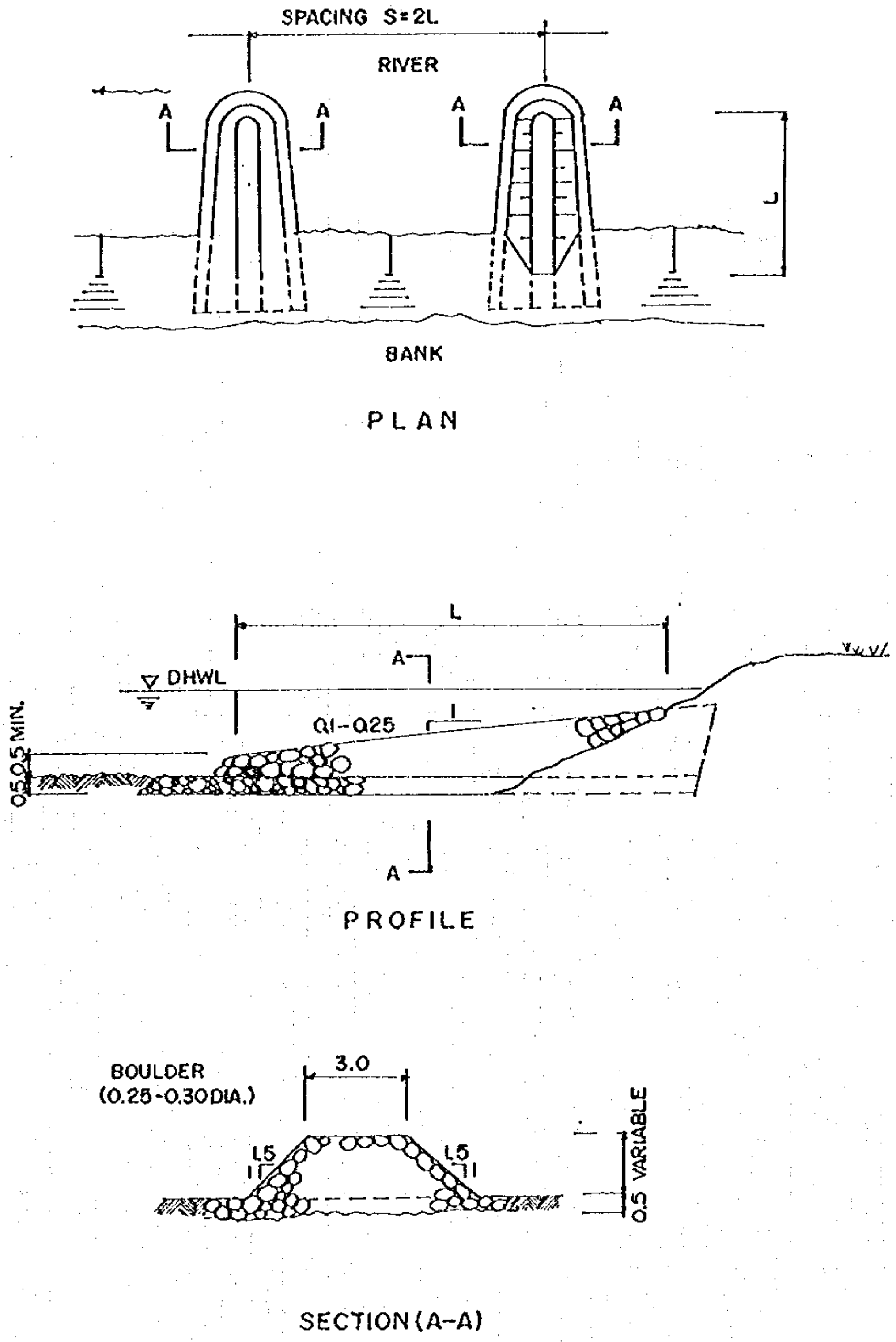


FLOOD WALL TYPE DIKE

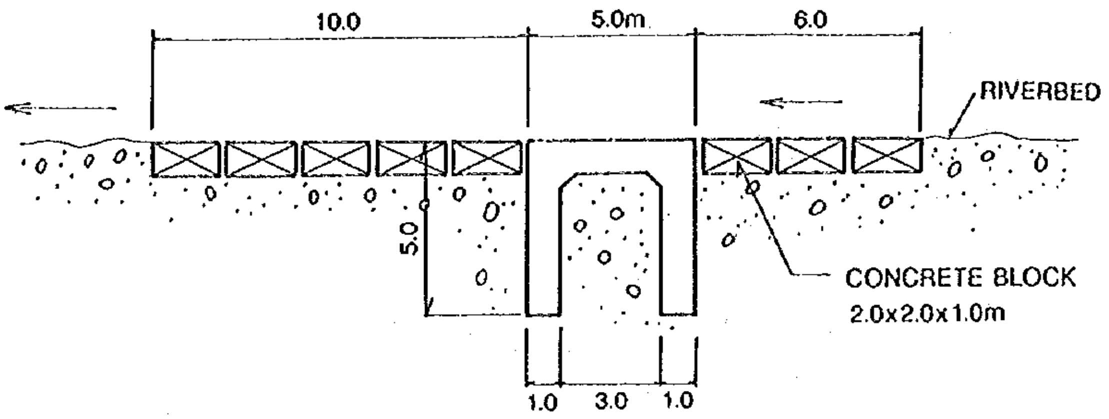
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. G.4.8** **Structural Layout of Proposed Dike and Floodwall**



