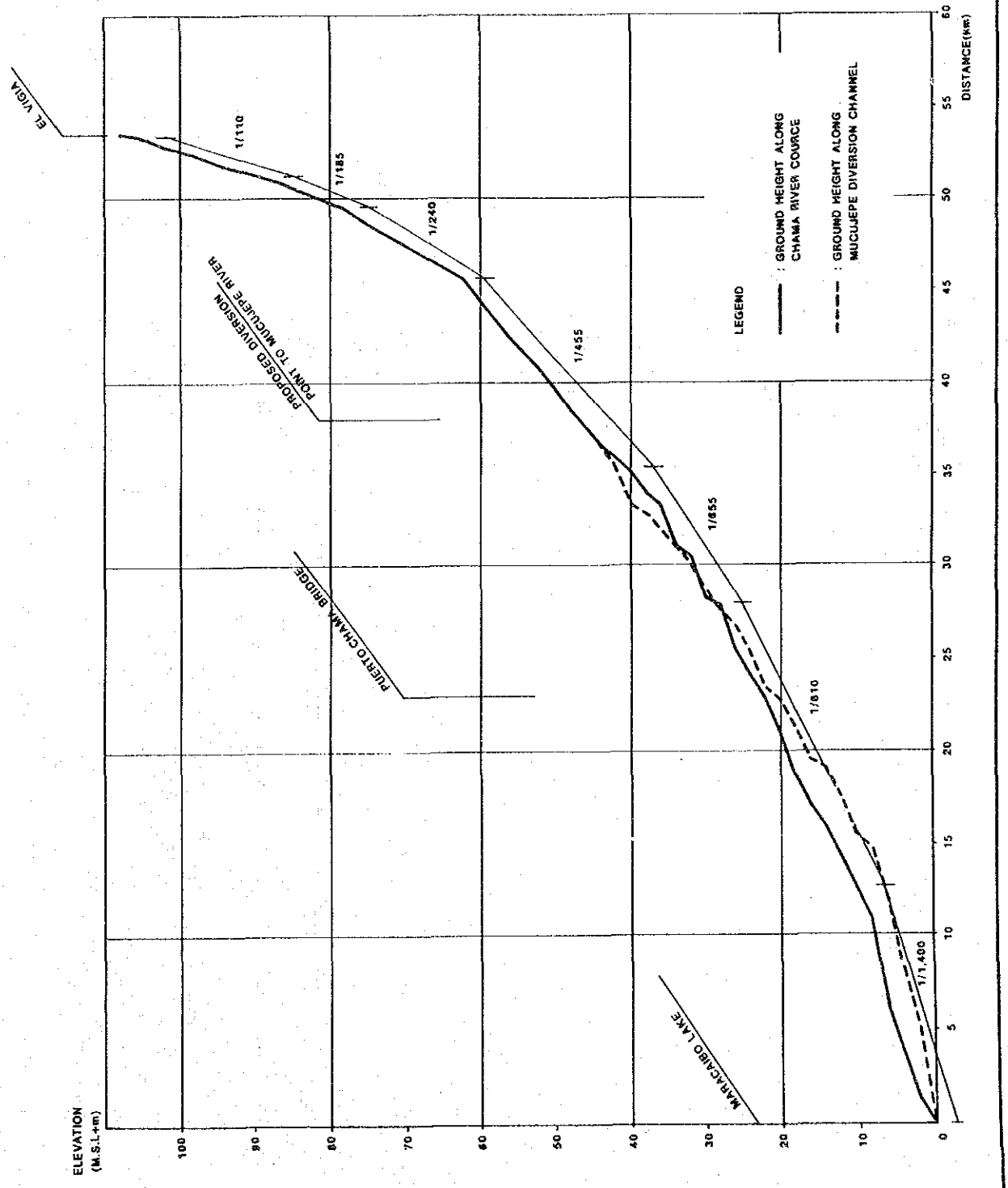
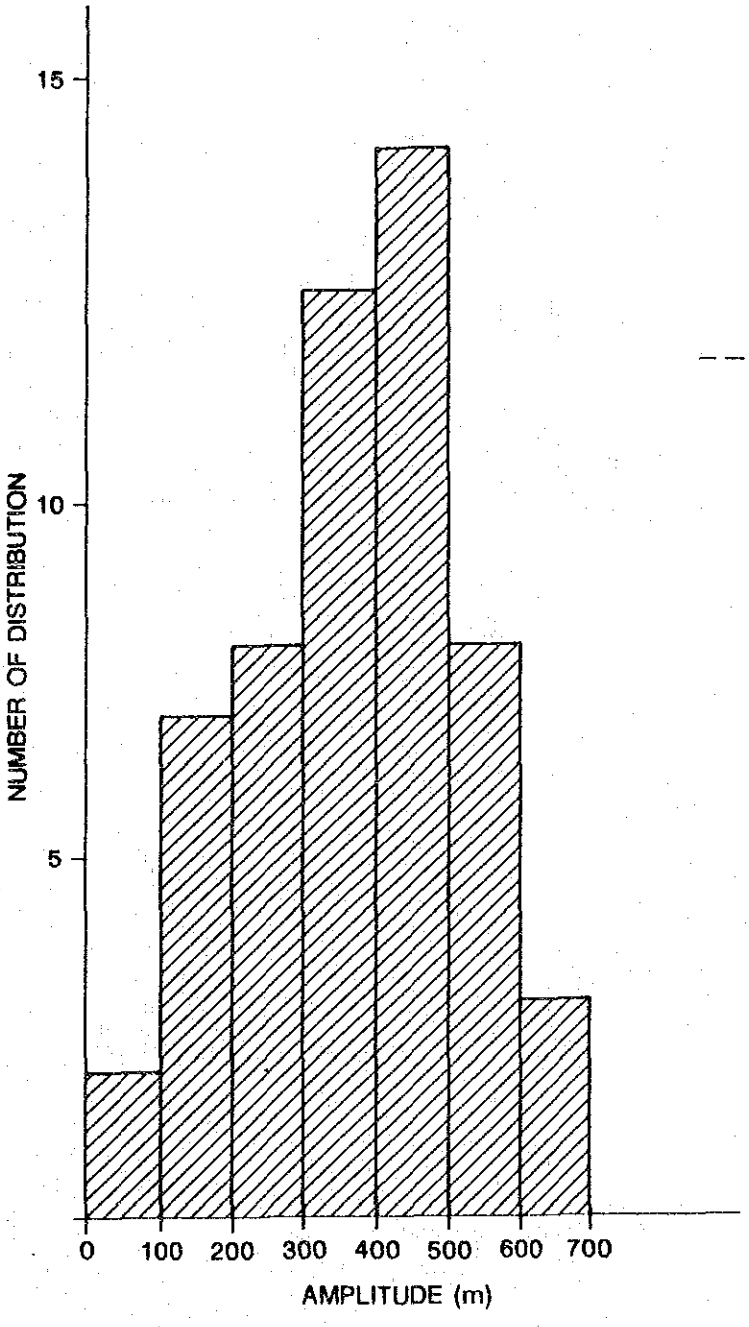