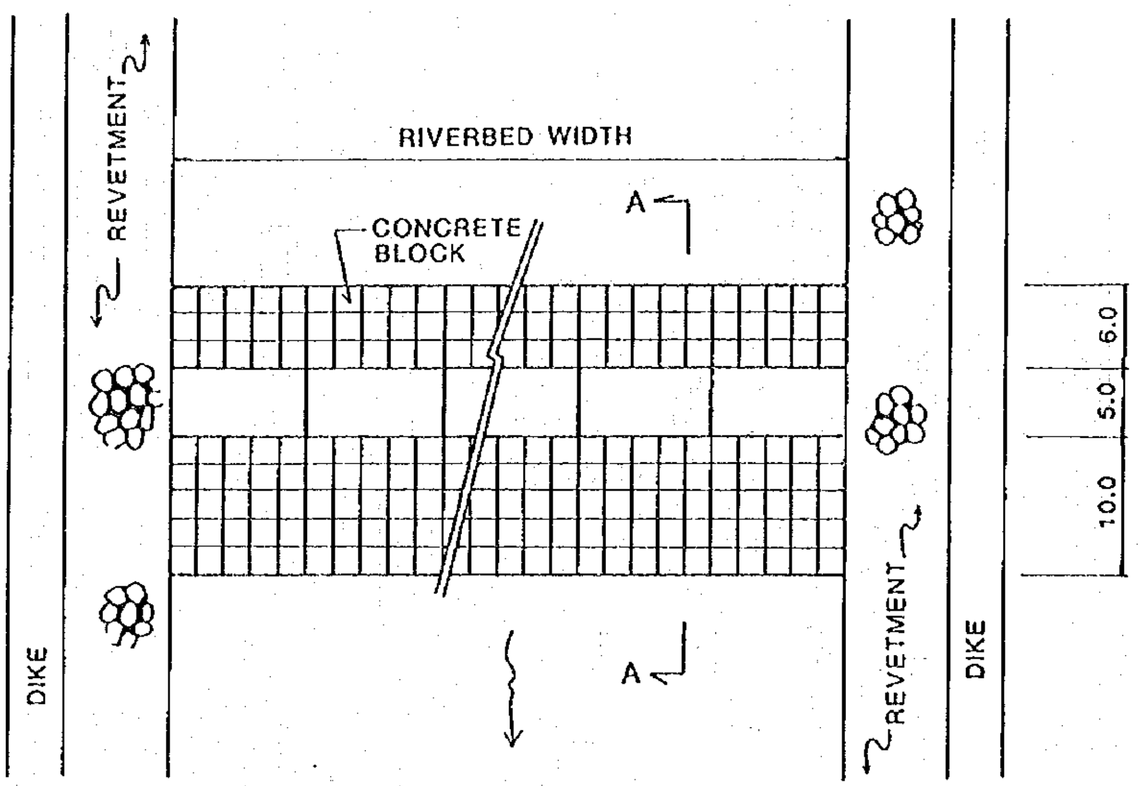
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	**Fig. G.4.9**
JAPAN INTERNATIONAL COOPERATION AGENCY	**Structural Layout of Proposed Revetment and Toe Protection**



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	**Fig. G.4.10**
JAPAN INTERNATIONAL COOPERATION AGENCY	**Structural Layout of Proposed Spurdike**

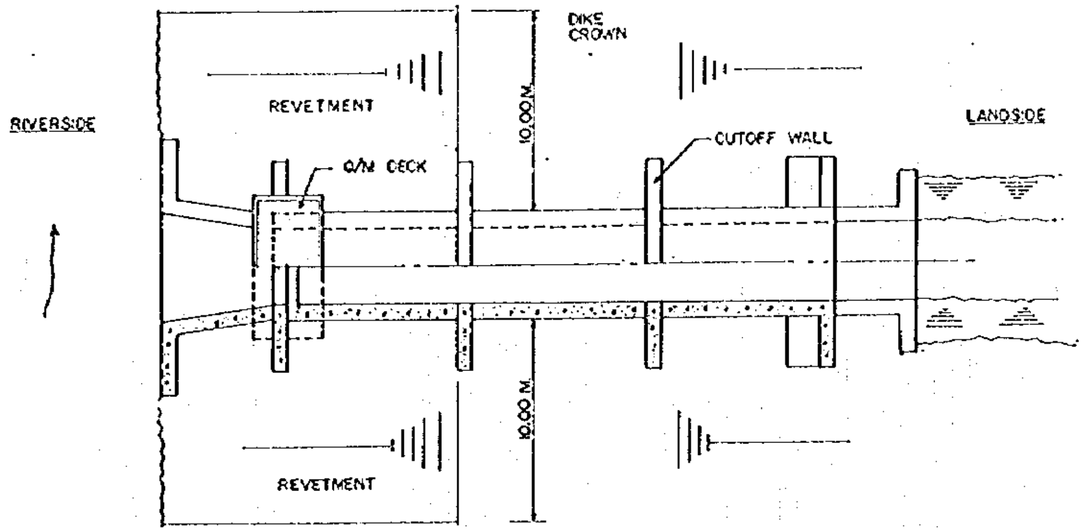


SECTION A-A

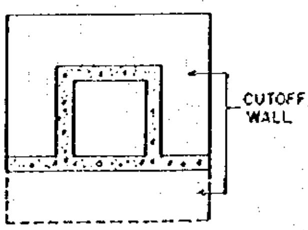


PLAN

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	**Fig. G.4.11** **Structural Layout of Proposed Groundsill**



PLAN



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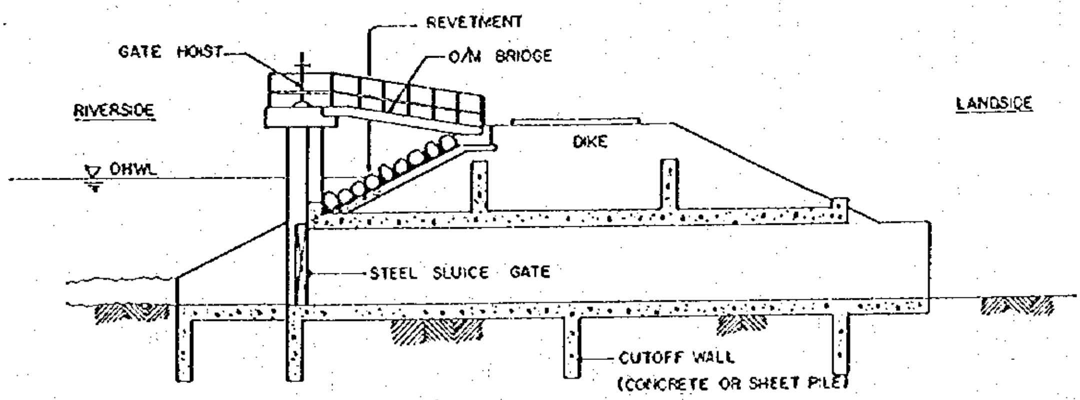

PROFILE

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	**Fig. G.4.12**
JAPAN INTERNATIONAL COOPERATION AGENCY	**Structural Layout of Proposed Sluiceway**

ATTACHMENT

DESIGN FLOOD DISCHARGE PROBABILITY OF THE MAJOR RIVERS IN THE PHILIPPINES

Design Flood Discharge Probability of the Major Rivers in the Philippines

The flood control projects in 10 major rivers and volcanoes have been studied by DPWH with foreign technical and financial assistance since 1981. The proposed design flood discharge probabilities of the projects are shown below along with the salient features of the project areas.

1 Cagayan River

1.1 Study Report

The Master Plan Study on the Cagayan River Basin Water Resources Development, Aug. 1987, by JICA

1.2 Project Area

(1) Drainage Basin : 27,300 km^2

(2) Number of Municipalities of Drainage Basin : 107

(3) Population of Drainage Basin

a) Total Population : 2,136,000 (1985)

b) Population Density : 78 persons/km^2 (1985)

c) Ratio of Urban Population to Total : 19% (1985)

(4) GRDP of Drainage Basin

a) Per Capita : P 1,105 =$ 61.4 (1984)

b) Total : P 2,360 million = $ 131 million (1984)

(5) Sectoral Structure of Drainage Basin

Sector	By GRDP(1985)	By Employment (1980)
Agriculture	47 %	73 %
Industry	15 %	8 %
Service	38 %	19 %

(6) Land Use of Drainage Basin (1984)

Agricultural Land	:	5,300 km^2	(19.4 %)
Forest	:	11,500 km^2	(42.1 %)
Idle Grassland	:	5,500 km^2	(20.1 %)
Bare Land/Swamp	:	4,950 km^2	(18.1 %)
Residential Area	:	50 km^2	(0.2 %)
Total	:	27,300 km^2	(100 %)

1.3 Potential Flood Damage of Drainage Basin

(1) Flooded Area : 1,860 km^2

(2) Affected Population : no data

(3) Probable Flood Damage

a) 25-year : P 10,490 million = $ 552.1 million (1985)

b) 100-year : P 13,004 million = $ 684.4 million (1985)

c) Average Annual : P 3,793 million = $ 199.6 million (1985)