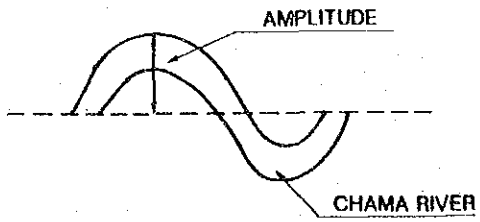
LONGITUDINAL PROFILES OF THE CHAMA RIVER AND THE MUCUJUPE DIVERSION CHANNEL

Fig. VII-14

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



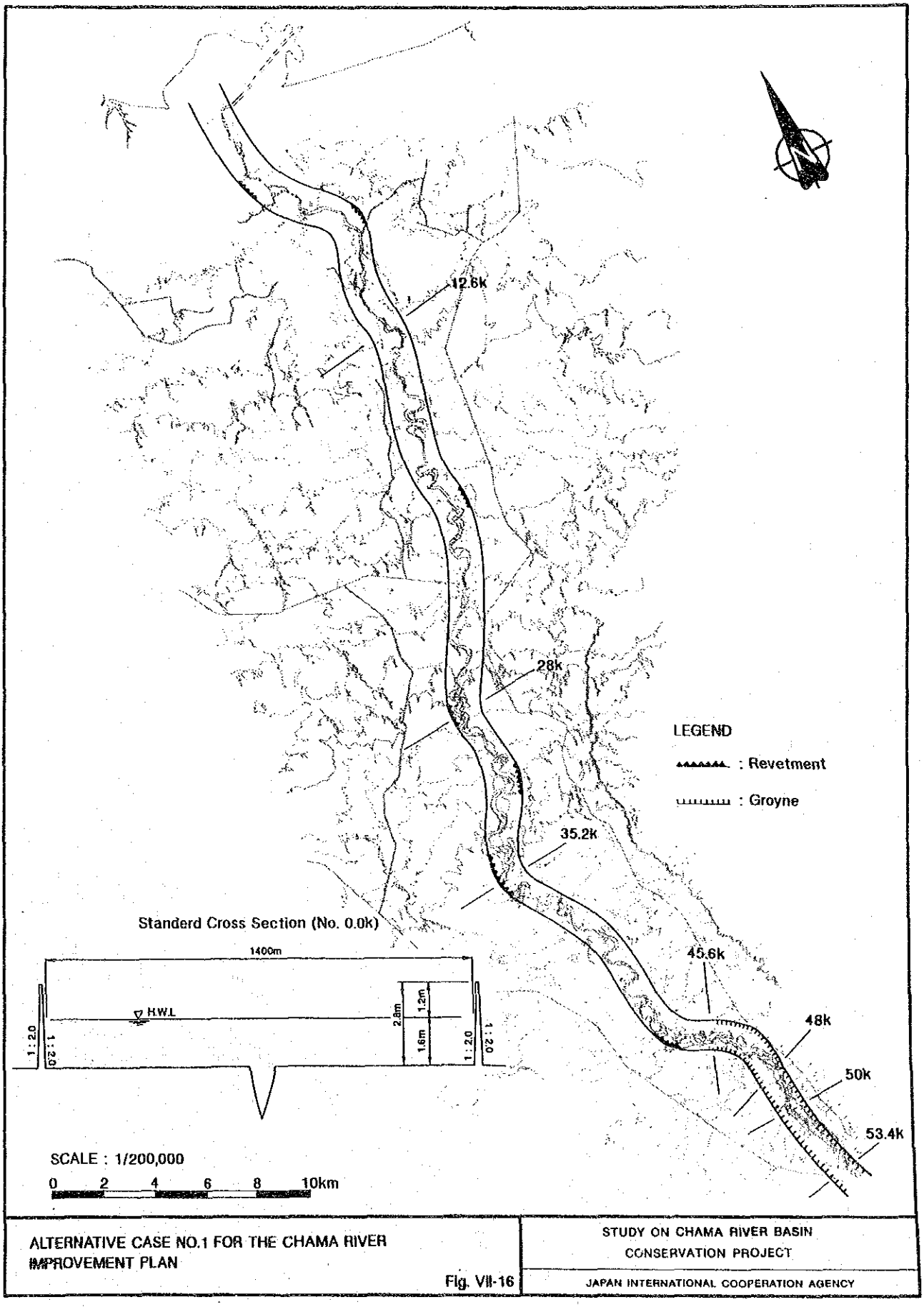


DISTRIBUTION OF MEANDERING AMPLITUDES OF THE CHAMA RIVER LOWER REACHES

Fig. VII-15

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

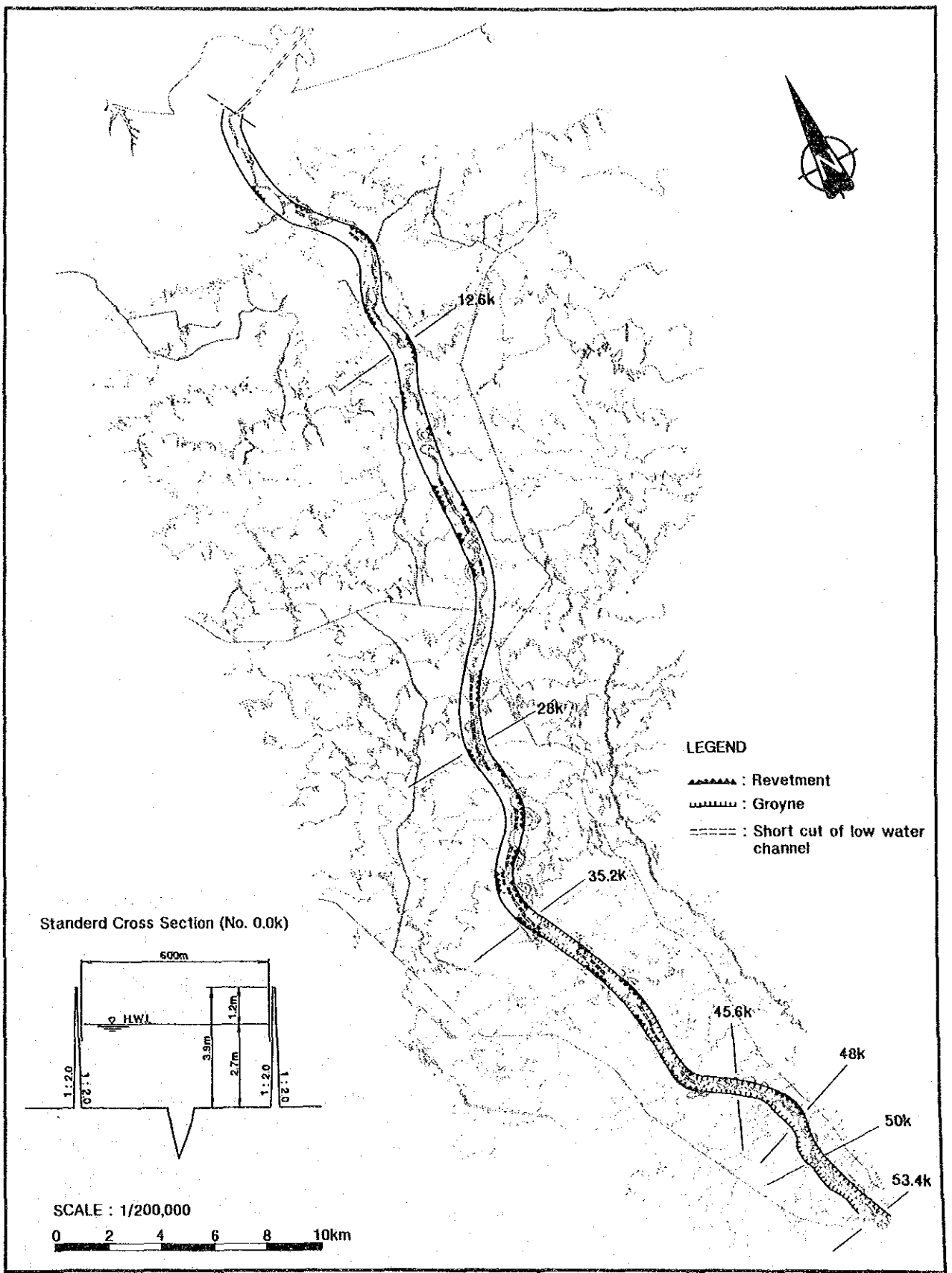


ALTERNATIVE CASE NO.1 FOR THE CHAMA RIVER IMPROVEMENT PLAN

Fig. VII-16

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

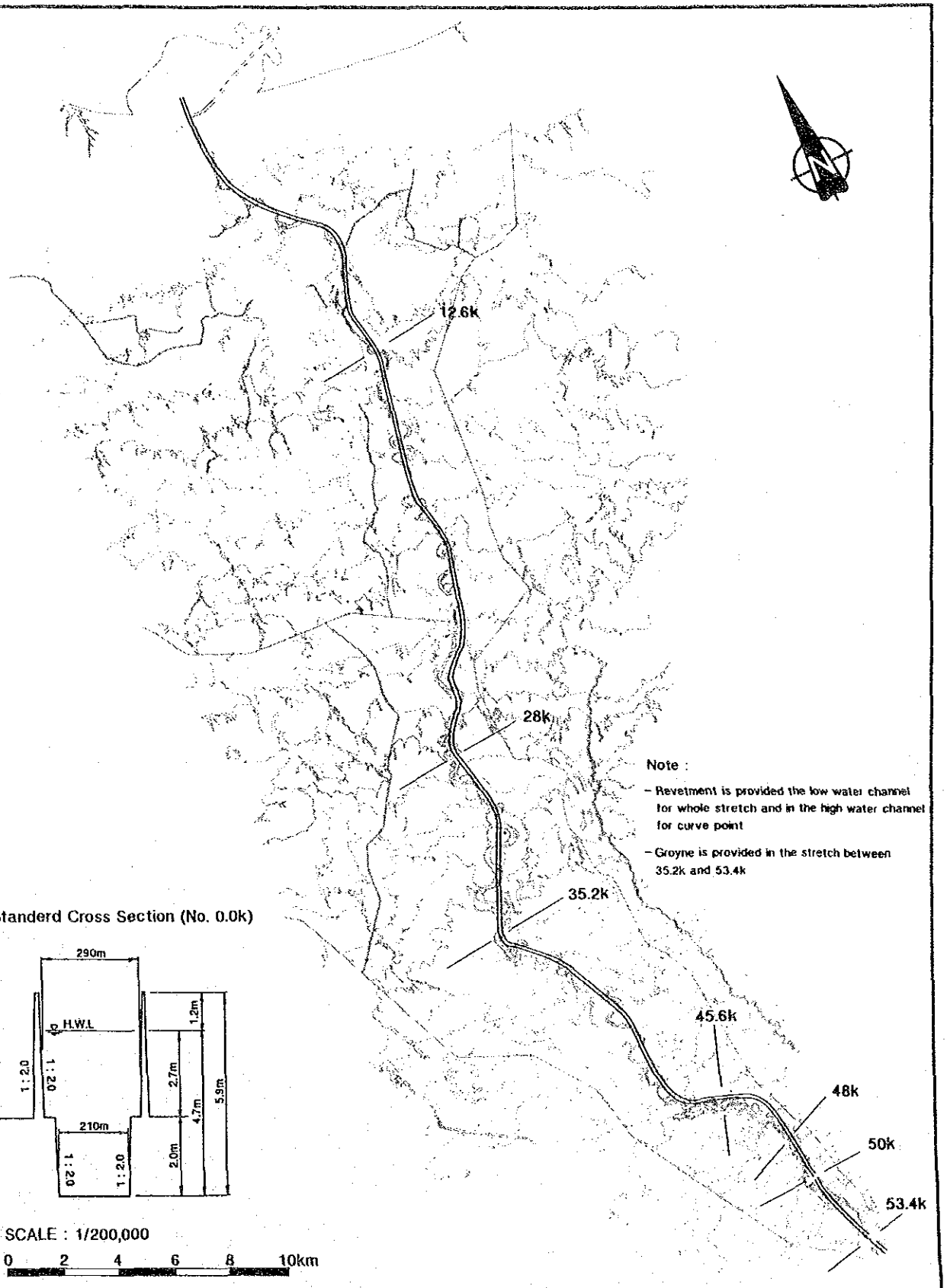


ALTERNATIVE CASE NO.2 FOR THE CHAMA RIVER IMPROVEMENT PLAN

Fig. VII-17

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

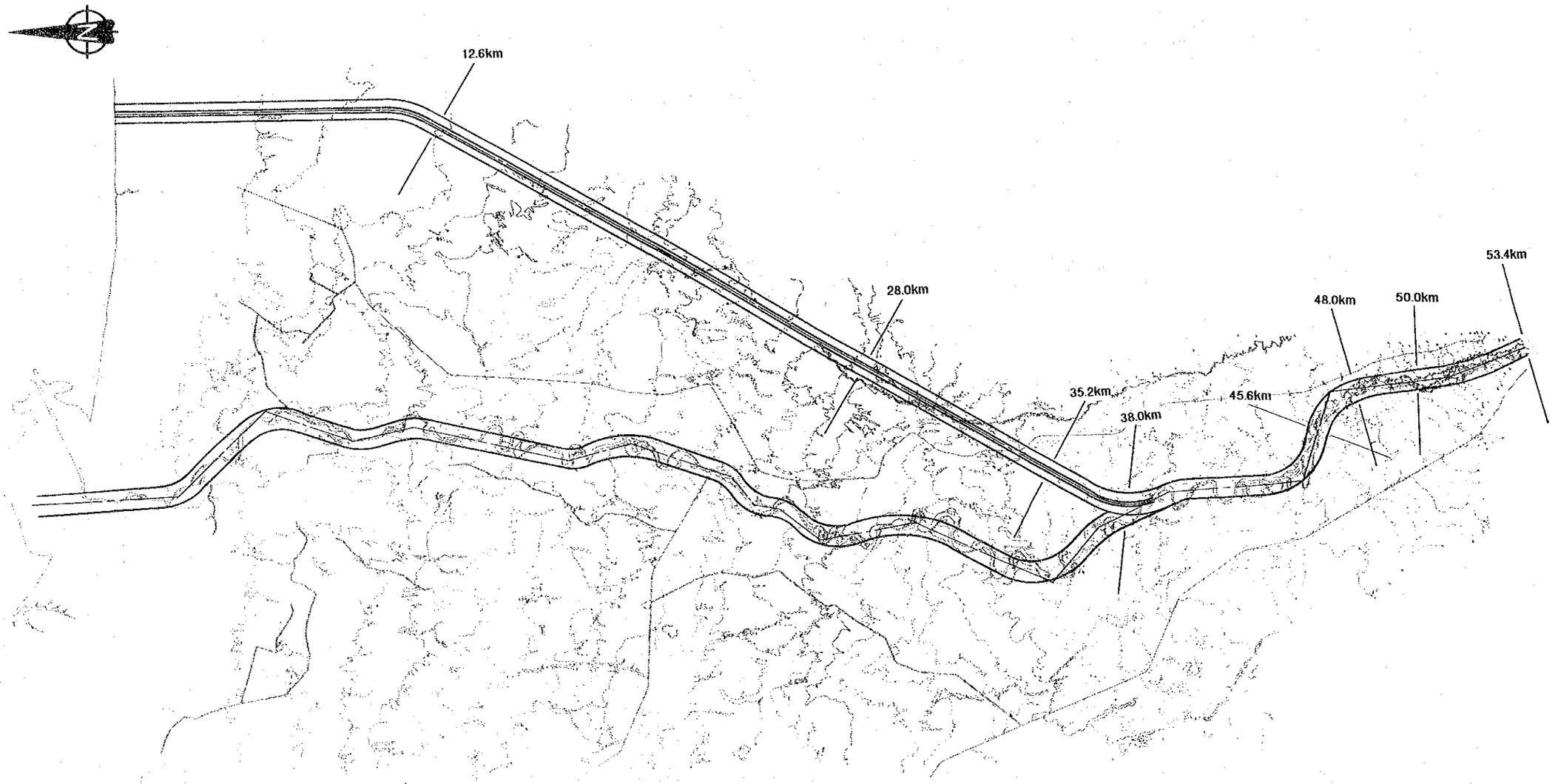


ALTERNATIVE CASE NO.3 FOR THE CHAMA RIVER IMPROVEMENT PLAN

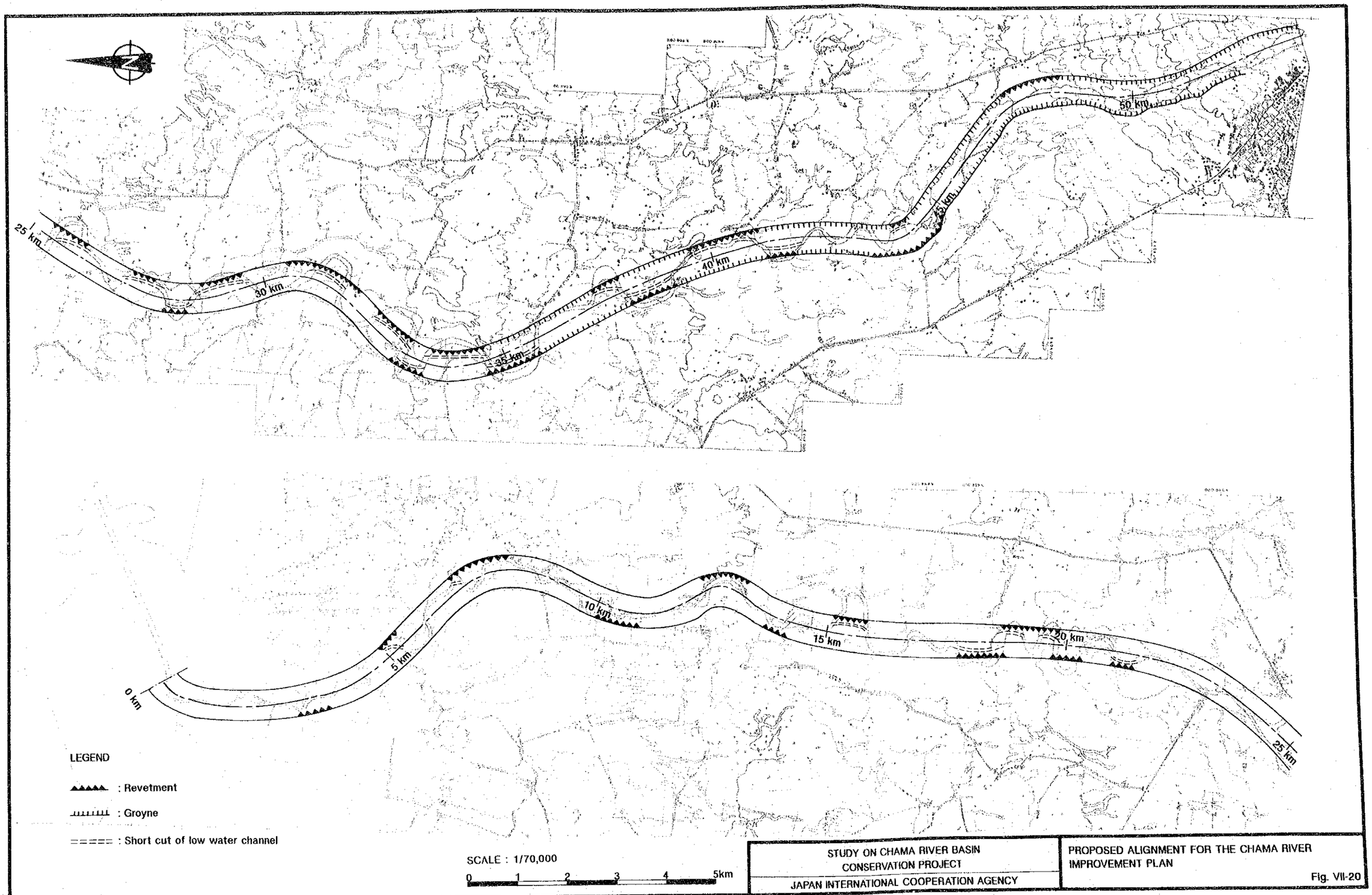
Fig. VII-18

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT	PLAN FOR THE ALTERNATIVE CASE OF THE MUCUJEPE DIVERSION CHANNEL
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VII-19

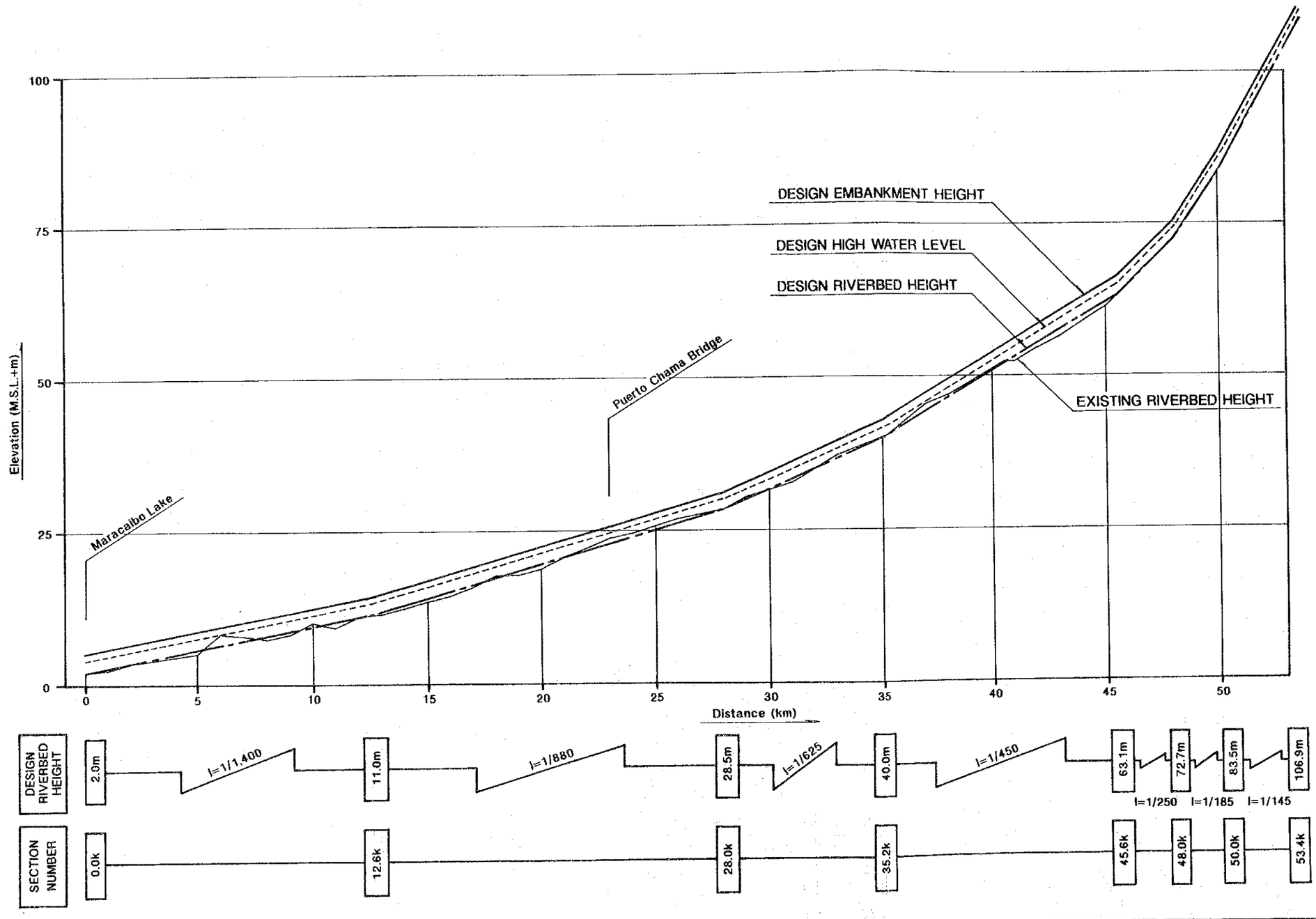


STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

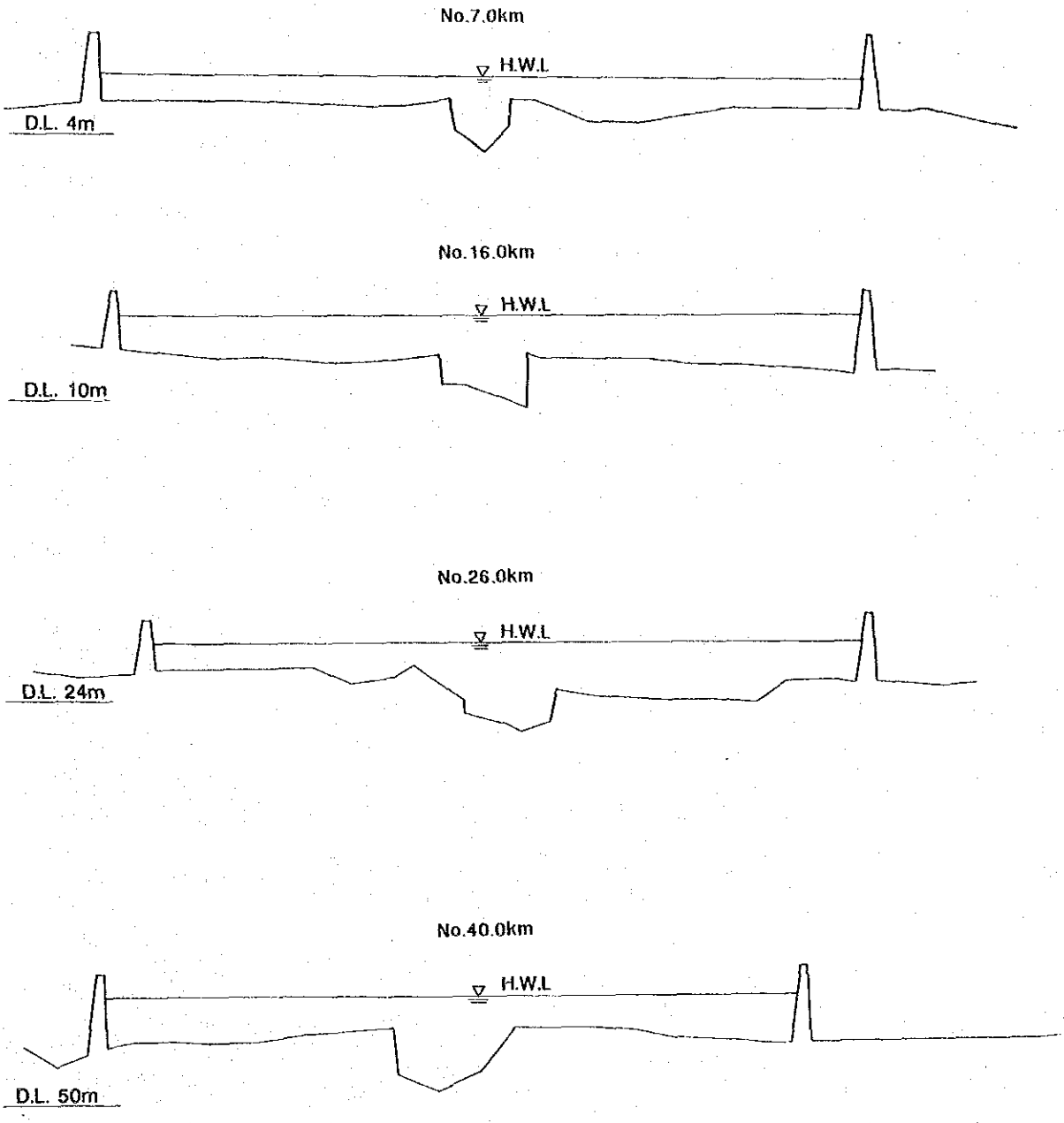
JAPAN INTERNATIONAL COOPERATION AGENCY

PROPOSED ALIGNMENT FOR THE CHAMA RIVER IMPROVEMENT PLAN

Fig. VII-20



STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY	PROPOSED LONGITUDINAL PROFILE FOR THE CHAMA RIVER IMPROVEMENT PLAN Fig. VII-21



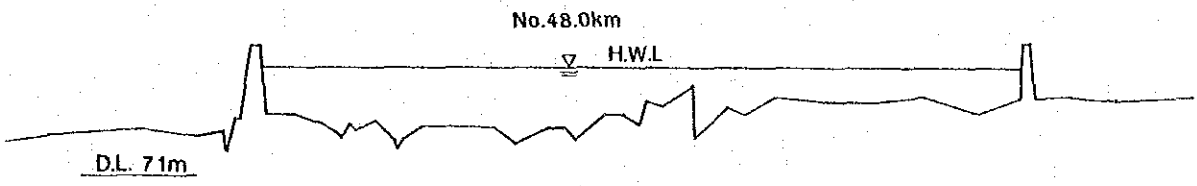
Note :
H.W.L : Design High Water Level

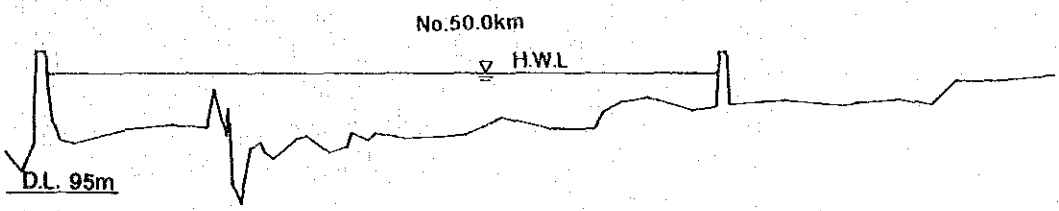
TYPICAL CROSS SECTION OF THE CHAMA RIVER IMPROVEMENT PLAN

Fig. VII-22(1/2)

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY





Note :

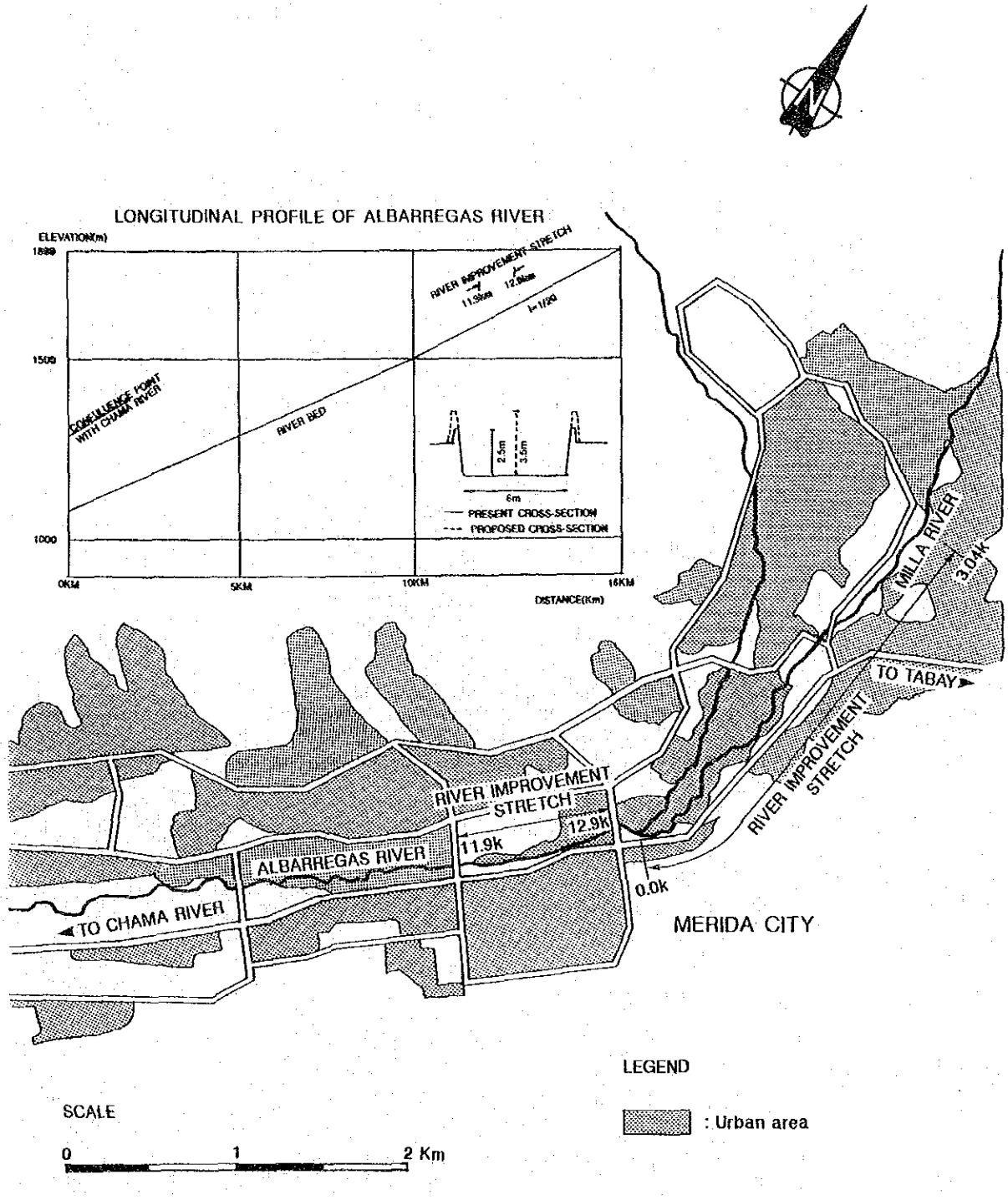
H.W.L : Design High Water Level

TYPICAL CROSS SECTION OF THE CHAMA RIVER IMPROVEMENT PLAN

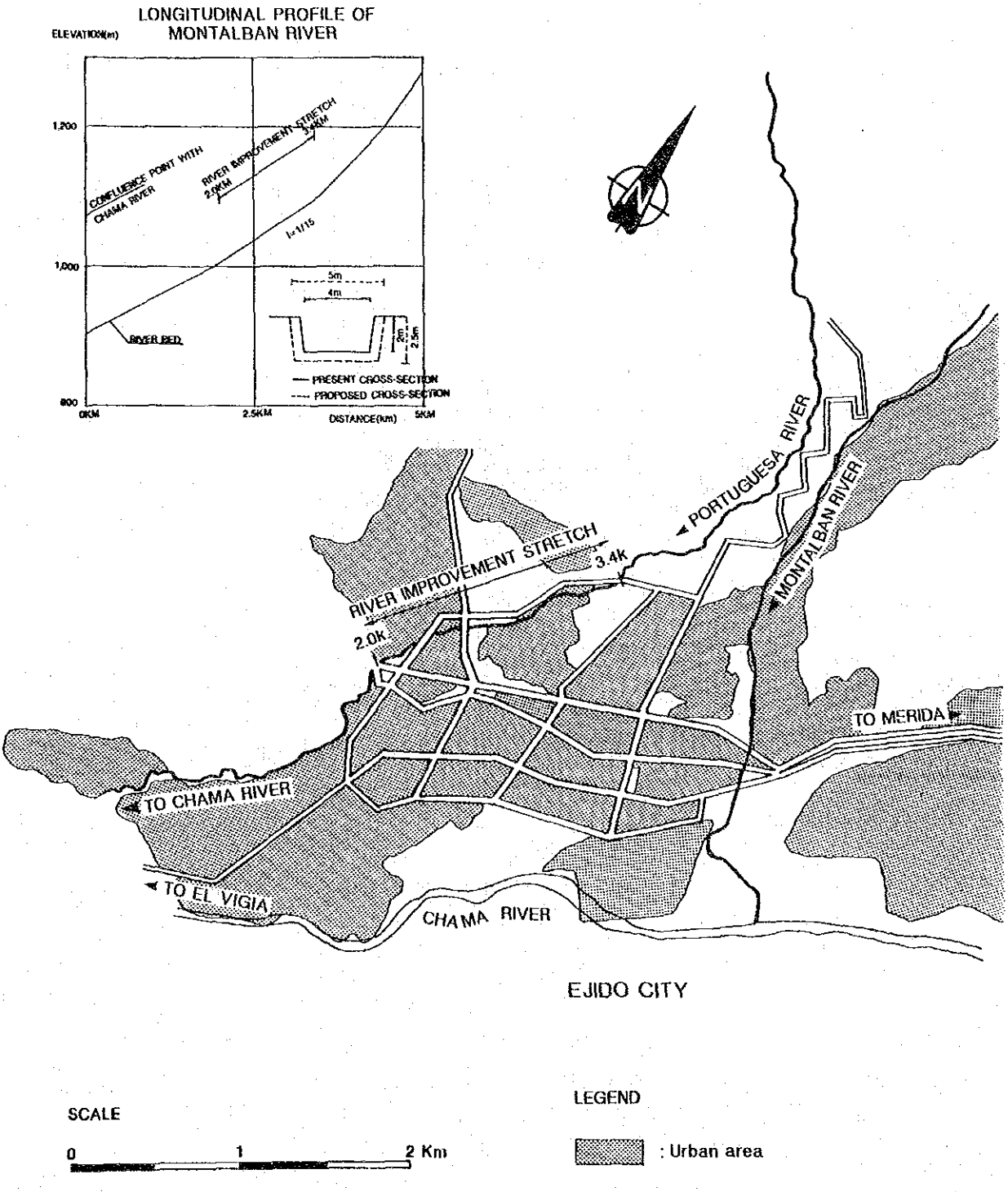
Fig. VII-22(2/2)

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



RIVER CHANNEL IMPROVEMENT PLAN FOR ALBARREGAS AND MILLA RIVER IN MERIDA CITY	STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT
Fig. VII-23	JAPAN INTERNATIONAL COOPERATION AGENCY

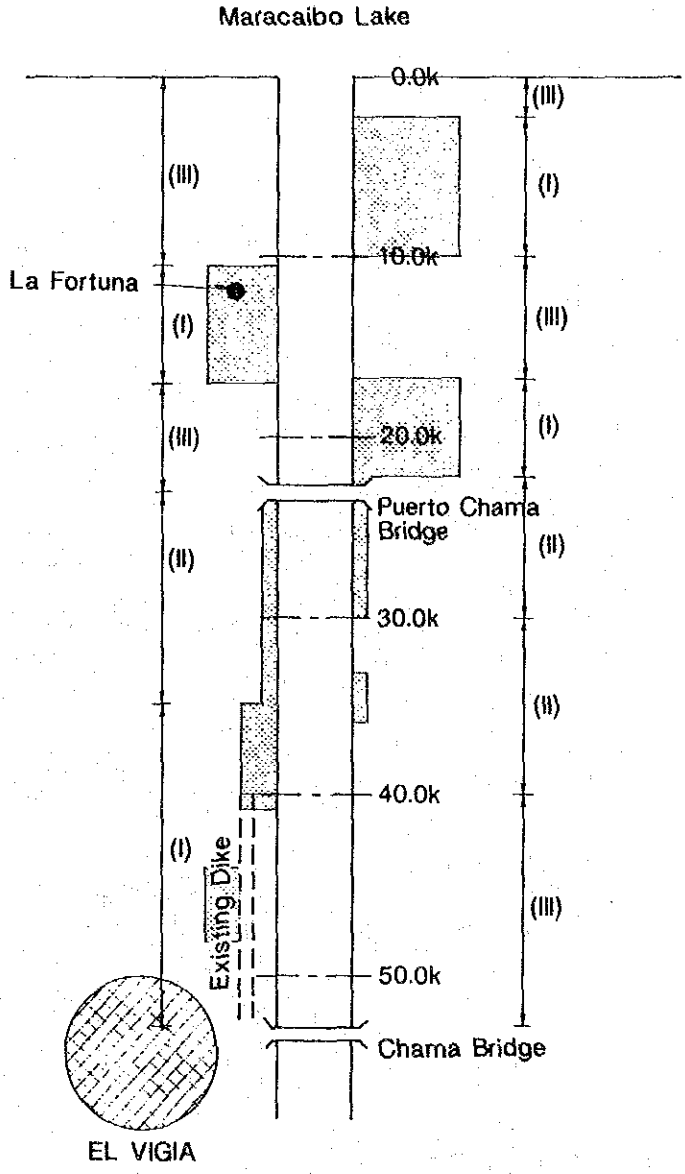


RIVER CHANNEL IMPROVEMENT PLAN FOR PORTUGUESA RIVER IN EJIDO CITY

Fig. VII-24

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

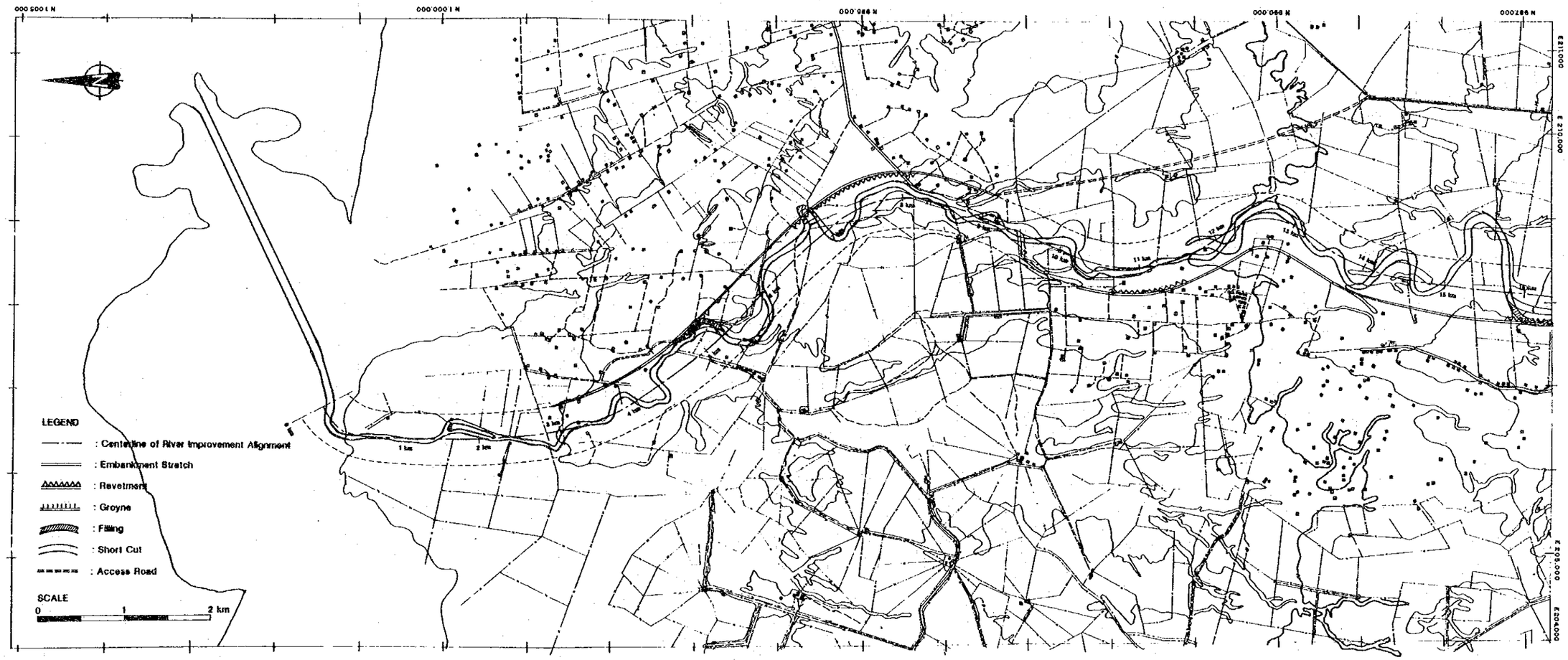
: Plantain area in flood inundation area

: Village

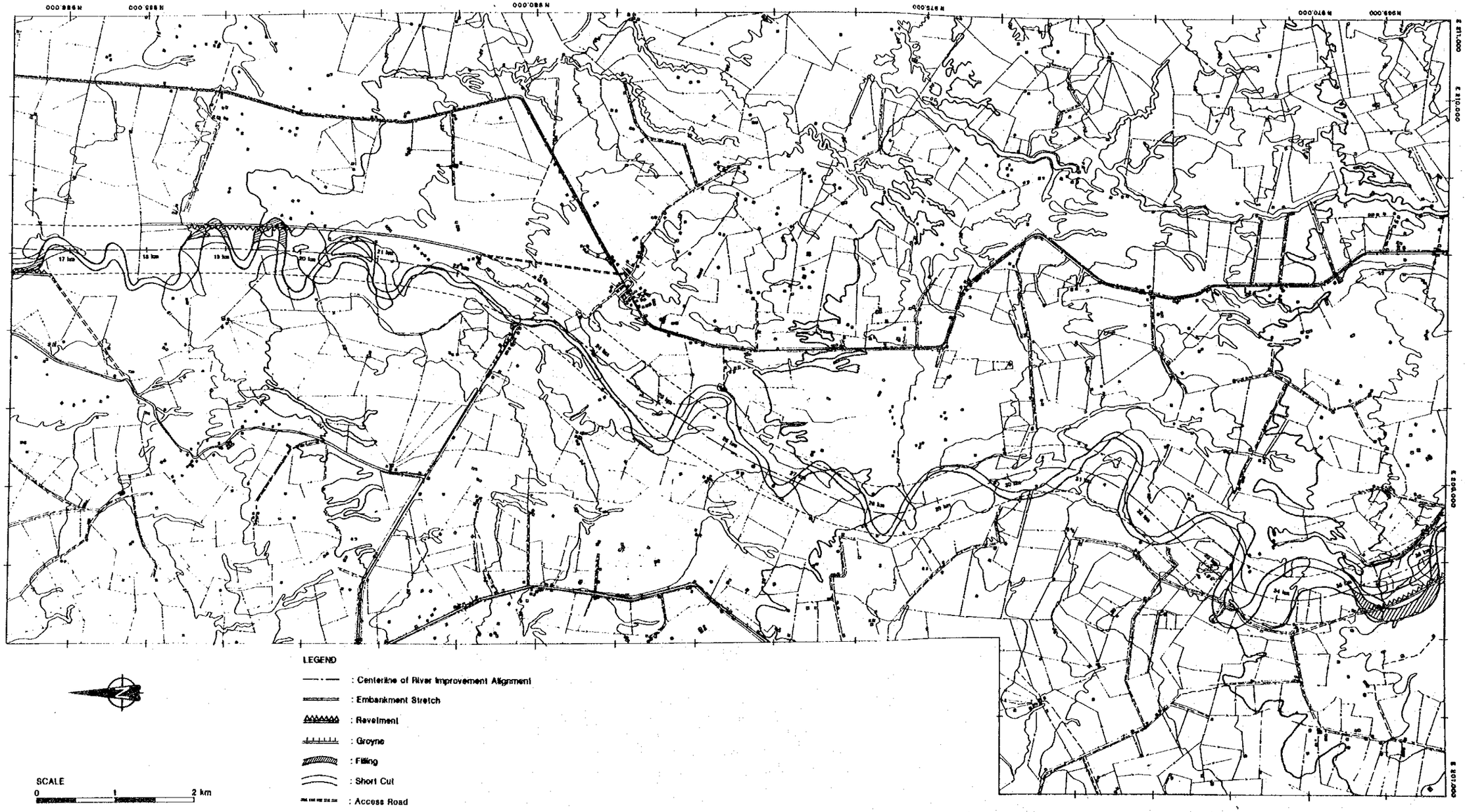
: Urban area

(I),(II),(III) : Priority of construction

PRIORITY OF CONSTRUCTION FOR RIVER CHANNEL IMPROVEMENT	STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT
Fig. VII-25	JAPAN INTERNATIONAL COOPERATION AGENCY



STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT	RIVER IMPROVEMENT PLAN FOR ACTION PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VII-26(1/3)

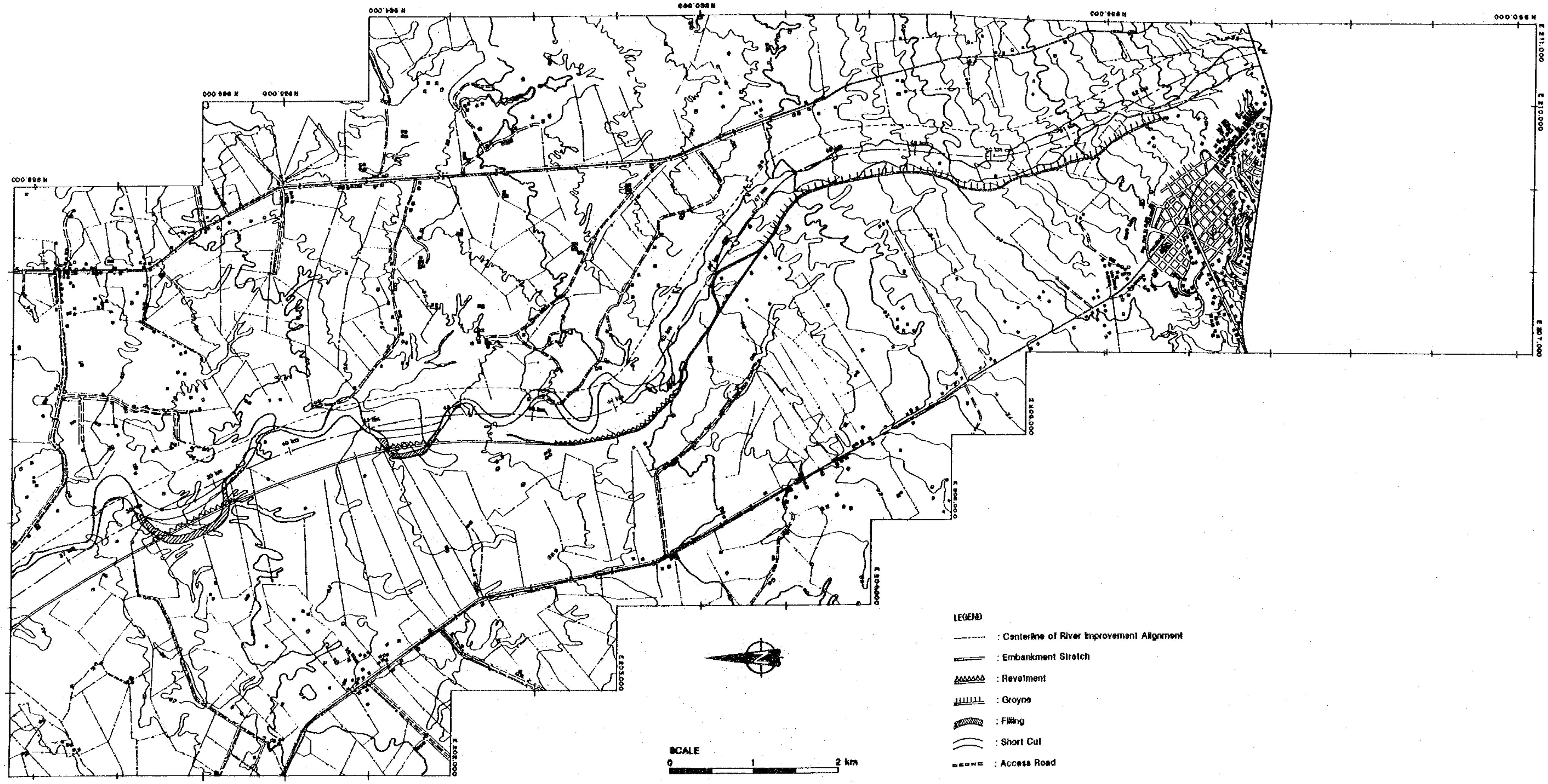


STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

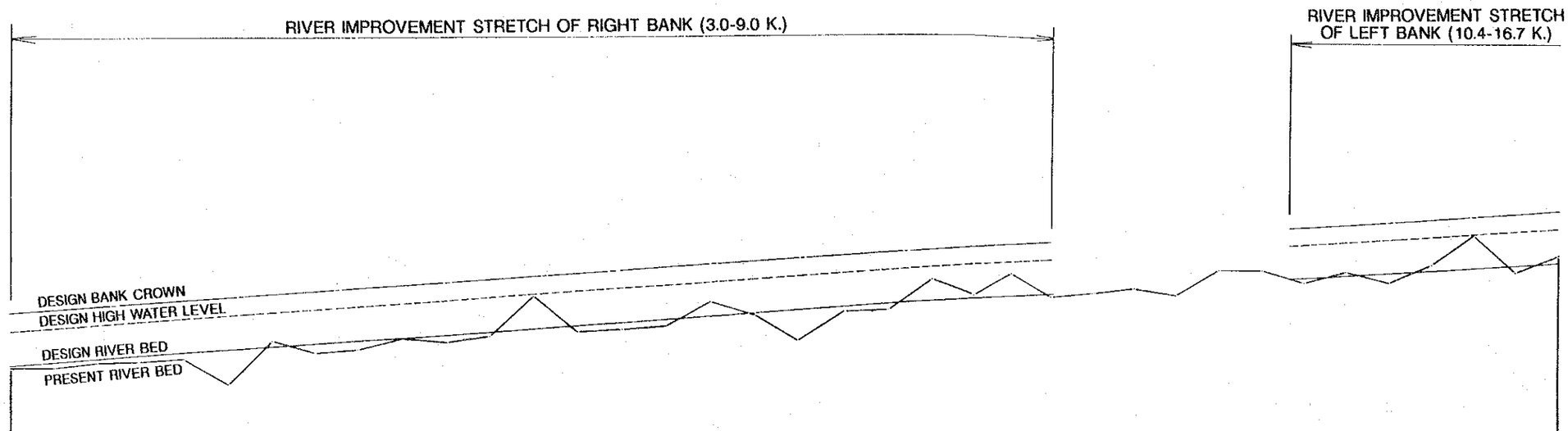
JAPAN INTERNATIONAL COOPERATION AGENCY

RIVER IMPROVEMENT PLAN FOR ACTION PLAN

Fig. VII-26(2/3)

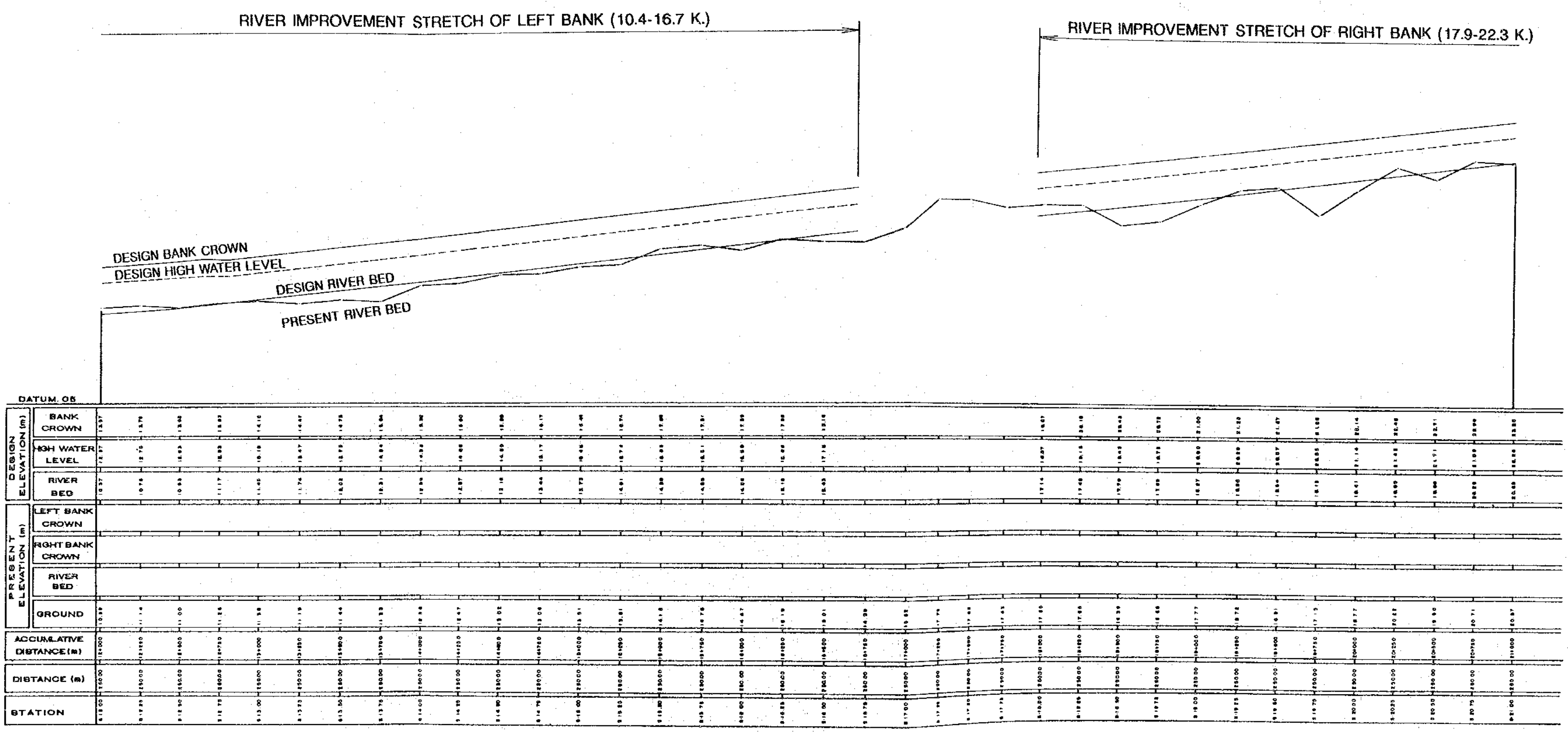


STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT	RIVER IMPROVEMENT PLAN FOR ACTION PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VII-26(3/3)

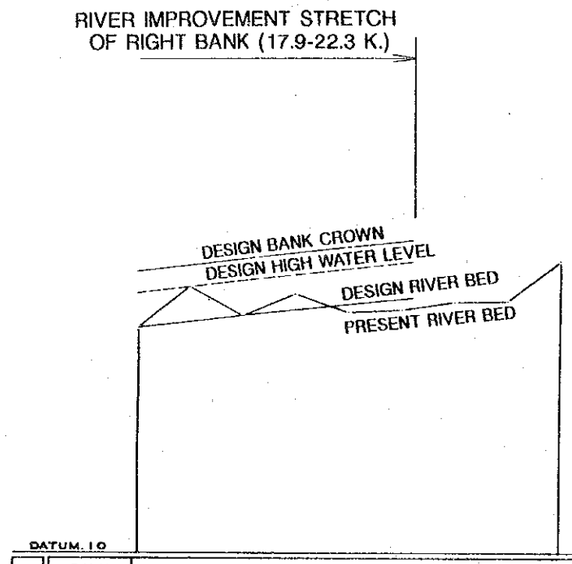


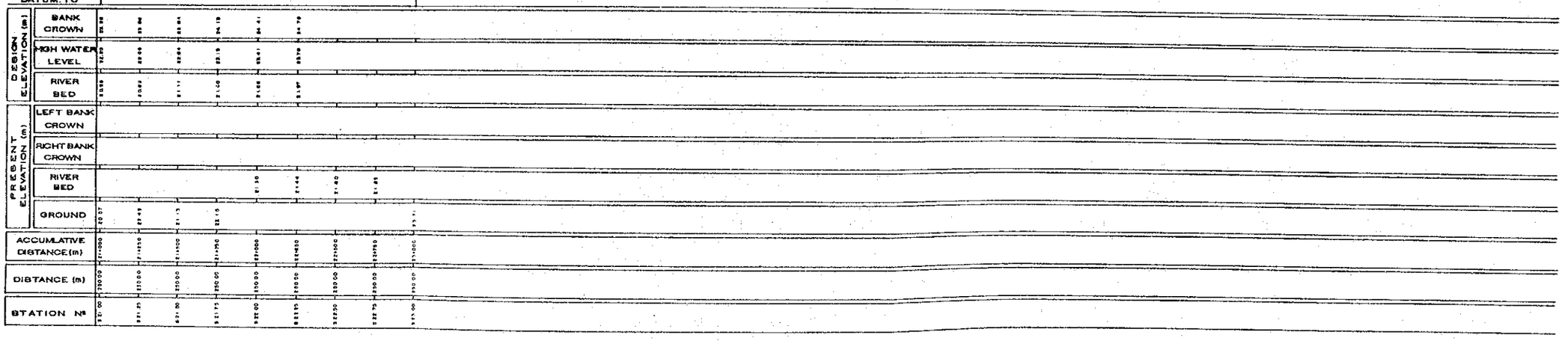
DESIGN ELEVATION (m)	BANK CROWN	
	HIGH WATER LEVEL	
	RIVER BED	
PRESENT ELEVATION (m)	LEFT BANK CROWN	
	RIGHT BANK CROWN	
	RIVER BED	
	GROUND	
ACCUMULATIVE DISTANCE(m)		
DISTANCE (m)		
STATION Nº		