1.4 Probable Flood Discharge

At River Mouth (27,300 km^2)

(1) 25-year :15,900 m^3/s (specific discharge : 0.6 m^3/s/km^2)

(2) 100-year : 21,600 m^3/s (specific discharge : 0.8 m^3/s/km^2)

1.5 Design Flood Discharge Probability

Plan	Probable Year	Remarks
Framework Plan	100-year	Full-scale plan. Implementation period is not specified.
Long-term Plan	25-year	Scaled down plan. Implementation period is not specified.
Master Plan	25-year	Consisting of priority projects selected from the long-term plan. To be achieved within 20 years.
Short-term Plan	25-year	Ist stage of the master plan to be achieved within 10 years.

1.6 Project Cost of Master Plan

(1) River channel improvement	:	P 5,766 million
(2) Allocated multipurpose dam	:	P 1,671 million
Total	:	P 7,437 million = $ 391.4 million (1985)

1.7 Progress of Project

The conduct of the feasibility study is under consideration.

Note: Exchange Rate: $ 1.00 = P18.0 = Y 234.0 (1984)
$ 1.00 = P19.0 = Y 200.0 (1985)

2 AGNO RIVER

2.1 Study Report

Study on Agno River Basin Flood Control , Dec. 1991, by JICA

2.2 Project Area

(1) Drainage Basin : 7,640 km^2

a) Agno River : 5,907 km^2

b) Related Rivers : 1,733 km^2

(2) Number of Municipalities of Drainage Basin : 83

(3) Population of Drainage Basin

a) Total Population : 2,324,000 (1987)

b) Population Density : 304 persons/km^2 (1987)

c) Ratio of Urban Population to Total : 26 % (1980)

(4) GRDP of Drainage Basin

a) Per Capita : P 7,539 = $ 367 (1987)

b) Total : P 17,521 million = $ 855 million (1987)

(5) Sectoral Structure of Drainage Basin

Sector	By GRDP (1987)	By Employment (1987)
Agriculture	37 %	51 %
Industry	26 %	15 %
Service	37 %	34 %

(6) Land Use of Drainage Basin (1987)

Agricultural Land	:	2,283 km^2	(30 %)
Forest & Others	:	5,357 km^2	(70 %)
Total	:	7,640 km^2	(100 %)

2.3 Potential Flood Damage of Drainage Basin

(1) Flooded Area : 2,465 km^2

(2) Affected Population : 1,457,000 (1987)

(3) Probable Flood Damage

a) 25-year : P 3,299 million = $ 155 million (1989)

b) 100-year : P 4,700 million = $ 221 million (1989)

c) Average Annual : P 1,262 million = $ 59 million (1989)

2.4 Probable Flood Discharge

Agno Main River at River Mouth (5,907 km^2)

(1) 25-year : 11,220 m^3/s (specific discharge : 1.9 m^3/s/km^2)

(2) 100-year : 17,310 m^3/s (specific discharge : 2.9 m^3/s/km^2)

2.5 Design Flood Discharge Probability

Plan	Probable Year	Remarks
Framework Plan	100-year	Full-scale plan. Implementation period is not specified.
Long-term Plan	25-year	Feasible scale plan. To be achieved within 20 years.
Short-term Plan	10-year	Priority projects. To be achieved within 10 years.

Note : Long-term plan is considered to correspond to master plan.

2.6 Project Cost

(1) Long -term Plan : P 15,974 million = $ 750 million (1989)

(2) Priority Projects : P 7,809 million = $ 281 million (1991)

2.7 Progress of Project

Priority projects are in the pre-construction phase, financed by the OECF.

Note : Exchange Rate : $ 1.00 = P 20.5 = Y 142.0 (1987)
$ 1.00 = P 21.3 = Y 132.0 (1989)
$ 1.00 = P 27.8 = Y 139.0 (1991)

3. PAMPANGA RIVER

3.1 Study Report

Feasibility Report on the Pampanga Delta Development Project, Feb. 1982, by JICA

3.2 Project Area

(1) Project Area

a) Pampanga- Pasag River Drainage Basin : 10,503 km^2

b) Project Area (Pampanga Delta Development Project) : 3,200 km^2

(2) Number of Municipalities of Project Area : 12

(3) Population of Project Area

a) Total Population : 1,792,000 (1980)

b) Population Density : 599 persons/km^2 (1980)

(4) GRDP of Central Luzon (Pampanga, Tarlac, Bataan, Nueva Ecija and Bulacan Provinces covering the drainage basin)

a) Per Capita : P 1,368 = $ 185 (1976)

b) Total : P 6,222 million = $ 841 million (1976)

(5) Sectoral Structure of Central Luzon

Sector	By GRDP (1976)	By Employment (1976)
Agriculture	37 %	43 %
Industry	35 %	27 %
Service	28 %	28 %