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT	LONGITUDINAL PROFILE OF RIVER IMPROVEMENT IN ACTION PLAN
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. VII-27(1/4)

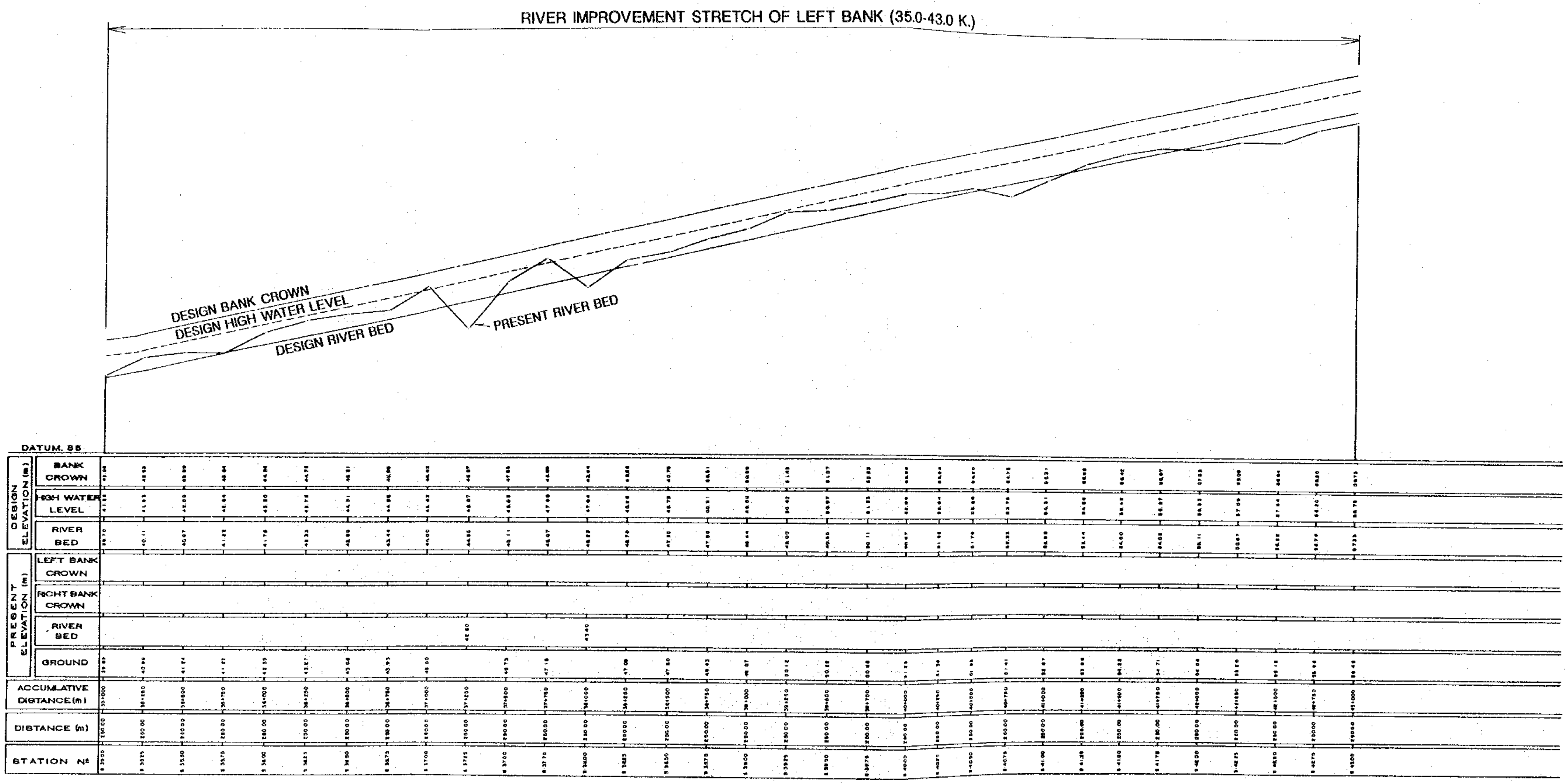


STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY	LONGITUDINAL PROFILE OF RIVER IMPROVEMENT IN ACTION PLAN Fig. VII-27(2/4)





STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY	LONGITUDINAL PROFILE OF RIVER IMPROVEMENT IN ACTION PLAN Fig. VII-27(3/4)

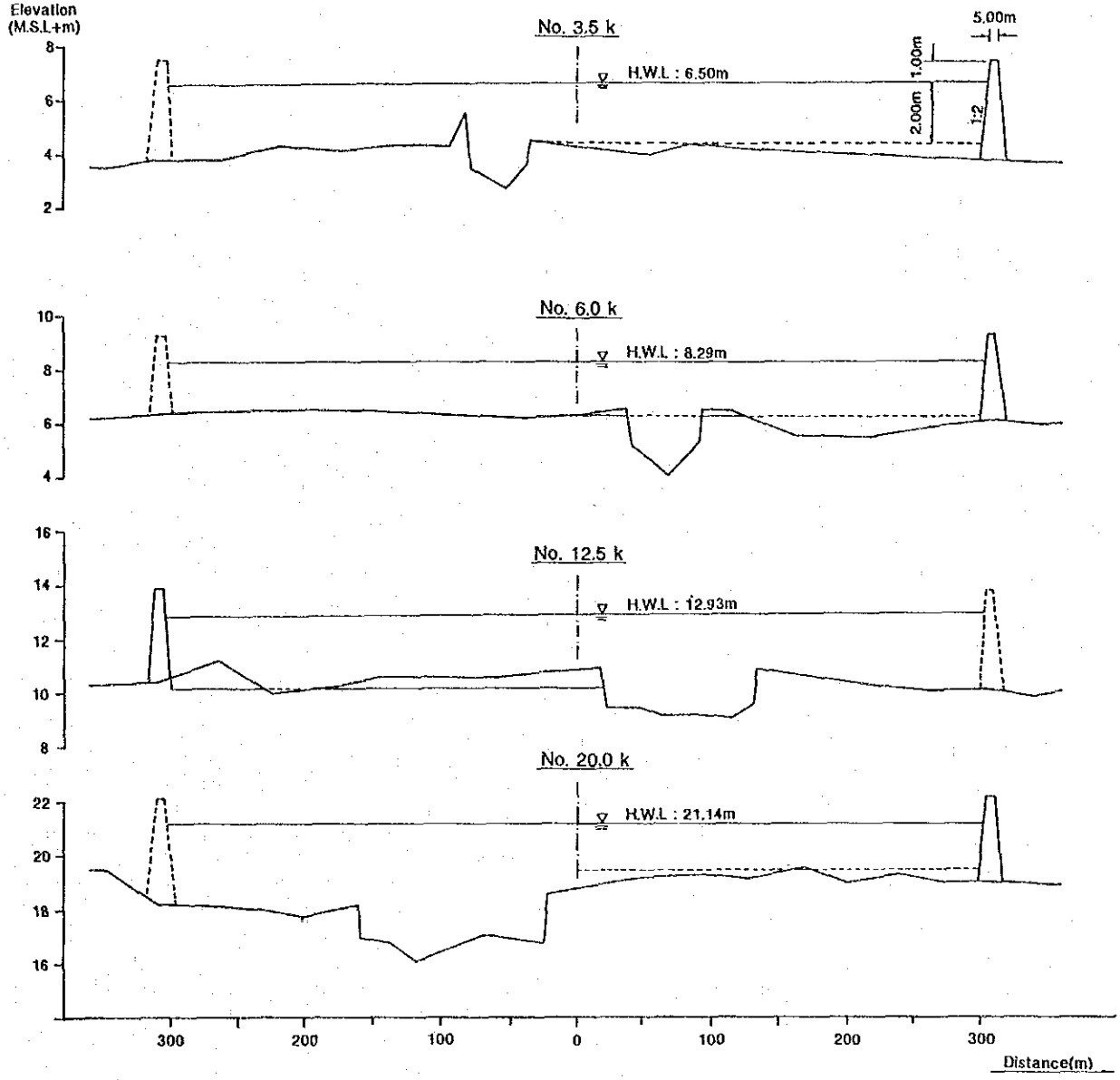


STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

LONGITUDINAL PROFILE OF RIVER IMPROVEMENT IN ACTION PLAN

Fig. VII-27(4/4)



LEGEND

H.W.L : Design High Water Level

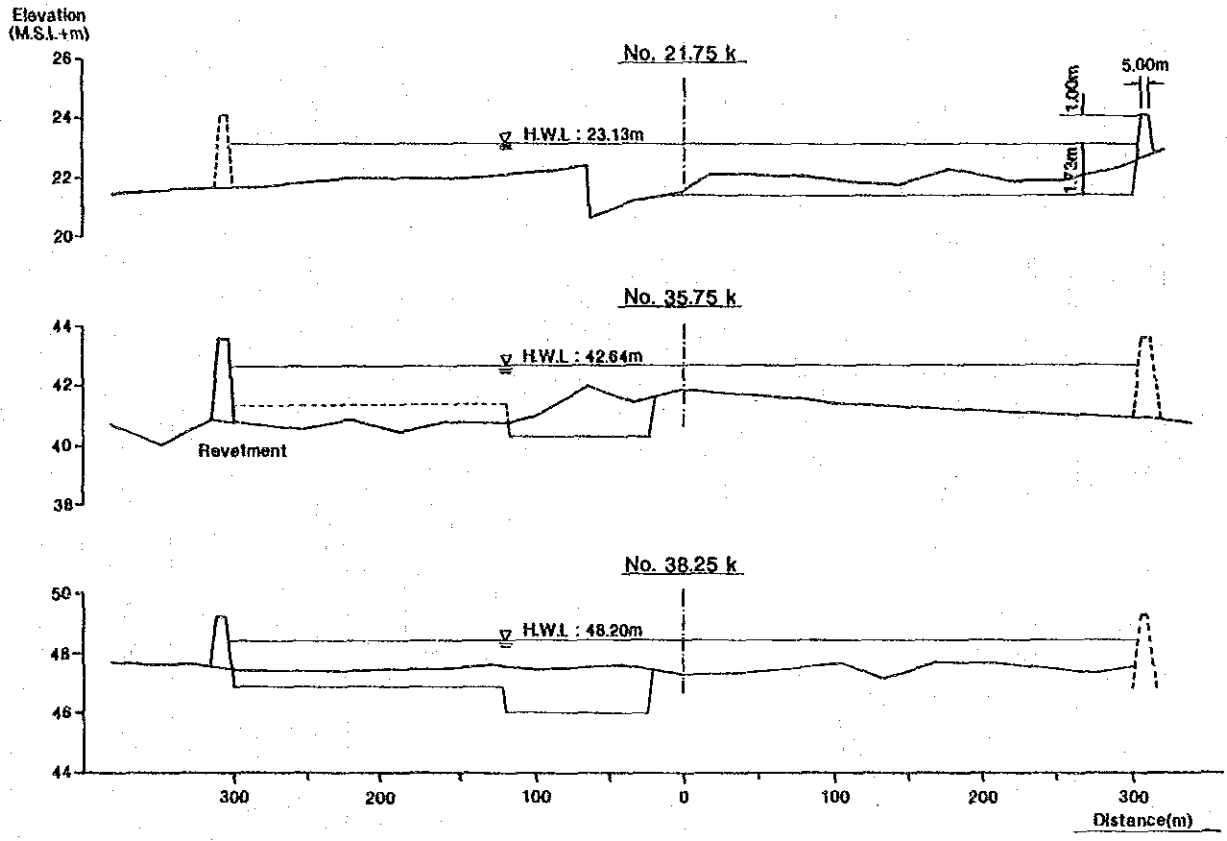
------- : Design Riverbed

TYPICAL CROSS SECTION OF RIVER IMPROVEMENT IN ACTION PLAN

Fig. VII-28 (1/2)

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

H.W.L : Design High Water Level

-------- : Design Riverbed

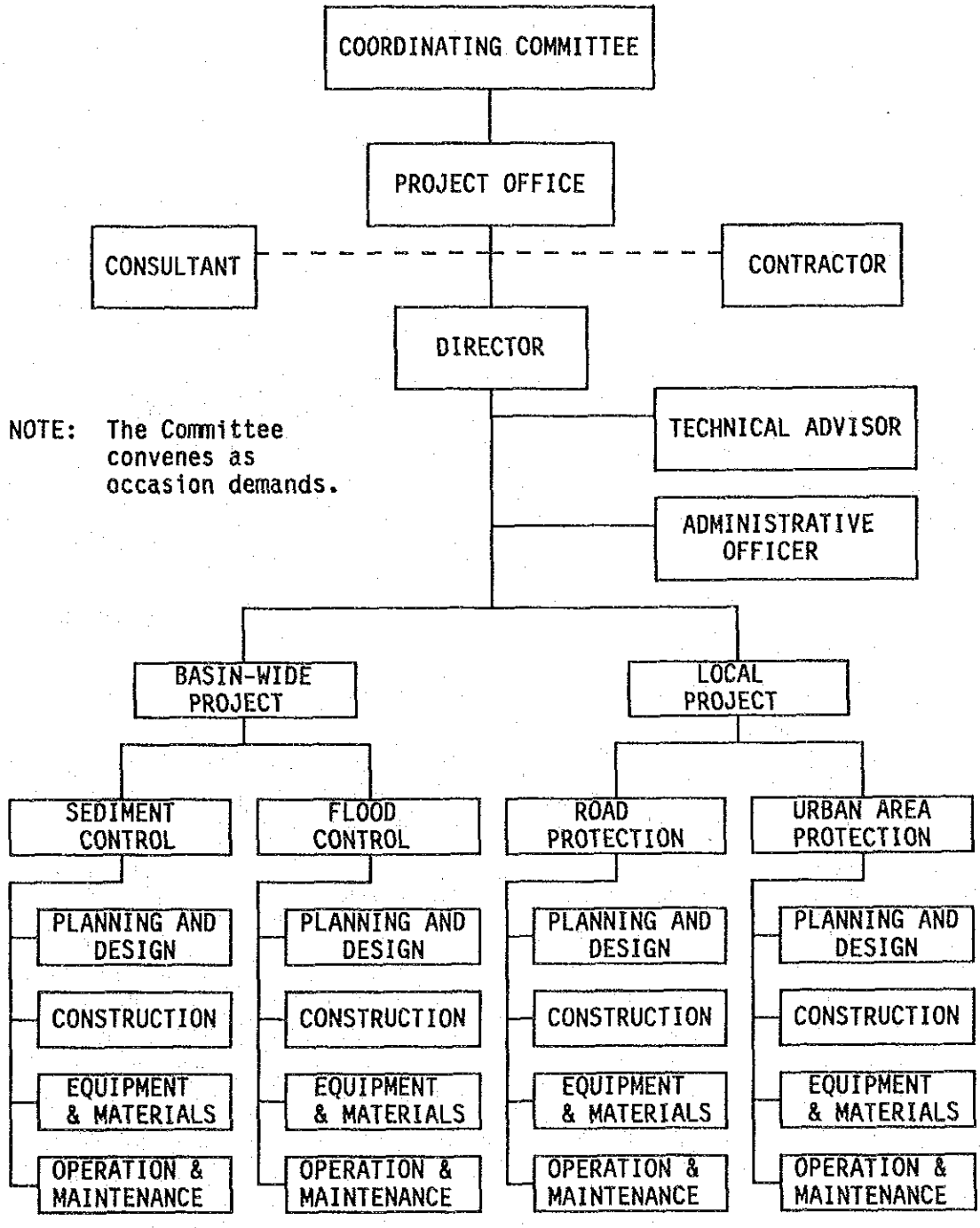
TYPICAL CROSS SECTION OF RIVER IMPROVEMENT IN ACTION PLAN	STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT
Fig. VII-28 (2/2)	JAPAN INTERNATIONAL COOPERATION AGENCY

ORGANIZATION OF PROJECT OFFICE (CASE 1)

Fig. VII-29

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

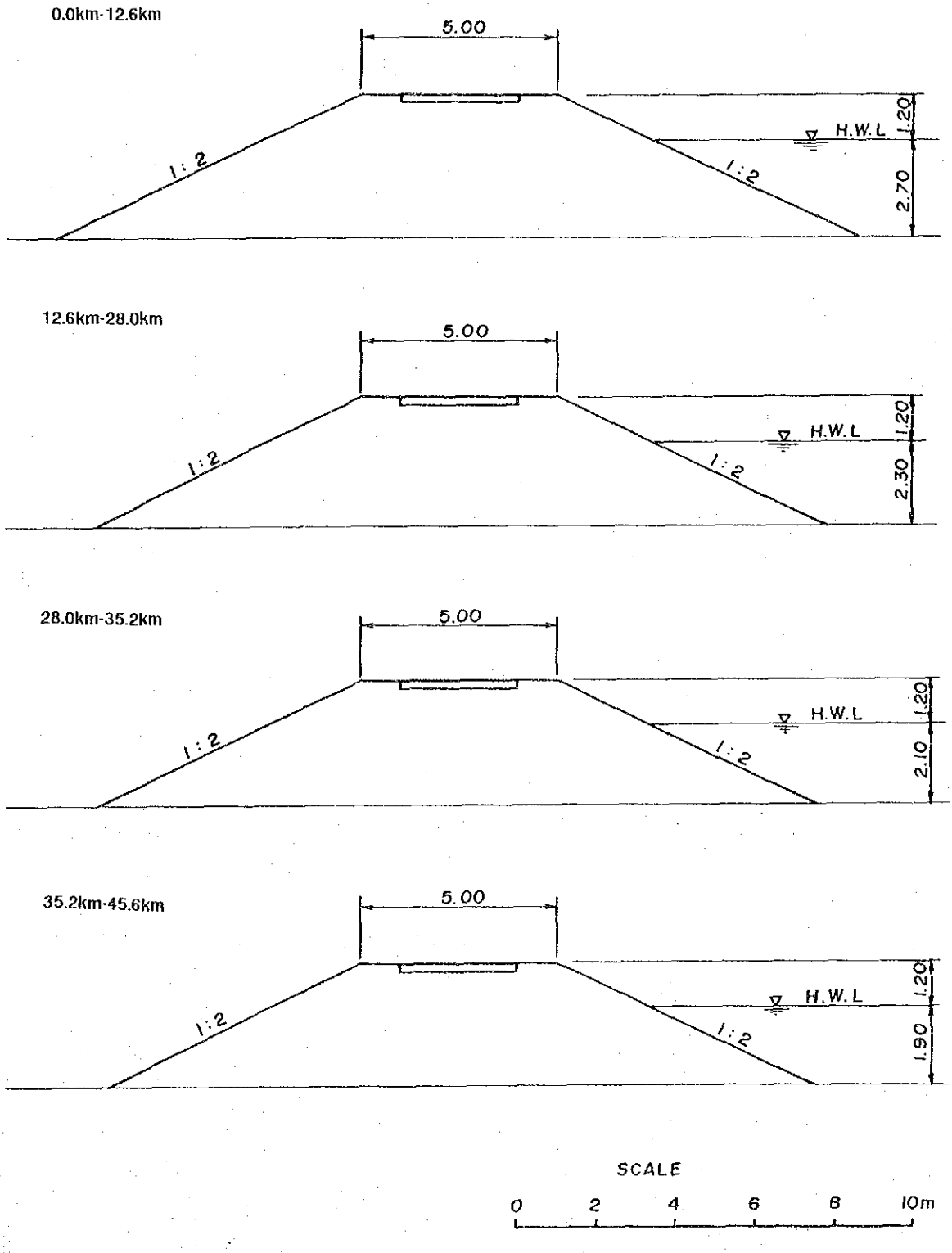


ORGANIZATION OF PROJECT OFFICE (CASE 2)

Fig. VII-30

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



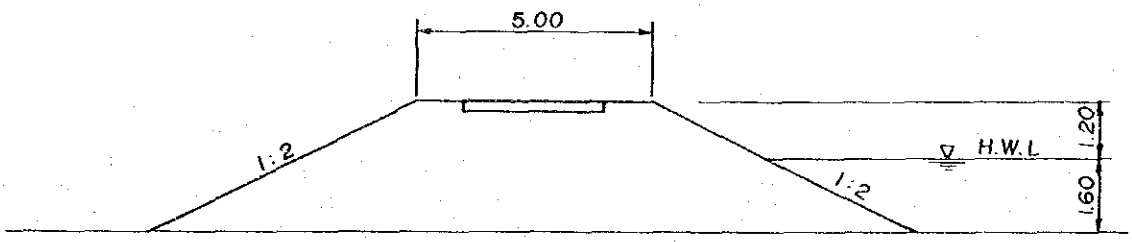
TYPICAL CROSS SECTIONS OF DIKE

Fig. VII-31(1/2)

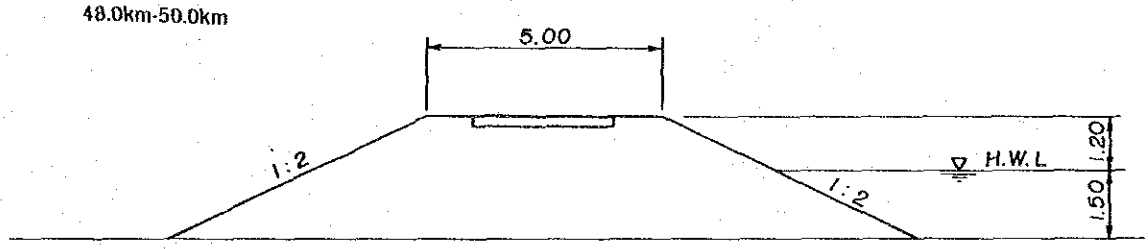
STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

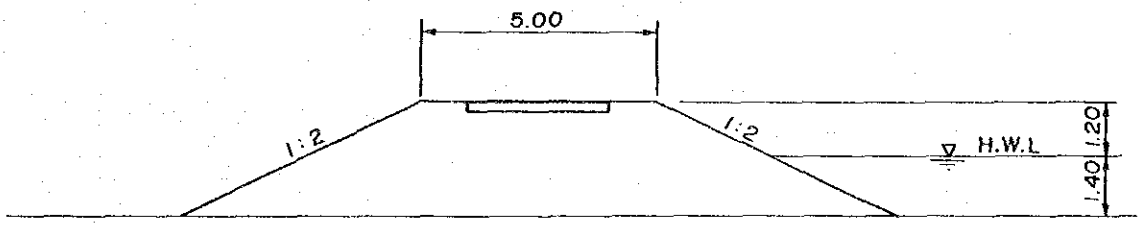
45.6km-48.0km



48.0km-50.0km



50.0km-53.4km

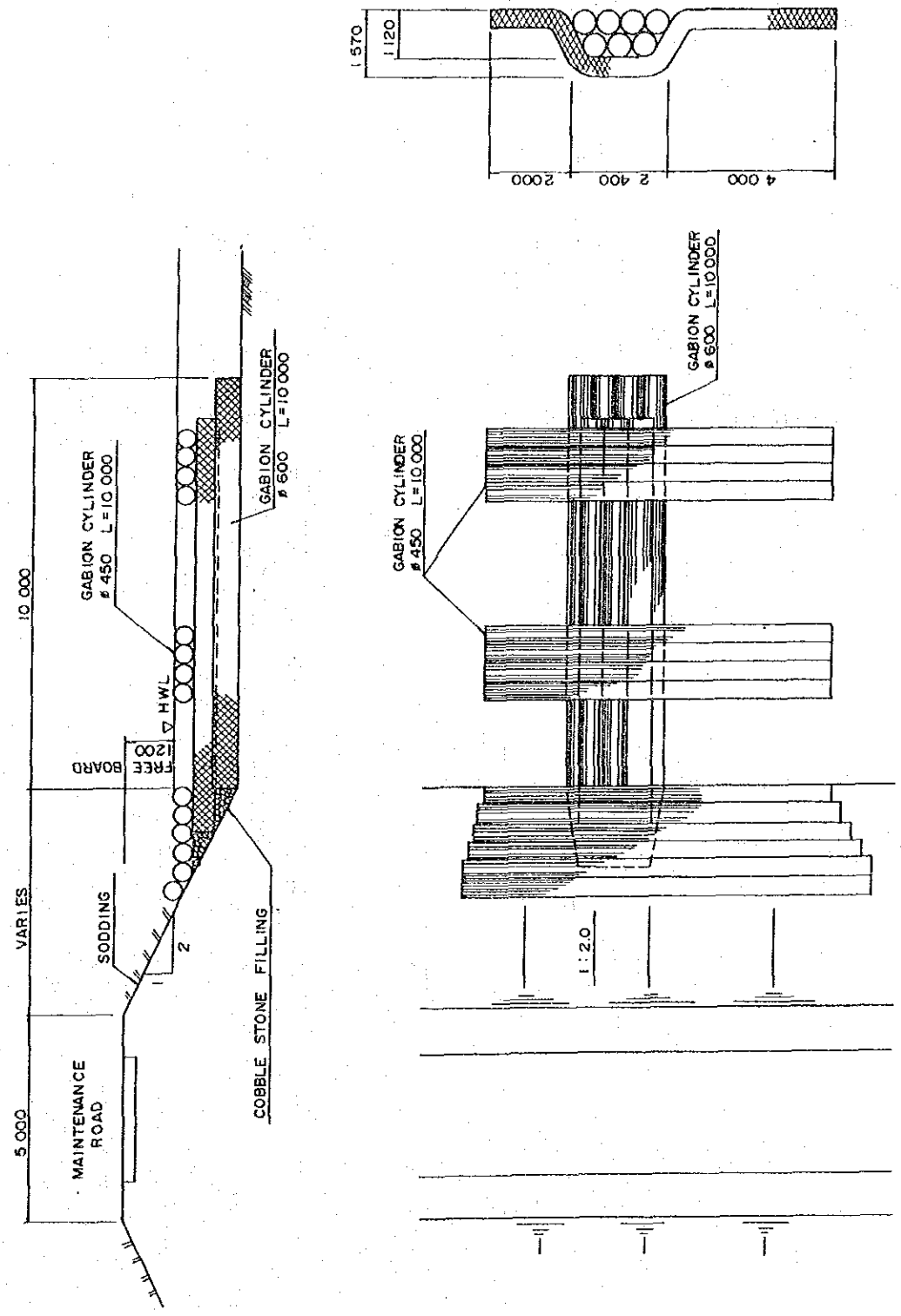


TYPICAL CROSS SECTIONS OF DIKE

Fig. VII-31(2/2)

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

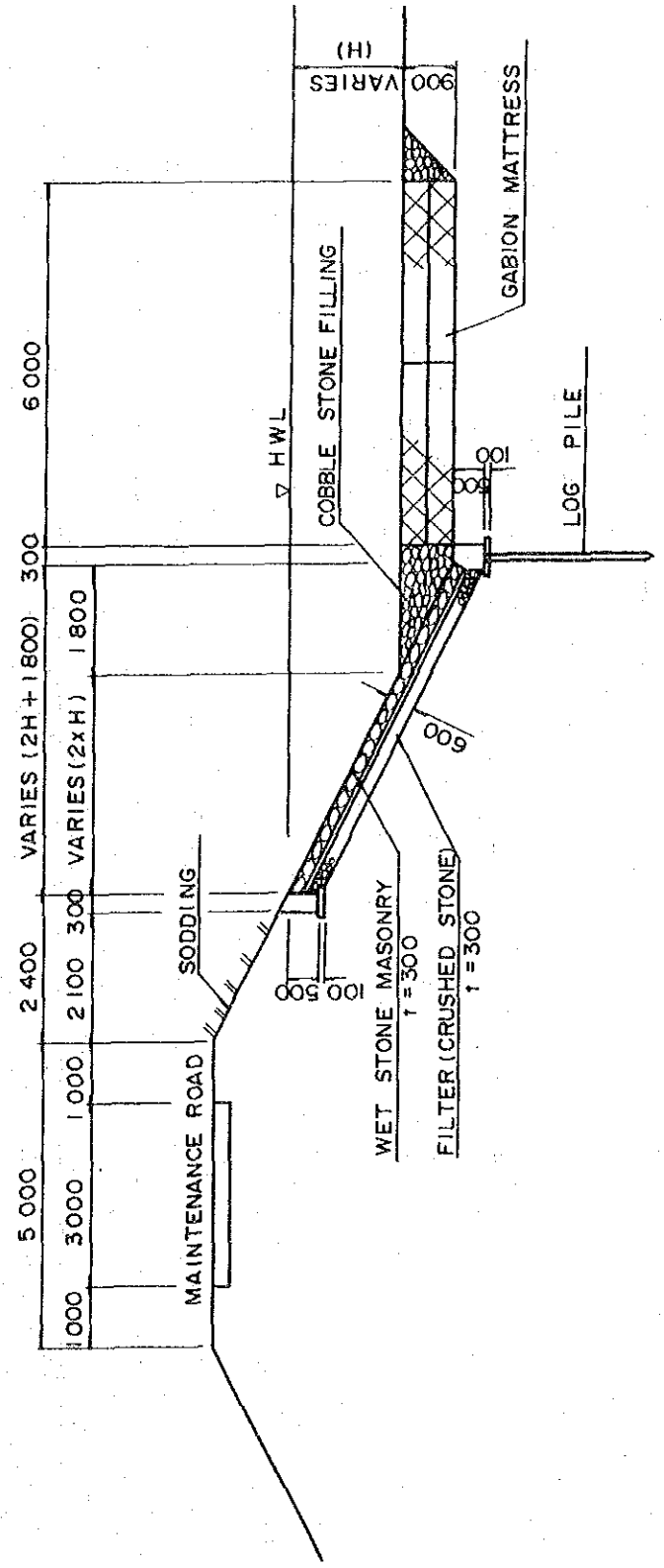


STANDARD DRAWING OF GROIN

Fig. VII-32

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

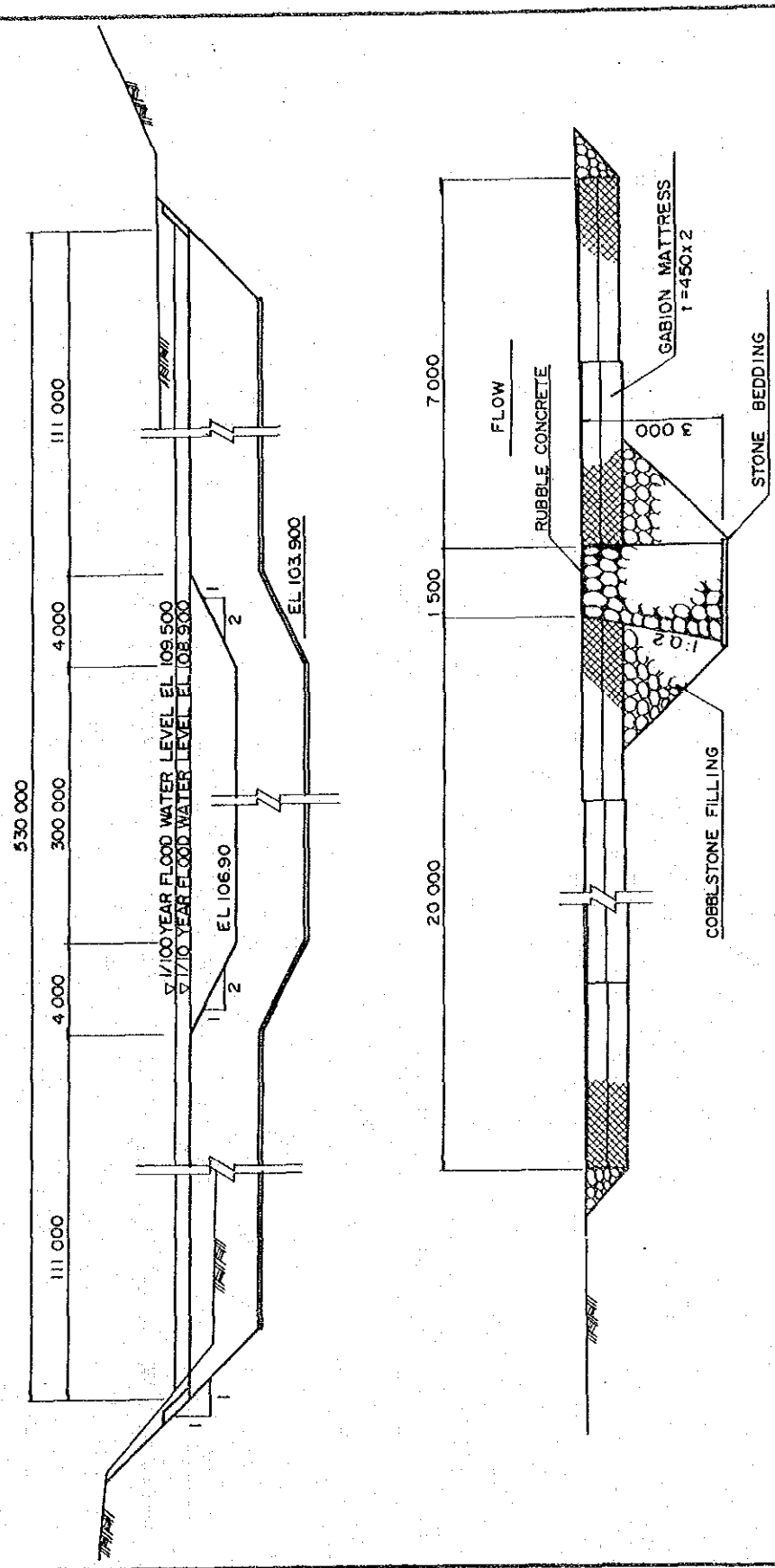


STANDARD DRAWING OF REVETMENT

Fig. VII-33

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

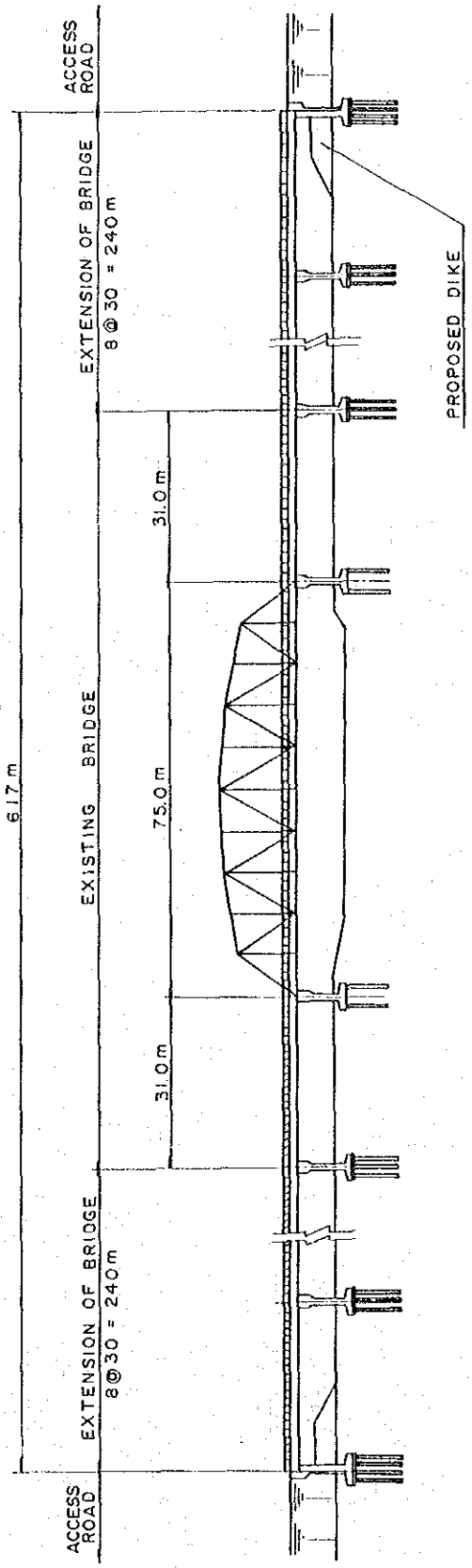


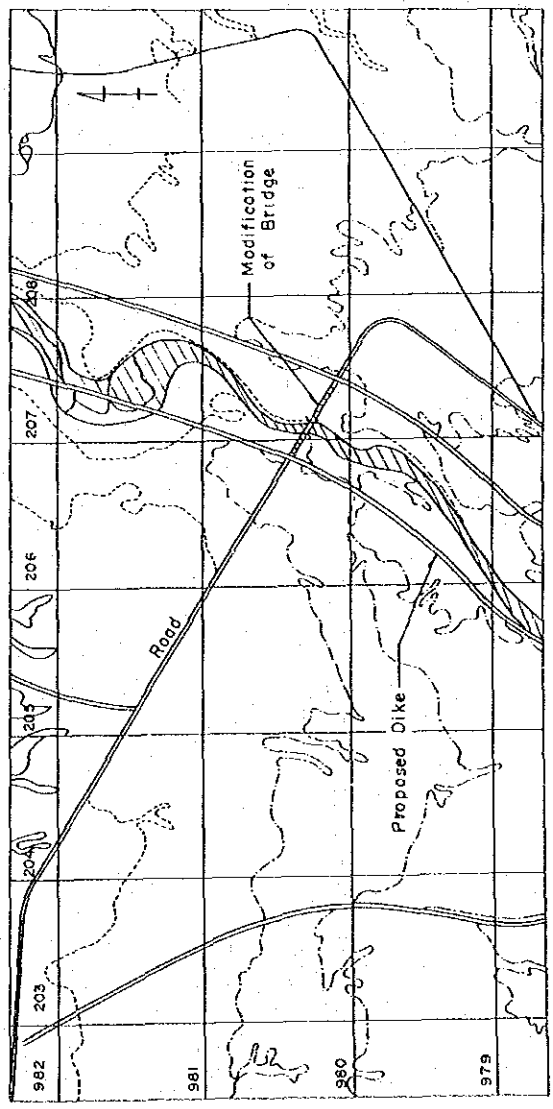
PROFILE AND STANDARD CROSS SECTION OF GROUNDSILL

Fig. VII-34

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



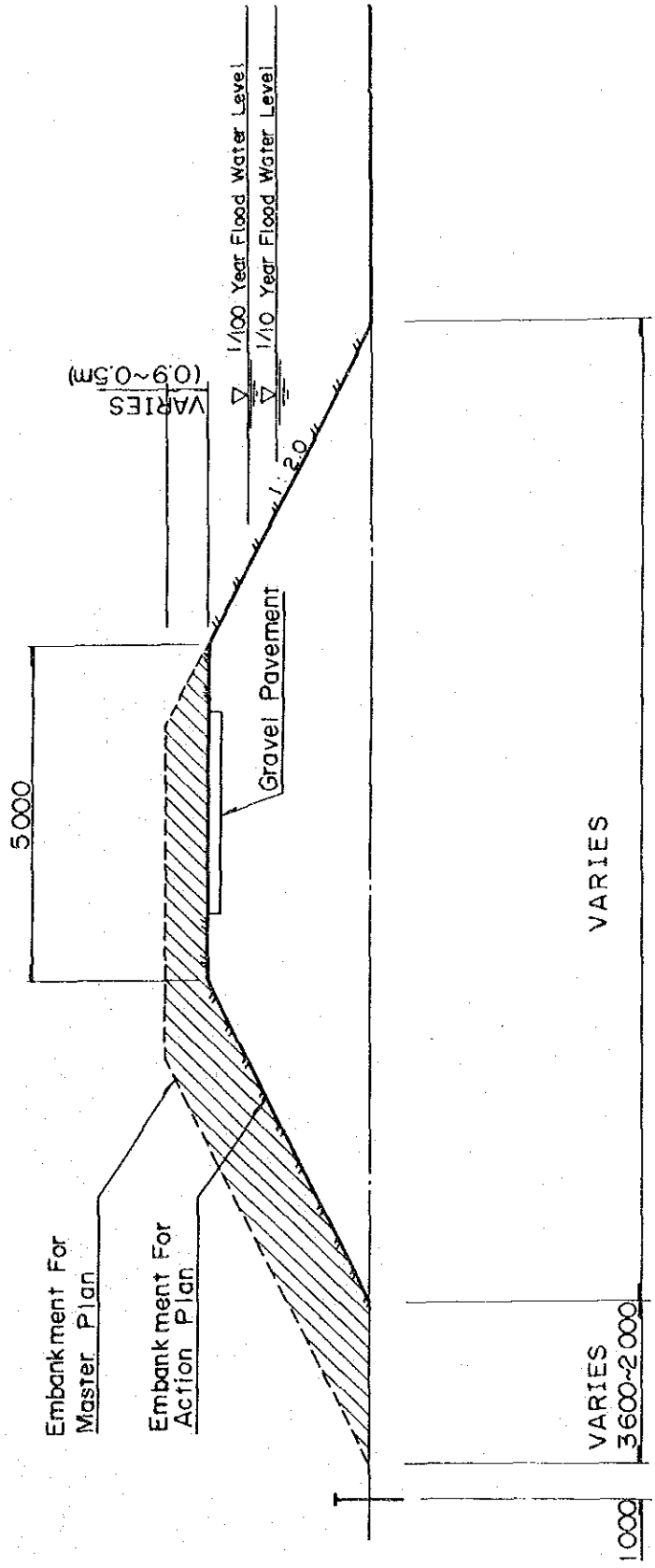


PROFILE OF THE PROPOSED PUERTO CHAMA BRIDGE EXTENTION

Fig. VII-35

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

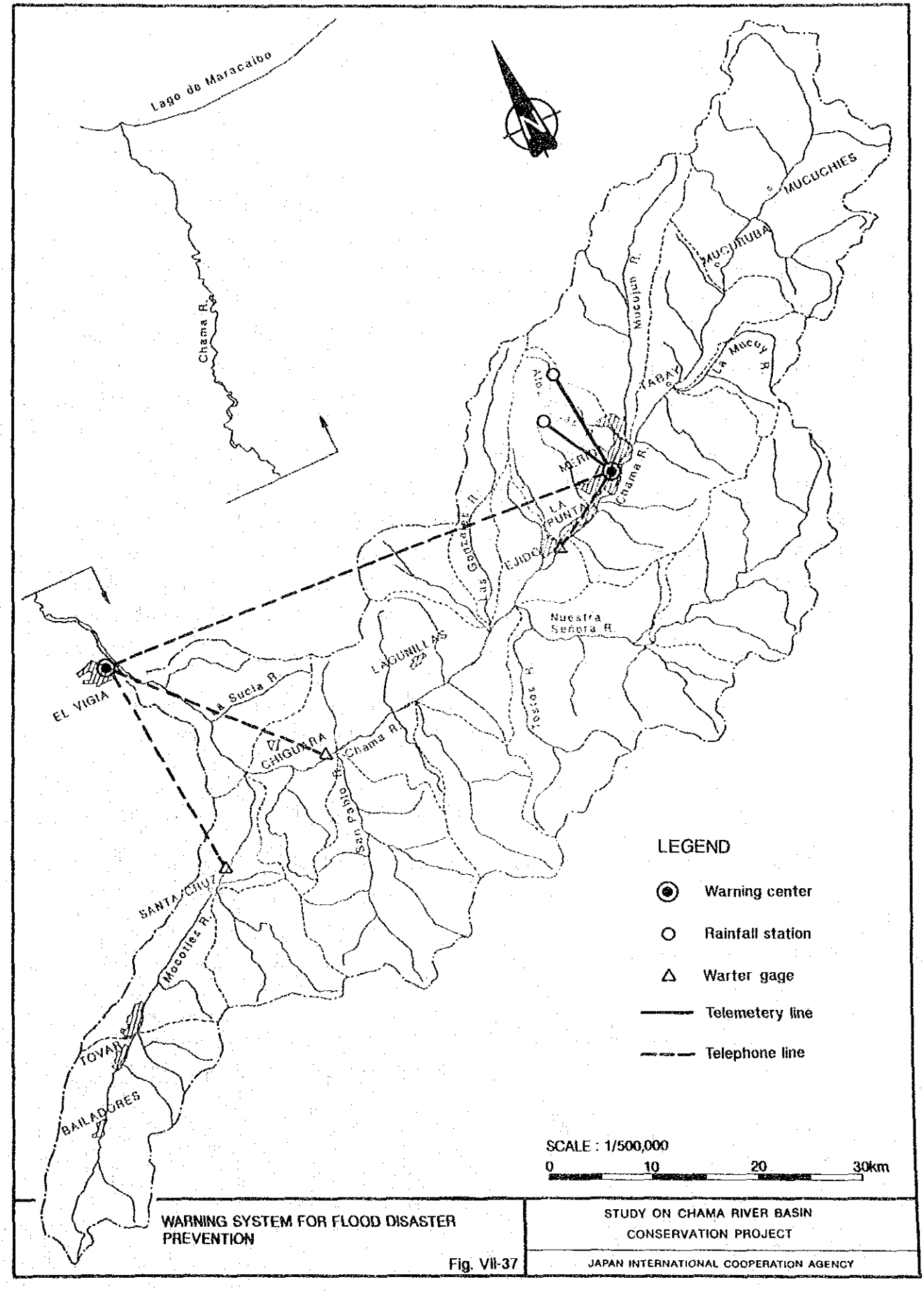


STANDARD CROSS SECTION OF DIKE IN ACTION PLAN

Fig. VII-36

STUDY ON CHAMA RIVER BASIN
CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



WARNING SYSTEM FOR FLOOD DISASTER PREVENTION

Fig. VII-37

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

ANNEX VII-1

GROIN AND REVETMENT

1. General

In this Chama River Basin Conservation Project, river improvement by embankment is selected as the optimum method of flood control. Since the riverbed gradient of the Chama River even in the lower reaches is very steep, protection works for the dike is indispensable; hence, groins and revetments are employed at the section with high current velocity and/or at the water colliding front depending on the river channel alignment.