(6) Land Use of Project Area (1976)

Farm Land (Paddy Field)	:	1,015 km^2	(32 %)
(Sugar Cane and Other Crops)	:	245 km^2	(8 %)
Land such as Fishpond, Residential, Non-Arable, etc.	:	1,940 km^2	(60 %)
Total	:	3,200 km^2	(100 %)

3.3 Potential Flood Damage of Project Area

(1) Flooded Area : 1,448 km^2

(2) Affected Population : no data

(3) Probable Flood Damage : no data

3.4 Probable Flood Discharge

At Sulipan (8,907 km^2)

(1) 20-year : 4,779 m^3/s (specific discharge :0.54 $m^3/s/km^2$)

(2) 100-year : 7,039 m^3/s (specific discharge : 0.79 $m^3/s/km^2$)

3.5 Design Flood Discharge Probability

Plan	Probable Year	Remarks
Basic Plan	100-year	Implementation period is not specified.
Stepwise Plan	20-year	To be achieved within 10 years.

Note : Basic plan is considered to correspond to framework plan.

3.6 Project Cost

(1) Basic Plan : P 1,081 million = $ 144 million (1981)

(2) Stepwise Plan : P 797 million = $ 106 million (1981)

3.7 Progress of Project

Priority projects are under construction with OECF fund.

Note : Exchange Rate : $ 1.00 = P 7.4 = Y 292 (1976)

$ 1.00 = P 7.5 = Y 225 (1981)

4 MT. PINATUBO

4.1 Study Report

The Study on Flood and Mudflow Control for Sacobia-Bamban / Abacan River Draining from Mt. Pinatubo, Mar. 1996, by JICA

4.2 Project Area

(1) Project Area

a) Project Area (covering drainage basin and flood area) : 1,296 km^2

b) Drainage Basin of River : 322 km^2

(2) Number of Cities & Municipalities of Project Area : 1 & 8

(3) Population of Project Area

a) 736,100 (1990)

b) Population Density : 568 persons/km^2

c) Ratio of Urban Population to Total : 59 %

(4) GRDP of Project Area :

a) Per Capita : P 13,600 = $ 486 (1990)

b) GRDP: P 10,011 million = $ 358 million (1990)

(5) Sectoral Structure of Project Area

Sector	By GRDP(1990)	By Employment(1990)
Agriculture	24 %	39 %
Industry	37 %	no data
Service	39 %	no data

(6) Land Use of Project Area

Agricultural Land	:	528 km^2	(41 %)
Residential Area	:	158 km^2	(12 %)
Others	:	610 km^2	(47 %)
Total	:	1,296 km^2	(100 %)

4.3 **Potential Flood Damage of Project Area**

(1) Flooded Area : 393 km^2

(2) Affected Population : 204,900 (1994)

(3) Probable Flood Damage

a) 20-year : P 1,077 million = $ 43.1 million (1994)

b) 100-year : P 1,808 million = $ 72.3 million (1994)

c) Average Annual : P 278 million = $ 11.1 million (1994)

4.4 **Probable Flood Discharge**

(1) Sacobia-Bamban River (245 km^2)

a) 20-year :1,110 m^3/s (specific discharge : 4.5 $m^3/s/km^2$)

b) 100-year : 1,610 m^3/s (specific discharge : 6.6 $m^3/s/km^2$)

(2) Abacan River (77 km^2)

a) 20-year : 520 m^3/s (specific discharge : 6.7 m^3/s)

b) 100-year : 710 m^3/s (specific discharge : 9.2 m^3/s)

4.5 **Design Flood Discharge Probability**

Plan	Probable Year	Remarks
Long-term Plan	-	Not including flood/mudflow control plan.
Proposed Plan	20-year	To be achieved within 10 years.

4.6 Project Cost of Proposed Plan

P 2,996 million = $ 120 million (1994)

4.7 Progress of Project

Detailed Engineering Design is being conducted with OECF fund.

Note: Exchange Rate : $ 1.00 = P 28 = Y 130 (1990)
$ 1.00 = P 25 = Y 100 (1994)

5 PASIG RIVER

5.1 Study Report

The Study on Flood Control and Drainage Project in Metro Manila, Mar. 1990, by JICA

5.2 Project Area

(1) Project Area

a) Drainage Basin : 4,678 km^2

b) Project Area : 981 km^2

(2) Number of Cities & Municipalities of Project Area : 7 & 10

(3) Population of Project Area

a) Total Population : 5,925,884 (1980)

b) Population Density : 6,040 persons / km^2 (1980)

c) Ratio of Urban Population to Total : mostly urbanized

(4) GRDP of Project Area

a) Per Capita : P 4,495 = $ 219 (1986)

b) Total : P 26,631 million = $ 1,299 million (1986)