However, the channel of the Chama River has always been meandering that such sections, especially the water colliding front, hardly identified. Furthermore, it is difficult to know the influence of these structures to the other sections with no protection works. Thus, the installation of these structures is forwarded step by step confirming the influence by trial and error through experimental installation at the site.

In this connection, the general features of the groin and the revetment are herein described for reference of successful installation.

2. Functions of Groin and Revetment

Basically, the groin and the revetment have the same function of protecting the dike. The minor differences are as follows:

- A groin has the function of regulating the flow direction, so that protecting the dike is a secondary function.
- A revetment has the function of directly protecting the dike from erosion and, therefore, regulates the flow direction.

3. Advantages and Disadvantages

The advantages and disadvantages of the structure come from their basic functions, as follows:

Advantage of Groin

The groin causes siltation in the vicinity of the dike, demonstrating the effect of decreasing the current velocity more positively; hence, the dike is protected from erosion.

Disadvantage of Groin

The groin may change the location of the water colliding front in the lower reaches, which will cause erosion of the dike at the site. The scouring occurs around the groins, depending on the location or the direction of the groin. (See Fig. 1.)

Advantage of the Revetment

Since the revetment directly covers the dike, the purpose of protecting the dike can be easily and definitely achieved.

Disadvantage of Revetment

The revetment does not have the function of decreasing current velocity, so that it may cause dike erosion in the upper and lower reaches of the section with revetment, and it brings about scouring at the foot of the revetment.

4. Matters to be Considered in Installation

Among the matters to be considered in the installation of groins or revetments, the following are specified:

Groin

- Groins are generally arranged upward or at right angles with the river flow. The downward direction is rarely employed for purposes other than water casting and low-flow channel maintenance, because this type of groin tends to make the sand

flow towards the center of the stream, lowering the bed in the vicinity of the groin.

- In general, the length of the groin is decided at less than 10% of the river width.

- Although the groin intervals are decided in consideration of the height and length, they are in the range of 1.5 to 3.5 times the length of the groin.

Revetment

- Generally, the revetments of a steep river extend over the entire stretch, but in case of a river with gentle gradient, the revetments are placed with emphasis on the water colliding front.

- The place of installation and extent are decided in consideration of past experiences.

- In principle, the height of revetment shall be the same as the design high water level.

5. Application to the Chama River

In the Chama River improvement plan, groins and revetments are arranged in the following principle, considering the aforementioned featues of these structures:

- In the stretch with high water velocity, the groin is proposed to decrease the velocity accelerating sedimentation, so that the dike is protected from erosion.

- Revetment is proposed at the water colliding front to ensure the protection of the dike from erosion.

In case of construction, however, it is recommended that construction should proceed step by step only after confirming the influence of these structures to the lower reaches.

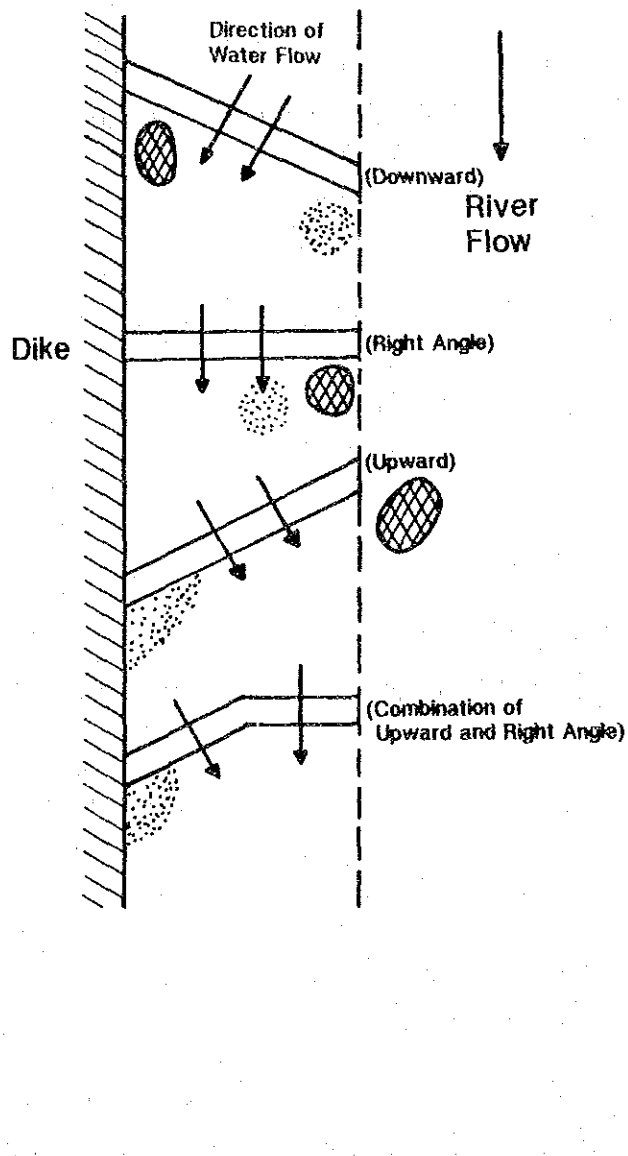


Fig-1 INFLUENCE AND EFFECT OF GROIN DEPENDING ON DIRECTION OF ARRANGEMENT

STUDY ON CHAMA RIVER BASIN CONSERVATION PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

VIII. CONSTRUCTION SCHEDULE AND COST ESTIMATES

SUPPORTING REPORT

VIII. CONSTRUCTION SCHEDULE AND COST ESTIMATES

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. GENERAL

The works for this river basin conservation project consists mainly of earth works and concrete works such as embankment of flood protection dike and construction of sabo dams.

The construction planning described in this report was prepared on the basis of the design of structures in consideration of results of investigations on the capability of contractors in Venezuela such as technical level, prevailing construction methods, similar international projects and so on.

Construction materials and equipment except specially specified ones will be procured in Venezuela.

Direct cost was estimated on the basis of the construction plan. The indirect cost was is estimated taking into account similar international competitive bidding projects and, at the same time, local projects.

2. CONSTRUCTION PLAN

2.1 Terms and Conditions

Climate

The project area has four seasons consisting of two rainy seasons, April to May and October to November, and two dry seasons, June to September and December to March. The annual mean rainfall is about 1,800 mm at El Vigía (R3035 station), 1,200 mm at the C-1 Sabo Dam site (R8053 station), 1,000 mm at the middle reaches of the Chama River (R8056 station), and 600 m at the Nuestra Señora River Basin (R3080 station). The average rainfall days in the recent 21 years (1967 to 1987) are as tabulated in the following tables.

(R3035 station) (Unit : days)

Rainfall	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
3-10 mm	3.4	2.7	4.3	4.0	3.6	3.5	3.5	3.7	4.5	4.8	4.3	3.6
10-15 mm	0.8	1.0	0.8	1.7	1.6	0.6	1.2	1.2	1.0	0.9	1.4	1.9
15-20 mm	0.4	0.7	0.8	0.9	0.8	0.4	0.6	0.5	1.3	1.0	1.4	0.7
20-30 mm	0.6	0.8	0.9	1.0	1.1	0.6	0.5	0.6	0.5	1.2	1.9	1.4
30-50 mm	0.7	0.8	1.2	1.8	0.6	0.6	0.3	0.4	0.5	1.4	1.7	1.2
50mm over	0.5	0.5	0.3	1.3	0.8	0.4	0.1	0.3	0.1	0.8	0.7	0.7

(R8053 station) (Unit : days)

Rainfall	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
3-10 mm	2.5	2.0	2.9	4.1	4.0	3.2	3.4	2.7	4.1	3.9	4.9	2.8
10-15 mm	1.1	0.6	0.5	1.5	0.9	0.8	0.6	0.7	1.1	1.2	1.1	0.9
15-20 mm	0.4	0.3	0.3	1.0	0.9	0.1	0.2	0.5	0.7	0.8	1.2	0.6
20-30 mm	0.6	0.8	0.7	0.6	0.9	0.5	0.4	0.6	0.5	0.8	0.8	0.8
30-50 mm	0.4	0.4	0.4	1.3	0.5	0.3	-	0.2	0.4	0.9	0.9	1.1
50mm over	0.2	0.4	0.4	0.8	0.5	0.2	-	0.1	0.1	0.7	0.6	0.2

(R8056 station) (Unit : days)

Rainfall	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
3-10 mm	1.7	1.7	2.4	3.4	4.0	2.9	2.6	2.8	4.2	3.8	3.9	2.0
10-15 mm	0.5	0.6	0.4	1.1	1.1	0.4	0.7	0.6	1.2	1.1	1.2	1.0
15-20 mm	0.2	0.5	0.2	1.0	0.5	0.1	0.3	0.6	0.4	0.6	1.0	0.2
20-30 mm	0.1	0.3	0.4	0.9	0.5	0.1	-	0.2	0.2	1.1	0.8	0.5
30-50 mm	0.3	0.4	0.3	0.3	0.2	0.1	-	0.2	0.2	0.8	0.5	0.2
50mm over	-	-	-	0.1	0.2	-	-	0.2	0.1	0.6	0.1	-

(R3080 station) (Unit : days)

Rainfall	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
3-10 mm	0.4	0.6	0.9	3.6	4.3	4.3	5.2	4.9	4.8	4.6	2.6	1.1
10-15 mm	0.1	0.1	0.3	0.8	1.3	1.2	1.0	0.8	0.9	1.1	0.9	-
15-20 mm	-	-	0.1	0.3	0.7	0.1	0.3	0.1	0.5	0.6	0.2	0.1
20-30 mm	-	-	-	0.3	0.1	0.1	-	0.1	0.4	0.3	0.2	0.1
30-50 mm	-	-	-	0.1	0.1	-	-	0.1	-	0.2	-	-
50mm over	-	-	-	-	-	-	-	-	-	-	-	-

The annual workable days for the proposed mechanized construction were estimated by applying the following criteria to the rainfall data from 1967 to 1987.

Work Item	Daily rainfall					
	3-10mm	10-15mm	15-20mm	20-30mm	30-50mm	50mm
Earth works	0.5	1.0	1.0	1.5	2.5	3.0
Rock works	0.0	0.0	0.5	1.0	1.5	1.5
Concrete	0.0	0.0	0.0	1.0	1.0	1.0

Based on the suspended days computed by the rainfall data for the recent 21 years from 1967 to 1987, and given the condition of Saturdays, Sundays and national holidays, the workable days for the construction planning were calculated, as shown in the following tables.

(R3035 station) (Unit : days)

Work Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Earth works	13	13	10	10	10	13	13	13	13	10	10	10	138
Rock works	19	19	15	15	15	19	19	19	19	15	15	15	204
Concrete	20	20	16	16	16	20	20	20	20	16	16	16	216

(R8053 station) (Unit : days)

Work Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Earth works	15	15	15	13	13	15	15	15	15	13	13	13	170
Rock works	20	20	20	16	16	20	20	20	20	16	16	16	220
Concrete	20	20	20	17	17	20	20	20	20	17	17	17	225

(R8056 station) (Unit : days)

Work Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Earth works	18	18	18	14	14	18	18	18	14	14	14	18	196
Rock works	20	20	20	18	18	20	20	20	18	18	18	20	230
Concrete	21	21	21	18	18	21	21	21	18	18	18	21	237

(R3080 station) (Unit : days)

Work Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Earth works	19	19	19	17	17	17	17	17	17	17	19	19	214
Rock works	22	22	22	19	19	19	19	19	19	19	22	22	243
Concrete	22	22	22	19	19	19	19	19	19	19	22	22	243

Remarks:

R3035 Apply to river improvement sites
R8053 Apply to the C-1 to C-3 dam sites
R8056 Apply to the C-4 to C-9 dam sites
R3080 Apply to the Nuestra Señora River basin sites

Working Hours

Daily working hours were set at 10 hours for Mondays to Thursdays and 8 hours for Fridays. Total working hours per week was fixed at 48 hours by the Labor Law.

Volume Change Factor of Earth Materials

In view of the characteristics of soil materials in the area, the volume change factor of the earth materials were assumed, as shown in the following table.

Material	Loose/Bank	Comp./Bank
Earth	1.20	0.90
Gravel	1.15	0.95
Soft rock	1.45	1.20

Mix Proportion of Concrete

Designed mix proportion is assumed as follows:

Type	Gmax (mm)	Air (%)	W/C (%)	S/a (%)	Unit Weight (kg/m^3) W	C	S	G	A
A	40	4.5	52	38	156	300	705	1,150	0.750
B	40	4.5	55	36	148	270	685	1,215	0.675
C	40	4.5	60	34	126	210	670	1,300	0.525

Design strength will be achieved at around 210 kg/cm^2 for Type B concrete. Water reducing agent is designed to be mixed to all types of concrete to save cement content. It is one of the most effective methods to prevent any crack in hardening at hot temperatures.

Natural Material Sources

Concrete aggregates are available from the Chama River deposit and the right bank of the Mocoties River deposit. Though aggregate material in the lower reaches of Estánquez along the Chama River will be weak, it has enough strength for any type of concrete.

Rock materials for stone works such as gravel pavement and gabions are available from river deposits at any site, except the lowest reaches of the Chama River.

Soil materials for the flood protection dike embankment will be available from the Chama River water course. Materials obtained at the lower reaches of the Chama River from station No. 35 involve some clay and fine silt. In this situation, the excavated material will be carefully compacted after several days to reduce the moisture content.

Construction Plant

(1) Concrete Plant

Portable concrete plant will be installed at each sabo dam site, except steel frame type sabo dams. In consideration of the delicate nature of placing concrete in C-1 Sabo Dam among the rubble concrete type of sabo dams, the capacity of the plant was calculated as follows:

- Total concrete : 39,040 m^3
- Workable days : 450 days
  = 2 years x 225 days/year
- Operation factor : 1.3
- Required capacity: 113 m^3/day (= 0.5 m^3 x 2 nos.)
  = 39,040 m^3 / 450 days x 1.3

Two concrete plants will be installed to minimize any accidental interruption of the concrete placing work.

(2) Aggregate Plant

Portable aggregate crushing plant will be installed beside the concrete plant. Capacity of the plant is also calculated in case of the C-1 Sabo Dam as follows:

- Concrete volume : 113 m^3/day
- Operation factor : 1.3
- Required capacity: 30 tons/hr
  = 217 tons / 10 hrs/day x 1.3

Public Supply for Construction Works

Existing roads will be utilized as access roads for construction purposes. Periodical repair and maintenance will be required for unpaved or narrow roads.

Though electric power cable lines are well distributed even in mountaneous areas, power will be supplied from diesel generators installed at the site because of the insufficient capacity.

Water for construction use will be taken from river water. It is then necessary to install submersible pumps, water pipeline, and water tanks.

Though a telecommunication system is well distributed, it has insufficient capacity to accept new lines immediately. Under such circumstances, it is necessary to install a radio communication system.

Temporary Facilities

Offices and quarters for construction personnel such as the client, the engineer and the contractor are necessary. Labor camps are also necessary near the construction sites. For the smooth execution of main works, warehouses, work shops, repair shops, motor pools, laboratories and a medical clinic should also be provided.

Safety Control

(1) Training Program

To ensure the safety of laborers and work efficiency, it is necessary to give instructions to newly engaged laborers such as daily morning meetings at work sites and training of equipment operators at job sites.

(2) Safety Instruments

Safety tools such as helmets, long boots and life vests will be provided to each laborer. If necessary, life lines and whistles will also be provided.

(3) Signboard

Traffic signboards and reflectors will be installed at intersections, junctions, borrow pits and spoil banks.

(4) Security System

An ambulance will be provided at the main site.

(5) Medical Clinic

A medical clinic with several beds and medical equipment will be installed at the main site. A doctor and nurses will stand-by to take care of patients.

(6) Safety Patrol

The engineer and counterparts will patrol each site periodically.

(7) Safety Meeting

Safety meetings will be held by members from the client, engineer and contractor at least once a month.

2.2 Construction Plan for the Master Plan

In compliance with the prioritization of construction of the proposed facilities, the construction time schedule shown in Fig. VIII-1 was prepared on account of the prevailing construction methods in Venezuela and the construction conditions.

(1) Project Components

The components of the master plan are tabulated as follows:

Sub-Project	Target Asset	Objective	Component	Quantity
Basin-wide Disaster Prevention Project	Agriculture; Urban Area and Public Facilities in Lower Reaches	Sediment Control	Sabo Dam	10 sites
			Continuous Dams	110 sites
			Retaining Wall	1,400 sites
		Flood Control	River Channel Improvement	53.4 km
			Groundsill	1 no.
Local Disaster Prevention Project	Routes 2 & 7 of National Road	Sediment Control	Check Dam	88 sites
			Retaining Wall	550 m
			Revetment Wall	720 m
	Urban Area of Mérida and Ejido cities	Flood Control	River Channel Improvement	5.4 km

(2) Plan for Basin-wide Project

(a) Sabo Dams

Major work quantities, construction phase, and types of sabo dams are tabulated as below.

Dam	Type	Phase	Excavation	Dam Volume
C-1	Rubblestone	1	145,000 m^3	62,500 m^3
C-2	Rubblestone	2	73,000 m^3	40,500 m^3
C-3	Steel frame	2	26,000 m^3	17,100 m^3
C-4	Steel frame	2	54,000 m^3	27,000 m^3
C-5	Steel frame	1	27,000 m^3	14,600 m^3
C-6	Steel frame	3	38,000 m^3	25,100 m^3
C-7	Steel frame	3	34,000 m^3	22,000 m^3
C-8	Steel frame	3	26,100 m^3	17,100 m^3
C-9	Steel frame	3	41,000 m^3	27,200 m^3
N-1	Rubblestone	1	54,000 m^3	65,000 m^3

For the purpose of rubblestone concrete type of dam construction, diversion works will be handled in two stages. First, a cofferdam enclosing a portion of the water channel at left or right bank is constructed. Then the cofferdammed area is unwatered, the enclosed dam foundation area excavated, and the foundation surface prepared to receive concrete. Concrete is poured into the enclosed dam monoliths until they reach an elevation above the impounded water surface. Second stage diversion starts at the beginning of the dry season. The order of pouring concrete is planned to be always higher in both bank portions than the middle portion to minimize damage caused by an unexpected flood water flow.

The major items of equipment required for the works are as follows:

Equipment	Activity
(1) Excavation	
Backhoe, 0.6 m^3	excavation
Dump truck, 8 t	hauling
Bulldozer, 21 t	spoilbanking
(2) Concrete	
Concrete plant, 0.5 m^3	mixing
Truck mixer, 3.2 m^3	hauling
Concrete pump, 30 m^3/hr	pouring
Vibrator, 45 mm	compacting
Air compressor, 10.5 m^3	clearing
Diesel generator, 50 kVA	power source
(3) Rubblestone	
Wheel loader, 2.1 m^3	loading
Dump truck, 8 t	hauling
Truck crane, 20 t	installing

For the purpose of steel frame type of dam construction, diversion is handled in two stages. First, a cofferdam enclosing a portion of the water channel at right bank is constructed. Then the cofferdammed area is unwatered, the enclosed dam foundation area excavated, and the foundation surface prepared to receive installation work of steel frame unit. Steel frame is installed and filled with rubblestone in the enclosed dam monoliths until they reach an elevation above the impounded water surface. Second stage diversion starts at the beginning of the dry season. The order of installing of steel frame is planned to be always higher in both bank portions than the middle portion to minimize damage caused by an unexpected flood water flow.

The major items of equipment required for the works are as follows.