(5) Sectoral Structure of Project Area

Sector	By GRDP (1986)
Agriculture	0 %
Industry	50 %
Service	50 %

(6) Land Use of Project Area

Residential Land	:	220 km^2 (22 %)
Industrial Land	:	38 km^2 (4 %)
Agricultural Land	:	11 km^2 (1 %)
Open Space	:	122 km^2 (13 %)
Fishpond / Paddy Field	:	106 km^2 (11 %)
Forest	:	484 km^2 (49 %)
Total	:	981 km^2 (100 %)

5.3Potential Flood Damage of Project Area

(1) Flooded Area : 110 km^2

(2) Affected Population : 1,100,000 (1982)

(3) Probable Flood Damage

a) 30-year : P 2,953 million = $ 139 million (1988)

b) 50-year : P 3,287 million = $ 154 million (1988)

c) 100-year : P 3,604 million = $ 169 million (1988)

5.4 Probable Flood Discharge

Pasig River at Mouth (4,678 km^2)

(1) 30-year : 1,200 m^3/s (specific discharge : 0.26 $m^3/s/km^2$)

(2) 50-year : 1,300 m^3/s (specific discharge : 0.28 $m^3/s/km^2$)

(3) 100-year : 1,450 m^3/s (specific discharge : 0.30 $m^3/s/km^2$)

5.5 Design Flood Discharge Probability

Plan	Probable Year	Remarks
Framework Plan	100-year	Implementation period is not specified.
Master Plan	100-year for flood control 5-year for drainage	To be achieved within 30 years.
Priority Projects	30-year for flood control 5-year for drainage	To be achieved within 10 years.

5.6 Project Cost

(1) Master Plan

a)	Pasig- Marikina River Improvement	: P 4,413 million
b)	Other River Improvement	: P 2,977 million
c)	Drainage Improvement	: P 6,133 million
	Total	: P 13,523 million= $ 635 million (1988)

(2) Priority Projects

a)	Pasig - Marikina River Improvement	: P 1,401 million
b)	Malabon - Navotas Drainage Improvement	: P1,115 million
c)	East and West Mangahan Drainage Improvement	: P 2,812 million
	Total	: P 5,328 million = $ 250 million (1988)

5.7 Progress of Project

Detailed engineering design of the East and West Mangahan Drainage Improvement Project was already completed. Financing of the west side area of the Project is under consideration by OECF.

Note : Exchange Rate : \$ 1.00 = P 21.3 = Y 132 (1988)
\$ 1.00 = P 20.5 = Y 166 (1986)

6 MAYON VOLCANO

6.1 Study Report

(1) Master Plan for Mayon Volcano Sabo and Flood Control Project, Mar. 1981, by JICA

(2) Re-study of Mayon Volcano Sabo and Flood Control Project, Mar. 1983, by JICA

6.2 Project Area

(1) Drainage Basin : 699 km^2

(2) Number of City & Municipalities of Drainage Basin : 1 & 22

(3) Population of Drainage Basin

a) Total Population : 419,000 (1980)

b) Population Density : 599 persons / km^2

c) Ratio of Urban Population to Total : 20 %

(4) GRDP of Drainage Basin

a) Per Capita : P 920 = \$ 115 (1980)

b) GRDP : P 385 million = \$ 48 million (1980)

(5) Sectoral Structure of Drainage Basin

Sector	By GRDP(1980)	Employment(1980)
Agriculture	52 %	58 %
Industry	no data	14 %
Service	no data	28 %

(6) Land Use of Drainage Basin (1980)

Agricultural Land	: 447 km^2	(64 %)
Forest	: 102 km^2	(15 %)
Grassland	: 77 km^2	(11 %)
Residential and Others	: 73 km^2	(10 %)
Total	: 699 km^2	(100 %)

6.3 Potential Flood Damage of Drainage Basin

(1) Flooded Area : 184 km^2

(2) Affected Population : 69,700 (1980)

(3) Probable Flood Damage

Largest Records : P 49 million = \$ 6.5 million (1981)

6.4 Probable Flood Discharge

At Quinali River (524 km^2)

50-year : 4,260 m^3/s (specific discharge : 8.1 $m^3/s/km^2$)

6.5 Design Flood Discharge Probability

Plan	Probable Year	Remarks
Master Plan	50-year	To be achieved within 10 years.

6.6 Project Cost of Master Plan

(1) Sabo Works : P 317.4 million = $ 36 million

(2) River Improvement : P 1,783.1 million = $ 203 million

Total : P 2,100.5 million = $ 239 million (1982)

6.7 Progress of Project

Some urgent sabo works were implemented with local funds.

Note : Exchange Rate : $ 1.00 = P 8.0 = Y 240 (1980)
$ 1.00 = P 7.5 = Y 225 (1981)

7 PANAY RIVER

7.1 Study Report

The Panay River Basin-wide Flood Control Study, Nov. 1985, by JICA

7.2 Project Area

(1) Drainage Basin : 2,181 km^2

(2) Number of Cities & Municipalities of Drainage Basin : 1 & 16

(3) Population of Drainage Basin

- a) Total Population : 447,800 (1980)
- b) Population Density : 187 persons / km^2 (1980)
- c) Ratio of Urban Population to Total : 14 %

(4) GRDP of Drainage Basin

- a) Per Capita : P 5,952 = $ 531 (1983)
- b) GRDP : P 2,665 million = $ 240 million (1983)

(5) Sectoral Structure of Drainage Basin

Sector	By GRDP(1983)	By Employment(1983)
Agriculture	38 %	61 %
Industry	29 %	no data
Service	33 %	no data

(7) Land Use of Drainage Basin (1983)

Agricultural Land	:	1,056 km^2 (48 %)
Forest & Shrub	:	986 km^2 (45 %)
Fishpond & Swamp	:	124 km^2 (6 %)
Residential Area	:	15 km^2 (1 %)
Total	:	2,181 km^2(100 %)

7.3 Potential Flood Damage of Drainage Basin

(1) Flooded Area : 338 km^2

(2) Affected Population : 121,000 (1980)

(3) Probable Flood Damage

a) 25-year : P 382 million = $ 21.2 million (1984)

b) 100-year : P 590 million = $ 32.8 million (1984)

c) Average Annual : P 104 million = $ 5.8 million (1984)

7.4 Probable Flood Discharge

At River Mouth(2,181 km^2)

(1) 10-year : 1,370 m^3/s (specific discharge : 0.6 $m^3/s/km^2$)

(2) 25-year : 1,830 m^3/s (specific discharge : 0.8 $m^3/s/km^2$)

(3) 100-year : 2,670 m^3/s (specific discharge : 1.2 $m^3/s/km^2$)

7.5 Design Flood Discharge Probability

Plan	Probable Year	Remarks
Long-term Plan	100-year	Targeting 45 years after but implementation period is not specified.
Mid-term Plan	25-year	To be achieved within 30 years.
Short-term Plan	10-year	To be achieved within 10 years.

Note : Long-term plan and mid-term plan are considered to correspond to frame-work plan and master plan respectively.

7.6 Project Cost

(1) Long-term Plan : P 5,027 million = $ 279.3 million (1984)

(2) Mid-term Plan : P 1,541 million = $ 85.6 million (1984)

(3) Short-term Plan : P 955 million = $ 53.1 million (1984)

7.7 Progress of Project

The conduct of the feasibility study is under consideration.

Note : Exchange Rate : $ 1.00 = P 11.2 = Y 237 (1983)
$ 1.00 = P 18 = Y 234 (1984)

8 AGUSAN RIVER

8.1 Study Report

Lower Agusan Development Project, Review Report, Dec. 1982 , by DPWH with OECF Fund

8.2 Project Area

(1) Project Area

a) Drainage Basin : 11,400 km^2

b) Project Area : 199 km^2

(2) Number of Cities & Municipalities of Project Area : 1 & 1

(3) Population of Project Area

a) Total Population : 134,000 (1980)

b) Population Density : 673 persons / km^2

c) Ratio of Urban Population to Total : mostly

(4) GRDP of Project Area

a) Per Capita : P 5,889 = $ 669 (1980 at 1982 price)

b) Total : P 789 million = $ 90 million (1980 at 1982 price)

(5) Sectoral Structure of Project Area

Sector	By GRDP(1980)	By Employment(1980)
Agriculture	no data	46 %
Industry	42 %	no data
Service	no data	no data

(6) Land Use of Project Area (1982)

Agricultural Land	:	121 km^2 (61 %)
Potential Agricultural Land	:	29 km^2 (14 %)
Grassland	:	19 km^2 (9 %)
River & Mangrove	:	15 km^2 (8 %)
Residential Area	:	15 km^2 (8 %)
Total	:	199 km^2(100 %)

8.3 Potential Flood Damage of Project Area

(1) Flooded Area : 79 km^2

(2) Affected Population : 115,000 (1980)

(3) Probable Flood Damage

a) 100-year : P 109 million = $ 12.4 million (1982)

b) Average Annual : P 83 million = $ 9.4 million (1982)

8.4 Probable Flood Discharge

Agusan River at River Mouth (11,400 km^2)

(1) 30-year : 6,000 m^3/s (specific discharge : 0.5 $m^3/s/km^2$)

(2) 100-year : 8,000 m^3/s (specific discharge : 0.7 m^3/s/km^2)

8.5 Design Flood Discharge Probability

Plan	Probable Year	Remarks
Basic Plan	100-year	Implementation period is not specified.
Proposed Plan	30-year	To be achieved within 10 years.

Note : Basic plan is considered to correspond to framework plan.

8.6 Project Cost of Proposed Plan

(1) Stage I : P 557 million = $ 63 million (1982)

(2) Stage II: P 177 million = $ 20 million (1982)

Total : P 734 million = $ 83 million (1982)

8.7 Progress of Project

Detailed engineering design was completed with OECF fund. Construction of Stage I is on-going, with OECF financing.