Equipment		Activity
(1)	Excavation	
	Backhoe, 0.6 m^3	excavation
	Dump truck, 8 t	hauling
	Bulldozer, 21 t	spoilbanking
(2)	Steel frame	
	Cargo truck, 2 t	handling
(3)	Rubblestone	
	Wheel loader, 2.1 m^3	loading
	Dump truck, 8 t	hauling
	Truck crane, 20 t	installing

(b) Continuous Dam

Work quantities are tabulated below.

Work Site	Phase	Quantity
Mucusós	1	3 nos.
Mucusurú	1	5 nos.
Mucusás	1	10 nos.
Other sites	2	44 nos.
Other sites	3	48 nos.

These sites are located in the branched streams of the middle reaches of the Chama River. The access road from Route 7 to each site is narrow and steep in some places. Therefore, the handling of construction materials and equipment to the site will be done through small cargo trucks. Though each site has enough space to employ mechanized construction methods, small sized equipment will be selected in consideration of site conditions.

In case of Mucusurú, it has the largest volume per dam and the required construction period per continuous dam was estimated, as follows:

Work Item	Required Period
Excavation	9 days
Inner concrete & cobblestone	57 days
Wet stone masonry	22 days
Total	88 days

The required construction period per dam should be decided taking into account the total project period and the reasonable number of equipment. The order of construction works shall be undertaken from the downstream reach in each stream

The major items of equipment required for the works on one continuous dam are as follows:

Equipment	Activity
(1) Excavation	
Backhoe, 0.6 m^3	excavation
Dump truck, 4 t	hauling
Bulldozer, 21 t	spoilbanking
(2) Concrete	
Concrete plant, 0.5 m^3	mixing
Concrete pump, 30 m^3/hr	pouring
Vibrator, 45 mm	compacting
Air compressor, 10.5 m^3	clearing
Diesel generator, 50 kVA	power source
(3) Rubblestone	
Wheel loader, 2.1 m^3	loading
Dump truck, 4 t	hauling
Truck crane, 4.9 t	installing
(4) Wet stone masonry	
Concrete mixer, 0.5 m^3	mixing
Wheel loader, 2.1 m^3	loading
Dump truck, 4 t	hauling
Truck crane, 4.9 t	installing

(c) Retaining Wall

Retaining walls will be constructed at the places where sediment discharges are observed from gullies in branch streams of the Chama River. Total numbers of retaining walls are tabulated as follows:

Phase	Quantity
1	340 nos.
2	450 nos.
3	610 nos.

The work quantities for each structure are as follows:

Work Item	Quantity
Excavation	2.1 m^3
Wet stone masonry	8.6 m^3

The access road from Route 7 to each site is narrow and steep in some places. Therefore, the handling of construction materials and equipment to the site will be done through small cargo trucks. Each site do not have enough space, excavation work will be carried out by manpower, and wet stone masonry work will be employed by small sized equipment.

Typically required construction period per continuous dam was estimated, as follows:

Work Item	Required Period
Excavation	1 day
Wet stone masonry	3 days
Total	4 days

The construction period per continuous dam mentioned above also considers the total project period and the reasonable number of equipment.

The major items of equipment required for the works for the construction of one retaining wall are as follows.

Equipment	Activity
(1) Wet stone masonry	
Concrete mixer, 0.5 m^3	mixing
Wheel loader, 2.1 m^3	loading
Dump truck, 4 t	hauling
Truck crane, 4.9 t	installing

(d) Flood Protection Works

Work items and quantities for each phase are described as follows:

Work	Item	P-1	P-2	P-3	Total
(1)	Clearing	674	653	973	2,300 ha
(2)	Dike Embankment	745,000	1,580,000	1,668,000	3,993,000 m^3
(3)	Pavement	15,420	32,600	16,080	64,100 m^3
(4)	Sodding	28	70	8.3	181 ha
(5)	Revetment	10,300	17,700	2,800	30,800 m
(6)	Groin	325	490	555	1,370 nos.
(7)	Groundsill	1	-	-	1 no.

Higher order of construction will be given where the residential area may be widely involved in the probable inundation area from the viewpoint of economic analysis and total construction period. In general, construction work will be undertaken from the downstream reaches.

According to the work items mentioned above, land clearing will be commenced first by removing trees and shrubs in structural areas. After land clearing, dike embankment will be started. Embankment materials will be taken from the river water course for the purpose of increasing the flow capacity of the Chama River.

After completion of dike embankment, gravel pavement will be commenced for the protection from grasses and keeping good traffic condition.

Following gravel pavement, revetment and groin work will be started. The work order of revetment work is firstly, backfilling by gravel, secondly, installing of wooden piles and concrete blocks, thirdly, construction of wet stone masonry, and the last is installing of gabion mattress and filling by cobblestone.

Groin works will be carried out for the reinforcement of the existing dike. In this section, gabion mattress type groin will be installed, and filled by cobblestone at the connecting portion of the dike and newly installed gabion mattress.

Groundsill will be constructed just downstream of the Chama Bridge to prevent foundation erosion because of the construction of the C-1 sabo dam. Groundsill works will be commenced by excavation work of the Chama River. After excavation to the bottom of the designed elevation, stone bedding will be started. After that, rubblestone concrete work and cobblestone filling will be commenced. In the final stage of the work, gabion mattress will be installed.

The major items of equipment required for the flood protection works are as follows:

Equipment		Activity
(1)	Land clearing	
	Bulldozer, 21 t	clearing
	Cargo truck, 6 t	hauling
(2)	Dike embankment	
	Bulldozer, 21 t	dozing
	Tractor shovel, 3.2 m^3	loading
	Backhoe, 1.2 m^3	loading
	Dump truck, 11 t	hauling
	Motor grader, 3.1 m	spreading
	Tamping roller, 5 t	compacting
	Bulldozer, 21 t	pulling of roller
	Sprinkler truck, 8 kl	moisture control
(3)	Gravel pavement	
	Wheel loader, 2.1 m^3	loading
	Dump truck, 8 t	hauling
	Motor grader, 3.1 m	spreading
	Vibrating roller, 4 t	compacting
(4)	Sod facing	
	Seed sprayer, 1.3 m^3	seed spraying
	Compactor, 90 kg	compacting
(5)	Revetment	
	Wheel loader, 2.1 m^3	loading
	Dump truck, 8 t	hauling
	Truck crane, 4.9 t	installation
	Truck crane, 20 t	installation
(6)	Ground-sill	
	Bulldozer, 21 t	dozing
	Tractor shovel, 3.2 m^3	loading
	Backhoe, 1.2 m^3	loading
	Wheel loader, 2.1 m^3	loading
	Dump truck, 11 t	hauling
	Truck crane, 20 t	installation
	Concrete plant, 0.5 m^3	mixing
	Truck mixer, 3.2 m^3	hauling
	Concrete pump, 30 m^3/hr	pouring concrete

(3) Plan for Local Project

(a) Retaining Wall

Retaining walls will be constructed along the old Route 7 where sediment discharges are observed from gullies. Total length of retaining walls of 750 meters wil be constructed in the Phase 1 project.

Work quantities per meter are as follows:

Work Item	Quantity
Concrete	1.523 m^3
Form	5.266 m^2
Backfilling	0.413 m^3

The access road from Route 7 to each site has enough width; therefore, the handling of construction materials is not a problem.

One unit of retaining wall is assumed to be 7.5 meters in accordance with pouring concrete condition. In this case, the required construction period per unit of retaining wall is estimated as follows:

Work Item	Required Period
Concrete	1 day
Form	2 days
Curing of concrete	1 day
Backfilling	1 day
Total	5 days

The required construction period per unit mentioned above also considers the reasonable number of equipment.

The major items of equipment required for the works on one unit of retaining wall are as follows:

Equipment	Activity
(1) Concrete	
Concrete mixer, 0.5 m^3	mixing
Concrete pump, 30 m^3/hr	pouring
Vibrator, 45 mm	compacting
Air compressor, 10.5 m^3	curing
Diesel generator, 50 kVA	power source
(2) Backfilling	
Backhoe, 0.6 m^3	loading
Compactor, 90 kg	compacting

(b) Check Dam

Check dams will be constructed at branches of the Mocoties River. The total number of check dams are 88 and they will be constructed in the Phase 1 project.

The sites are located in the branched streams of the Mocoties River. The access road from Route 7 to each site has a narrow width. Therefore, handling of construction materials and equipment to the site will be done through small cargo trucks. Though each site has enough space to employ mechanized construction methods, small sized equipment will be selected in consideration of site conditions.

Typical work quantities and required construction period per check dam was estimated, as follows:

Work Item	Volume	Period
Preparation	L.S.	1 day
Excavation	12.0 m^3	1 day
Concrete	7.2 m^3	1 day
Cobblestone	10.2 m^3	1 day
Wet stone masonry	40.0 m^2	1 day
Site clearance	L.S.	1 day
Total		6 days

The required construction period per dam mentioned above also considers the reasonable number of equipment.

The major items of equipment required for the works on one check dam are as follows:

Equipment	Activity
(1) Concrete	
Concrete plant, 0.5 m^3	mixing
Concrete pump, 30 m^3/hr	pouring
Vibrator, 45 mm	compacting
Air compressor, 10.5 m^3	clearing
Diesel generator, 50 kVA	power source
(2) Cobblestone	
Wheel loader, 2.1 m^3	loading
Dump truck, 4 t	hauling
Truck crane, 4.9 t	installing
(3) Wet stone masonry	
Concrete mixer, 0.5 m^3	mixing
Wheel loader, 2.1 m^3	loading
Dump truck, 4 t	hauling
Truck crane, 4.9 t	installing

(c) Revetment

Revetment will be constructed at the lower stream of the confluence of the Chama River and the Nuestra Señora River, and the lower stream of the N-1 sabo dam. The total length of revetment is 720 meters for the six sites. All of this work item is included in the Phase 1 project.

Work quantities and required construction period per unit of 7.5 meters were estimated, as follows:

Work Item	Volume	Period
Preparation	L.S.	1 day
Concrete block	1.6 m^3	1 day
Curing	L.S.	1 day
Wet stone masonry	67.1 m^2	1 day
Backfilling	23.6 m^3	1 day
Gabion mattress	36.0 m^3	1 day
Cobblestone filling	7.5 m^3	1 day
Site clearance	L.S.	1 day
Total		7 days

The required construction period per unit also considers the reasonable number of equipment.

The major items of equipment required for the works on one unit of revetment are as follows:

Equipment	Activity
(1) Wet stone masonry	
Concrete mixer, 0.5 m^3	mixing
Wheel loader, 2.1 m^3	loading
Dump truck, 4 t	hauling
Truck crane, 4.9 t	installing
(2) Concrete	
Concrete plant, 0.5 m^3	mixing
Concrete pump, 30 m^3/hr	pouring
Vibrator, 45 mm	compacting
Air compressor, 10.5 m^3	clearing
Diesel generator, 50 kVA	power source
(3) Backfilling	
Backhoe, 0.6 m^3	loading
Compactor, 90 kg	compacting
(4) Gabion mattress & cobblestone filling	
Wheel loader, 2.1 m^3	loading
Dump truck, 8 t	hauling
Truck crane, 20 t	installation

(d) Flood ControlWorks

All of the flood control works are involved in the Phase 1 project.

Work quantities for these works are estimated as follows:

Work Item		Volume
(1)	Albarregas	
	(a) Concrete parapet	660 m^3
(2)	Q'da Milla	
	(a) Concrete flume	3,480 m^3
	(b) Earth work	5,083 m^3
(3)	Albarregas	
	(a) Earth work	4,550 m^3

The work for the Albarregas River consists of the construction of additional concrete walls on both existing banks of the flume. One construction unit of the concrete parapet wall is planned to be five meters having about 30 cm thickness, so that one unit is 1.65 cubic meters. Work quantity per day is estimated at 10 units, and the period for 10 units is 2.5 days. Under this circumstances, the total construction period si around 108 days or 6 months, including site clearance.

Construction works for the Milla River consist of earth works for the excavation of the riverbed and pouring concrete to form a flume. Total construction period will require 18 months taking into account the capacity of a concrete mixer and work efficiency.

The works for the Portuguesu River consist of an earth flume, excavating the riverbed for 1.4 km. Total construction period will require 6 months.

Required construction period for three sites are summarized as follows:

Work Item	Construction Period
(1) Albarregas	6 months
(2) Q'da Milla	18 months
(3) Albarregas	6 months

The major items of equipment required for the works on one unit of revetment are as follows:

Equipment	Activity
(1) Albarregas River	
Concrete mixer, 0.5 m^3	mixing
Concrete pump, 30 m^3/hr	pouring
Vibrator, 45 mm	compacting
Air compressor, 10.5 m^3	clearing
Diesel generator, 50 kVA	power source
(2) Milla River	
Concrete mixer, 0.5 m^3	mixing
Concrete pump, 30 m^3/hr	pouring
Vibrator, 45 mm	compacting
Air compressor, 10.5 m^3	clearing
Diesel generator, 50 kVA	power source
Backhoe, 0.2 m^3	loading
(3) Portuguesu River	
Backhoe, 0.6 m^3	loading

2.3 Construction Plan for the Action Plan

In compliance with the prioritization of construction of the proposed facilities, the construction time schedule of the action plan shown in Fig. VIII-2 was prepared taking into account the prevailing construction methods in Venezuela and construction conditions. Order of construction was decided from the result of prioritization.

(1) Project Components

The components of the Action Plan are tabulated as follows:

Sub-Project	Target Asset	Objective	Component	Quantity
Basin-wide Project	Agriculture; Urban Area in Lower Reaches	Sediment Control	Sabo Dam	3 sites
			Continuous Dams	18 sites
			Retaining Wall	340 sites
		Flood Control	River Channel Improvement	24.7 km
			Reinforcement of Existing Dike	10.4 km
			Groundsill	1 no.
Local Project	Routes 2 & 7 of Arterial Road	Sediment Control	Check Dam	88 sites
			Retaining Wall	750 m
			Revetment/ Wall	720 m
	Urban Area of Merida and Ejido cities	Flood Control	River Channel Improvement	2.4 km

(2) Plan for Basin-wide Project

(a) C-1 Sabo Dam

Construction of the C-1 sabo dam is required to commence as soon as possible, so that it can prevent a certain volume of sediment flow into the lower reaches of the Chama River.

Major work quantities are tabulated as follows:

Work Item	Quantity
Excavation	145,000 m^3
Outer concrete	23,400 m^3
Inner concrete	15,640 m^3
Rubble stone	23,460 m^3

For the purpose of C-1 dam construction, diversion is handled in two stages. First, a cofferdam enclosing a portion of the water channel at left bank is constructed. Then the cofferdammed area is unwatered, the enclosed dam foundation area excavated, and the foundation surface prepared to receive concrete.

Concrete is poured in the enclosed dam monoliths until they reach an elevation above the impounded water surface. Second stage diversion starts at the beginning of the dry season. The order of pouring concrete is planned to be always higher in both bank portions than the middle portion to minimize damage caused by an unexpected flood water flow.

The construction will commence in June 1993 and all works to be completed, including site clearance, in December 1995.

The major items of equipment required for the works are as follows:

Equipment	Unit	Activity
(1) Excavation		
Backhoe, 0.6 m^3	2	excavation
Dump truck, 8 t	4	hauling
Bulldozer, 21 t	1	spoilbanking
(2) Concrete		
Concrete plant, 0.5 m^3	2	mixing
Truck mixer, 3.2 m^3	4	hauling
Concrete pump, 30 m^3/hr	1	pouring
Vibrator, 45 mm	10	compacting
Air compressor, 10.5 m^3	1	clearing
Diesel generator, 50 kVA	1	power source
(3) Cobblestone		
Wheel loader, 2.1 m^3	1	loading
Dump truck, 8 t	1	hauling
Truck crane, 20 t	1	installing

(b) C-5 Sabo Dam

Construction of the C-5 sabo dam is required to commence next to the C-1 sabo dam construction.

Major work quantities are tabulated as follows:

Work Item	Quantity
Excavation	27,000 m^3
Steel frame	1,139 tons
Rubble stone	14,600 m^3

For the purpose of the C-5 dam construction, diversion is handled in two stages. First, a cofferdam enclosing a portion of the water channel at right bank is constructed. Then the cofferdammed area is unwatered, the enclosed dam foundation area excavated, and the foundation surface prepared to receive installation work of steel frame unit. Steel frame is installed and filled with rubble stones in the enclosed dam monoliths until they reach an elevation above the impounded

water surface. Second stage diversion starts at the beginning of the dry season. The order of installing of steel frame is planned to be always higher in both bank portions than the middle portion to minimize damage caused by an unexpected flood water flow.

The construction will commence in January 1996, and all works to be completed, including site clearance, in December 1997.

The major items of equipment required for the works are as follows:

Equipment	Unit	Activity
(1) Excavation		
Backhoe, 0.6 m^3	1	excavation
Dump truck, 8 t	2	hauling
Bulldozer, 21 t	1	spoilbanking
(2) Steel frame		
Cargo truck, 2 t	4	handling
(3) Cobblestone		
Wheel loader, 2.1 m^3	1	loading
Dump truck, 8 t	1	hauling
Truck crane, 20 t	1	installing

(c) N-1 Sabo Dam

The construction of the N-1 sabo dam has third priority in this action plan which is far from the damage area, since the Nuestra Señora River Basin produces much volume of sediment.

Major work quantities are tabulated as follows:

Work Item	Quantity
Excavation	54,500 m^3
Outer concrete	19,800 m^3
Inner concrete	18,080 m^3
Cobblestone	27,120 m^3

For the purpose of the N-1 dam construction, diversion is handled in two stages. First, a cofferdam enclosing a portion of the water channel at the right bank is constructed. Then the cofferdammed area is unwatered, the enclosed dam foundation area excavated, and the foundation surface prepared to receive concrete. Excavated materials will be utilized for embankment materials for the temporary access road from Route 7 to the construction site. Concrete is poured in the enclosed dam monoliths until they reach an elevation above the impounded water surface. Second stage diversion starts at the beginning of the dry season. The order of pouring concrete is planned to be always higher in both bank portions than the middle portion to minimize damage caused by an unexpected flood water flow.

The construction will commence in January 1998 and all works to be completed, including site clearance, in December 2000.

The major items of equipment required for the works are as follows:

Equipment	Unit	Activity
(1) Excavation		
Backhoe, 0.6 m^3	1	excavation
Dump truck, 8 t	2	hauling
Bulldozer, 21 t	1	spoilbanking
(2) Concrete		
Concrete plant, 0.5 m^3	2	mixing
Truck mixer, 3.2 m^3	4	hauling
Concrete pump, 30 m^3/hr	1	pouring
Vibrator, 45 mm	10	compacting
Air compressor, 10.5 m^3	1	clearing
Diesel generator, 50 kVA	1	power source
(3) Cobblestone		
Wheel loader, 2.1 m^3	1	loading
Dump truck, 8 t	1	hauling
Truck crane, 20 t	1	installing

(d) Continuous Dam

Work quantities are tabulated as follows:

Work Site	Quantity
Mucusós	3 nos.
Mucusurú	5 nos.
Mucusás	10 nos.

These sites are located in El Morro on the branched streams of the Nuestra Señora River. Access road from Route 7 near Merida City to each site has narrow width and steep slope in some places. Therefore, handing of construction materials and equipment to the site will be done through small cargo trucks. Though each site has enough space to employ mechanized construction methods, small sized equipment will be selected in consideration of site conditions.

Order of construction will be first to Mucusás, second to Mucusurú and third to Mucusós taking into account of prioritization and total construction period.

In the case of Mucusurú, it has the largest volume per dam, so that the required construction period per continuous dam was estimated, as follows:

Work Item	Required Period
Excavation	9 days
Inner concrete & Rubble stone	57 days
Wet stone masonry	22 days
Total	88 days

The required construction period per dam also considers the total project period and the reasonable number of equipment.

The construction of Mucusás continuous dams will commence in June 1993 and all works to be completed, including site clearance, in December 1995.

The construction of Mucusurú continuous dams will commence in January 1996 and all works to be completed, including site clearance, in June 1998.

The construction of Mucusós continuous dams will commence in June 1998 and all works to be completed, including site clearance, in December 2000.

The major items of equipment required for the works on one continuous dam are as follows:

Equipment	Unit	Activity
(1) Excavation		
Backhoe, 0.6 m^3	1	excavation
Dump truck, 4 t	2	hauling
Bulldozer, 21 t	1	spoilbanking
(2) Concrete		
Concrete mixer, 0.5 m^3	1	mixing
Concrete pump, 30 m^3/hr	1	pouring
Vibrator, 45 mm	2	compacting
Air compressor, 10.5 m^3	1	clearing
Diesel generator, 50 kVA	1	power source
(3) Cobblestone		
Wheel loader, 2.1 m^3	1	loading
Dump truck, 4 t	1	hauling
Truck crane, 4.9 t	1	installing
(4) Wet stone masonry		
Concrete mixer, 0.5 m^3	1	mixing
Wheel loader, 2.1 m^3	1	loading
Dump truck, 4 t	1	hauling
Truck crane, 4.9 t	1	installing

(e) Retaining Wall

Retaining walls will be constructed at the places where sediment discharges are observed from gullies in branch

streams of the Chama River. The total number of retaining walls are estimated at 340.

Work quantities for each structure are as follows:

Work Item	Quantity
Excavation	2.1 m^3
Wet stone masonry	8.6 m^3

The access road from Route 7 to each site has narrow width and steep slope in some places. Therefore, handling of construction materials and equipment to the site will be done through small cargo trucks. Each site does not have enough space, excavation work will be carried out by manpower, and wet stone masonry work will be applied by small sized equipment.

In the case of Mucusurú, it has the largest volume per dam, so that the required construction period per continuous dam was estimated, as follows:

Work Item	Required Period
Preparation	1 day
Excavation	1 day
Wet stone masonry	3 days
Total	5 days

The required construction period per unit also considers the total project period and the reasonable number of equipment.

The construction of 113 retaining walls will commence in June 1993 and all works to be completed, including site clearance, in December 1995.

The construction of 227 retaining walls will commence in January 1996 and all works to be completed, including site clearance, in December 2000.