Note : Exchange Rate : $ 1.00 = P 8.8 = Y 265 (1982)

9 ILOG-HILABANGAN RIVER

9.1 Study Report

Study on Ilog -Hilabangan River Basin Flood Control Project, March 1991, by JICA

9.2 Project Area

(1) Drainage Basin : 2,162 km^2

(2) Number of Municipalities of Drainage Basin : 4

(3) Population of Drainage Basin

a) Total Population : 347,000(1990)

b) Population Density : 160 persons / km^2

c) Ratio of Urban Population to Total : 20 %

(4) GRDP of Drainage Basin

a) Per Capita : P 13,500 = $ 620 (1989)

b) Total : P 4685 million = $ 215 million (1989)

(5) Sectoral Structure of Drainage Basin

Sector	By GRDP(1989)
Agriculture	32 %
Industry	25 %
Service	43 %

(6) Land Use of Drainage Basin (1990)

Agricultural Land	:	1,072 km^2 (49 %)
Grassland	:	537 km^2 (25 %)
Forest & Shrub	:	448 km^2 (21 %)
Fishpond, River and Swamp	:	70 km^2 (3 %)
Residential Area	:	35 km^2 (2 %)
Total	:	2,162 km^2 (100 %)

9.3 Potential Flood Damage of Drainage Basin

(1) Flooded Area : 120 km^2

(2) Affected Population : 47,000 (1990)

(3) Probable Flood Damage

100-year : P 406 million = $ 14.5 million (1990)

9.4 Probable Flood Discharge

At the Confluence of Ilog and Hilabangan Rivers (1,960 km^2)

(1) 25-year : 3,690 m^3/s (specific discharge : 1.9 $m^3/s/km^2$)

(2) 100-year : 5,430 m^3/s (specific discharge : 2.8 $m^3/s/km^2$)

9.5 Design Flood Discharge Probability

Plan	Probable Year	Remarks
Master Plan	100-year	To be achieved within 20 years
Phase I Plan	25-year	To be achieved within 10 years

9.6 Project Cost of Master Plan

P 1,224 million = $ 43.7 million (1990)

9.7 Progress of Project

The conduct of the feasibility study is under consideration.

Note : Exchange Rate : $ 1.00 = P 21.8 = Y 138 (1989)
$ 1.00 = P 28 = Y 130 (1990)

10 JARO AND ILOILO RIVERS IN ILOILO CITY

10.1 Study Report

Study on the Flood Control for Rivers in the Selected Urban Centers, Feb. 1995, by JICA

10.2 Project Area

(1) Drainage Basin : 505 km^2

a) Jaro River : 412 km^2

b) Iloilo River : 93 km^2

(2) Population of Drainage Basin

a) Total Population : 309,500 (1990)

b) Population Density : 613 persons / km^2

c) Ratio of Urban Population to Total : mostly urbanized

(3) GRDP of Drainage Basin

a) Per Capita : P 18,500 = $ 680 (1993)

b) Total : P 5,720 million = $ 210 million (1993)

(4) Land Use in Iloilo City (1994)

Agricultural Land	:	29 km^2
Park / Open Spaces	:	1 km^2
Built-up Area	:	24 km^2
Others	:	2 km^2
Total	:	56 km^2

10.3 Potential Flood Damage of Drainage Basin

(1) Flooded Area : 41 km^2

(2) Affected Population : 149,000

(3) Probable Flood Damage

a) 20-year : P 1,125 million = $ 42 million (1994)

b) 50-year : P 1,378 million = $ 51 million (1994)

10.4 Probable Flood Discharge

(1) Jaro River

a) 20-year : 1,000 m^3/s (specific discharge : 2.4 $m^3/s/km^2$)

b) 50-year : 1,400 m^3/s (specific discharge : 3.4 $m^3/s/km^2$)

(2) Iloilo River

a) 20-year : 400 m^3/s (specific discharge : 4.3 $m^3/s/km^2$)

b) 50-year : 600 m^3/s (specific discharge : 6.4 $m^3/s/km^2$)

10.5 Design Flood Discharge Probability

Plan	Probable Year	Remarks
Master Plan	50-year	To be achieved within 20 years
Urgent Plan	20-year	To be achieved within 10 years

10.6 Project Cost

(1) Master Plan

a) Flood Control	:	P 2,499 million	= $ 93 million
b) Drainage	:	P 176 million	= $ 6 million
Total	:	P2,675 million	= $ 99 million (1994)

(2) Urgent Plan

a) Flood Control : P 1,322 million = $ 49 million

b) Drainage : P 166 million = $ 6 million

Total : P 1,488 million = $ 55 million(1994)

10.7 Progress of Project

Construction of urgent projects is proposed for foreign financing.

Note : Exchange Rate : $ 1.00 = P 26.9 = Y 98.8 (1994)