The major items of equipment required for the works on one retaining wall are as follows:

Equipment	Unit	Activity
(1) Wet stone masonry		
Concrete mixer, 0.5 m^3	1	mixing
Wheel loader, 2.1 m^3	1	loading
Dump truck, 4 t	1	hauling
Truck crane, 4.9 t	1	installing

(f) Flood Protection Works

Work items and quantities for each section are given as follows:

Work Item	Sec. 1	Sec. 2	Sec. 3	Sec. 4	Sec. 5	Total
Clearing	157	170	119	212	16	674 ha
Embankment of dike	198,000	195,000	131,000	200,000	21,000	745,000 m^3
Pavement	3,600	3,800	2,600	4,800	600	15,400 m^3
Sodding	8.0	7.0	4.2	7.4	1.4	28.0 ha
Revetment	2,000	2,000	1,500	3,200	1,600	10,300 m
Groin	0	0	0	0	325	325 nos.
Ground-sill	-	-	-	-	1	1 no.

Remarks:

(a) Sec. 1: Station number 3.0 to 9.0 (right bank)
(b) Sec. 2: Station number 10.4 to 16.7 (left bank)
(c) Sec. 3: Station number 17.9 to 22.3 (right bank)
(d) Sec. 4: Station number 35.0 to 43.0 (left bank)
(e) Sec. 5: Existing flood protection dike (left bank)

Order of construction will be first to Section 1, second to Section 5, third to Section 3, fourth to Section 2, and the last to Section 4 taking into account prioritization study in viewpoint of economic analysis and total construction period.

According to the abovementioned work items, land clearing will be commenced first clearing of trees and shrubs in structural areas. Following land clearing, dike embankment will be started. Embankment materials will be taken from the river water course for the purpose of increasing the flow capacity of the Chama River.

After finishing dike embankment, gravel pavement will be commenced for the protection from grasses and keeping good traffic conditions.

Following gravel pavement, revetment and groin works will be started. Work order of the revetment work is firstly,

backfilling by gravel, secondly, installing of wooden piles and concrete blocks, thirdly, construction of wet stone masonry, and the last is installing of gabion mattress and filling by cobblestone.

Groin works will be carried out for the reinforcement of the existing dike. In this section, gabion mattress type groin will be installed, and filled by cobblestone at the connecting portion of the dike and newly installed gabion mattress.

Groundsill works will be constructed just downstream of the Chama Bridge to prevent bridge foundation erosion because of the construction of the C-1 sabo dam. Groundsill works will be commenced by excavation work of the Chama River. After excavation to the bottom of the designed elevation, stone bedding will be started. After that, cobblestone concrete work and cobblestone filling will be commenced. In the final stage of the work, gabion mattress will be installed.

The construction of Section 1, from 3.0 km to 9.0 km in the right bank, will be commenced in June 1993 and all work to be completed, including site clearance, in October, 1994.

The construction of Section 5, reinforcement of the existing dike including groundsill works will be commenced in October 1994 and all work to be completed, including site clearance, in December 1995.

The construction of Section 2, from 10.4 km to 16.7 km in the left bank, will be commenced in January 1996 and all work to be completed, including site clearance, in May 1977.

The construction of Section 3, from 17.9 km to 22.3 km in the right bank, will be commenced in June 1997 and all work to be completed, including site clearance, in September 1998.

The construction of Section 4, from 35.0 km to 43.0 km in the right bank, will be commenced in October 1998 and all work to be completed, including site clearance, in December 2000.

The construction of the groundsill works will be commenced in June 1993 and all work to be completed, including site clearance, in June 1994.

The major items of equipment required for the flood control works on each section are as follows:

Equipment	Unit	Activity
(1) Land clearing		
Bulldozer, 21 t	1	clearing
Cargo truck, 6 t	1	hauling
(2) Dike embankment		
Bulldozer, 21 t	1	dozing
Tractor shovel, 3.2 m^3	1	loading
Backhoe, 1.2 m^3	1	loading
Dump truck, 11 t	4	hauling
Motor grader, 3.1 m	1	spreading
Tamping roller, 5 t	1	compacting
Bulldozer, 21 t	1	pulling of roller
Sprinkler truck, 8 kl	1	moisture control
(3) Gravel pavement		
Wheel loader, 2.1 m^3	1	loading
Dump truck, 8 t	1	hauling
Motor grader, 3.1 m	1	spreading
Vibrating roller, 4 t	1	compacting
(4) Sod facing		
Seed sprayer, 1.3 m^3	2	seed spraying
Compactor, 90 kg	1	compacting
(5) Revetment		
Wheel loader, 2.1 m^3	1	loading
Dump truck, 8 t	4	hauling
Truck crane, 4.9 t	1	installation
Truck crane, 20 t	1	installation
Concrete mixer, 0.5 m^3	1	mixing
(6) Ground-sill		
Bulldozer, 21 t	1	dozing
Tractor shovel, 3.2 m^3	1	loading
Backhoe, 1.2 m^3	1	loading
Wheel loader, 2.1 m^3	1	loading
Dump truck, 11 t	4	hauling
Truck crane, 20 t	1	installation
Concrete plant, 0.5 m^3	1	mixing
Truck mixer, 3.2 m^3	2	hauling
Concrete pump, 30 m^3/hr	1	pouring concrete

(3) Plan for Local Project

(a) Retaining Wall

Retaining walls will be constructed along the old Route 7 where sediment discharges are observed from gullies. Total length of retaining walls are estimated at 750 meters.

Work quantities per one meter are tabulated below.

Work Item	Quantity
Concrete	1.523 m^3
Form	5.266 m^2
Backfilling	0.413 m^3

Access road from Route 7 to each site has enough width. Therefore, the handling of construction materials is not a problem.

One unit of the retaining wall is assumed to be 7.5 m in accordance with pouring concrete condition. In this case, the required construction period per unit of retaining wall is estimated as follows:

Work Item	Required Period
Concarete	1 day
Form	2 days
Curing of concrete	1 day
Backfilling	1 day
Total	5 days

The required construction period per unit also considers the reasonable number of equipment.

The construction of 750 meters of retaining wall will be commenced in June 1992 and all work to be completed, including site clearance, in December 1994.

The major items of equipment required for one unit of retaining wall are as follows:

Equipment	Unit	Activity
(1) Concrete		
Concrete mixer, 0.5 m^3	1	mixing
Concrete pump, 30 m^3/hr	1	pouring
Vibrator, 45 mm	2	compacting
Air compressor, 10.5 m^3	1	clearing
Diesel generator, 50 kVA	1	power source
(2) Backfilling		
Backhoe, 0.6 m^3	1	loading
Compactor, 90 kg	1	compacting

(b) Check Dam

Check dams will be constructed at branches of the Mocoties River. The total number of check dams are 88.

The sites are located between Santa Cruz City and Tovar City on the branched streams of the Mocoties River. Access road from Route 7 to each site has narrow width. Therefore, handling of construction materials and equipment to the site will be done through small cargo trucks. Though each site has enough space for mechanized construction methods, small sized equipment will be selected in consideration of site conditions.

Work quantities and required construction period for one check dam were estimated, as follows:

Work Item	Volume	Period
Preparation	L.S.	1 day
Excavation	12.0 m^3	1 day
Concrete	7.2 m^3	1 day
Cobblestone	10.2 m^3	1 day
Wet stone masonry	40.0 m^2	1 day
Site clearance	L.S.	1 day
Total		6 days

The required construction period per dam also considers the reasonable number of equipment.

The construction of all check dams will commence in January 1995 and all works to be completed, including site clearance, in June 1997.

The major items of equipment required for the works on one check dam are as follows:

Equipment	Unit	Activity
(1) Concrete		
Concrete Mixer, 0.5 m^3	1	mixing
Concrete pump, 30 m^3/hr	1	pouring
Vibrator, 45 mm	2	compacting
Air compressor, 10.5 m^3	1	clearing
Diesel generator, 50 kVA	1	power source
(2) Cobblestone		
Wheel loader, 2.1 m^3	1	loading
Dump truck, 4 t	1	hauling
Truck crane, 4.9 t	1	installing
(3) Wet stone masonry		
Concrete mixer, 0.5 m^3	1	mixing
Wheel loader, 2.1 m^3	1	loading
Dump truck, 4 t	1	hauling
Truck crane, 4.9 t	1	installing

(c) Revetment

Revetment will be constructed at the lower stream of the confluence of the Chama River and the Nuestra Señora River. The total length of revetment is 720 meters for six sites.

Work quantities and required construction period per unit od 7.5 meters is estimated as follows:

Work Item	Volume	Period
Preparation	L.S.	1 day
Concrete block	1.6 m^3	1 day
Curing	L.S.	1 day
Wet stone masonry	67.1 m^2	1 day
Backfilling	23.6 m^3	1 day
Gabion mattress	36.0 m^3	1 day
Cobblestone filling	7.5 m^3	1 day
Site clearance	L.S.	1 day
Total		8 days

The abovementioned required construction period per unit also considers the reasonable number of equipment.

The construction of all revetments will be commenced in July 1997 and all work to be completed, including site clearance, in December 2000.

The major items of equipment required for the works on one unit of revetment are as follows:

Equipment	Unit	Activity
(1) Wet stone masonry		
Concrete mixer, 0.5 m^3	1	mixing
Wheel loader, 2.1 m^3	1	loading
Dump truck, 4 t	1	hauling
Truck crane, 4.9 t	1	installing
(2) Concrete block		
Concrete mixer, 0.5 m^3	1	mixing
Concrete pump, 30 m^3/hr	1	pouring
Vibrator, 45 mm	2	compacting
Air compressor, 10.5 m^3	1	clearing
Diesel generator, 50 kVA	1	power source
(3) Backfilling		
Backhoe, 0.6 m^3	1	loading
Compactor, 90 kg	1	compacting
(4) Gabion mattress & cobblestone filling		
Wheel loader, 2.1 m^3	1	loading
Dump truck, 8 t	2	hauling
Truck crane, 20 t	1	installation

(d) Flood Control Works

Work quantities for these works are estimated as follows:

Work Item	Volume
(1) Albarregas	
(a) Concrete Parapet	660 m^3
(2) Milla River	
(a) Concrete Flume	3,480 m^3
(b) Earth Works	5,083 m^3
(3) Portuguesu River	
(a) Earth Works	4,550 m^3

The work for the Albarregas River is the construction of additional concrete parapet walls on both existing banks of the flume. One construction unit of the concrete parapet wall is planned to be five meters having about 30 cm thickness, so

that one unit is 1.65 cubic meters. Work quantity per one day is estimated at 10 units, and cycle time for 10 units will require 25 days. Under these circumstances, the total construction period is around 108 days or 6 months, including site clearance.

Construction works for the Milla River area consist of earth works for excavation of the riverbed and pouring concrete to form a flume. Total construction period is 18 months taking into account of the capacity of a concrete mixer and work efficiency.

The work for the Portuguesu River is the construction of an earth flume, excavating the riverbed for 1.4 km. Total construction period is 6 months.

Required construction period for three sites are summarized as follows:

Work Item	Construction Period
(1) Albarregas	6 months
(2) Milla	18 months
(3) Albarregas	6 months

The construction for the Albarregas River will be commenced in July 1992 and all works to be completed, including site clearance, in December 1992.

The construction for the Milla River will be commenced in January 1993 and all works to be completed, including site clearance, in June 1994.

The construction for Portuguesu River will be commenced in July 1994 and all works to be completed, including site clearance, in December 1994.

The major items of equipment required for the works on one unit of revetment are as follows:

Equipment	Unit	Activity
(1) Albarregas River		
Concrete mixer, 0.5 m^3	1	mixing
Concrete pump, 30 m^3/hr	1	pouring
Vibrator, 45 mm	2	compacting
Air compressor, 10.5 m^3	1	clearing
Diesel generator, 50 kVA	1	power source
(2) Q'da Milla		
Concrete mixer, 0.5 m^3	1	mixing
Concrete pump, 30 m^3/hr	1	pouring
Vibrator, 45 mm	2	compacting
Air compressor, 10.5 m^3	1	clearing
Diesel generator, 50 kVA	1	power source
Backhoe, 0.2 m^3	1	loading
(3) Q'da La Portuguesa		
Backhoe, 0.6 m^3	1	loading

3. COST ESTIMATES

3.1 Terms and Conditions

The construction cost for the Project is estimated on the basis of the preliminary design and construction plan.

The cost estimates are prepared on the following basic assumptions and conditions.

(1) Price Level

Construction cost for the project is estimated on the price level of January 1989.

(2) Exchange Rate

The foreign currency conversion rate from U.S. dollar to Venezuelan bolivar to Japanese yen is US$1.00 = Bs40 = ¥130.

(3) Currency of Cost Estimates

The construction cost is estimated for the foreign currency component and local currency component in accordance with the origin of material.

The currency for cost estimate is expressed in Venezuelan bolivar for the local currency component and in Japanese yen for the foreign currency component. Total construction cost is expressed in Venezuelan bolivar.

The local and foreign currency components include the following items.

(a) Foreign Currency Component

- Cost of Plant and Equipment
- Cost of Imported Materials
- Cost of Engineering Services of Consultant
- Physical Contingency

(b) Local Currency Component

- Labor Cost
- Cost of local materials such as cement, aggregate, reinforcement bars, P.O.L.
- Cost of plant and equipment
- Project administration expenses
- Local currency portion of engineering services
- Land Compensation Cost
- Physical Contingency

(4) Labor Wages, Material Cost and Equipment Cost

The direct construction cost for civil works is estimated on the unit price basis multiplying the unit price of works by the corresponding work quantity.

The unit price is estimated on the basis of the construction plan. The unit price of each work item consists of the costs of material, labor and equipment. The contractor's indirect cost and mark-up are also incorporated in these unit prices.

(a) Labor Cost

The labor cost is computed under the local currency component of the cost estimates.

The rates of labor wage shown in Table VIII-1 include all the laborers fringe benefits such as vacation and sick leave, insurance premiums, medicare, living allowance and others, according to the Labor Law in Venezuela. The foreign labor wage is computed in foreign and local currencies taking into account the annual income, air fare and living allowance, etc.

(b) Materials Cost

Prices of materials required for construction were canvassed in Mérida and El Vigia, referring to the prevailing market price in Venezuela and foreign market prices as well. These prices are counted in the local currency component for local

material and foreign currency component for imported material, taking into consideration availability of materials.

The unit cost of each construction material described in bolivar is listed in Table VIII-2.

(c) Equipment Cost

The equipment cost consists of the depreciation cost, repairing cost and annual administration cost, which are calculated using a rate of C.I.F. price at the construction site. Hourly or daily equipment costs are shown in Table VIII-3.

The currency component of the equipment cost is assumed as follows:

i) Imported Equipment

Foreign Currency Component:
- Depreciation Cost
- Spare Parts Cost
- Annual Administration cost

Local Currency Component:
- Mechanic Labor Cost
- Spare Parts Cost

ii) Locally Procured Equipment

Local currency component:
- Depreciation Cost
- Spare Parts Cost
- Mechanic Labor Cost
- Annual Administration Cost

(5) Contractor's Indirect Cost

The contractor's expenses are counted proportinately in every unit price. These expenses are assumed to be thirty (30%) percent of the direct cost to cover the following costs.

- Field Administration and Supervision (12%);
- Corporate Overhead, Profit and Tax (12%);
- Security and Safety Control (4%); and
- Other Incidentals (2%)

(6) Constitution of the Capital Cost

Construction cost is estimated in accordance with the direct construction cost and the costs for the project administration, and the engineering service cost is also estimated. Contingency is provided for the physical changes of work conditions.

(a) Direct Construction Cost

Constitution of the project facilities are as follows:

i) Sediment Control Works
ii) Flood Control Works

(b) Land Acquisition Cost

Target areas are classified as follows:

i) Platano
ii) Pasture

(c) Administration Expenses

Government administration expense is assumed at five (5%) percent of the total of the direct construction cost and the land acquisition cost taking into account the project scale both in the basin-wide and local projects.

(d) Engineering Services Cost

Engineering services cost including detailed design and assistance for the tendering is assumed at ten (10%) percent of the direct construction cost taking into account the project scale both in the basin-wide and local projects.

(e) Physical Contingency

Physical contingency is assumed at ten (10%) percent of the total cost taking into account the project features both in the basin-wide and local projects, because the direct construction works consist mainly of civil works.

3.2 Unit Construction Cost for Work Items

The direct construction cost is estimated on the unit price basis multiplying the unit price of works by the corresponding work quantities.

The unit price is estimated based on the construction method in this report. The first breakdown of unit price for each work item consists of costs of labor, materials and equipment. The contractor's indirect cost and mark-up are also incorporated in these unit prices.

Unit price list and first breakdown of unit price are shown in Table VIII-4 and in the APPENDIX, respectively.

3.3 Construction Cost for the Master Plan

The total construction cost for the basin-wide project is estimated at 3,503.1 million bolivares as shown in Table VIII-5.

The total construction cost for the local project is estimated at 47.8 million bolivares as shown in Table VIII-6.

Financial year for the disbursement schedule in Venezuela is the same as the calender year starting in January and ending in December. According to the construction schedule mentioned in Chapter 2.2, the construction cost for the basin-wide and local projects are assumed to be disbursed as shown in Fig. VIII-1.

3.4 Construction Cost for the Action Plan

The total construction cost for the basin-wide project is estimated at 1,054.7 million bolívares as shown in Table VIII-7.

The total construction cost for the local project is estimated at 47.8 million bolívares as shown in Table VIII-8.

Financial year for the disbursement schedule in Venezuela is the same as the calender year starting in January and ending in December. According to the construction schedule mentioned in Chapter 2.3, the construction cost for the basin-wide and local projects are assumed to be disbursed as shown in Tables VIII-9 and VIII-10, respectively.

Table VIII-1 DAILY LABOR WAGE BY CLASSIFICATION

NO.	CLASSIFICATION	UNIT	LABOR WAGE F.C. (Yen)	LABOR WAGE L.C. (Bs)
1.	Foreman	day	0	675
2.	Operator	day	0	600
3.	Asst. Operator	day	0	500
4.	Driver	day	0	500
5.	Mechanic	day	0	515
6.	Electrician	day	0	515
7.	Welder	day	0	565
8.	Carpenter	day	0	515
9.	Concrete Worker	day	0	465
10.	Mason	day	0	515
11.	Steel Worker	day	0	515
12.	Rigger	day	0	565
13.	Skilled Labor	day	0	515
14.	Semi-skilled Labor	day	0	465
15.	Common Labor	day	0	450
16.	Foreman (foreign)	day	30,000	1,400

NOTE: Minimum wage up to Feb.1989 = 2,000 Bs./month
Minimum wage after Mar.1989 = 4,000 Bs./month
Workable days will be assumed at 22 days per month

Working hour Mon.to Thu.;
7:00-12:00 and 13:00-18:00(10 hrs)
Fri.;
7:00-12:00 and 13:00-16:00(8 hrs)
(48 hrs. per week)

Overtime work 35% up for night
60% up for midnight
100% up for horiday

Table VIII-2 UNIT PRICE OF MATERIALS

NO.	DESCRIPTION	UNIT	PRICE (Bs)
1.	Portland Cement	ton	1,180.0
2.	Reinforcing Bar	ton	9,450.0
3.	Channel Steel	ton	11,800.0
4.	Steel Angle	ton	11,800.0
5.	Cobble & Rubble	ton	240.0
6.	River Run (screened)	ton	300.0
7.	Concrete Aggregate	ton	400.0
8.	Water-reducing Agent	kg	46.2
9.	Annealed Iron Wire	kg	9.3
10.	Nail	kg	25.0
11.	Seed	kg	1.2
12.	Fertilizer	kg	8.5
13.	Form Oil	lit.	24.6
14.	Metal Form, 300x1500	no.	531.0
15.	Metal Form, 200x1500	no.	531.0
16.	Timber	m3	9,300.0
17.	Bolt and Nut	kg	43.6
18.	Clump	no.	38.8
19.	Clip	no.	6.5
20.	Concrete Pipe, 1m dia.	m	1,840.0
21.	PVC Pipe, 50mm	m	33.0
22.	Light Oil	lit.	0.7
23.	Gasoline	lit.	2.5
24.	Lubricant	lit.	25.9
25.	Steel frame	ton	13,000.0
26.	Pipe Support, 48.6mm	m	56.5
27.	Anchor Bolt, 22mm	no.	39.3

Table VIII-3 PLANT AND EQUIPMENT EXPENCE

No.	Equipment	Specification	Unit	Equipment cost F/C (JYE)	L/C (Bs.)
1.	Bulldozer	21t	hr	0	2,538
2.	Tractor shovel	3.2m3	hr	0	2,814
3.	Wheel loader	2.1m3	hr	0	1,412
4.	Backhoe	1.2m3	hr	0	3,158
5.	Backhoe	0.6m3	hr	0	1,398
6.	Backhoe	0.2m3	hr	0	856
7.	Dump truck	11t	hr	0	742
8.	Dump truck	8t	hr	0	581
9.	Cargo truck	6t	hr	0	394
10.	Cargo truck,w/crane	2t	hr	0	250
11.	Truck crane	20t	hr	0	1,683
12.	Truck crane	4.9t	hr	0	684
13.	Motor grader	3.1m	hr	0	1,144
14.	Tamping roller	5t	hr	0	431
15.	Vibrating roller	4t	hr	0	683
16.	Vibrating roller	0.5t	hr	0	210
17.	Vibrating compactor	90kg	day	0	207
18.	Sprinkler truck	8kl	hr	0	707
19.	Truck mixer	3.2m3	hr	0	677
20.	Concrete plant	0.5m3	hr	0	1,398
21.	Concrete pump	30m3/h	hr	0	1,839
22.	Concrete bucket	1.0 m3	day	0	420
23.	Concrete vibrator	45mm	day	0	131
24.	Concrete mixer	0.5m3	day	0	1,220
25.	Seed sprayor	1.3m3	hr	0	456
26.	Volute pump	150mm	day	0	214
27.	Volute pump	80mm	day	0	100
28.	Volute pump	50mm	day	0	49
29.	Water tank	5m3	day	0	837
30.	Welder	300A	day	0	72
31.	Diesel generator	200kvA	day	0	2,601
32.	Diesel generator	50kvA	day	0	986
33.	Diesel generator	10kvA	day	0	416
34.	Diesel generator	3kvA	day	0	195
35.	Centrifugal pump	50 mm	day	0	63
36.	Air compressor	10.5m3/min	day	0	3,113