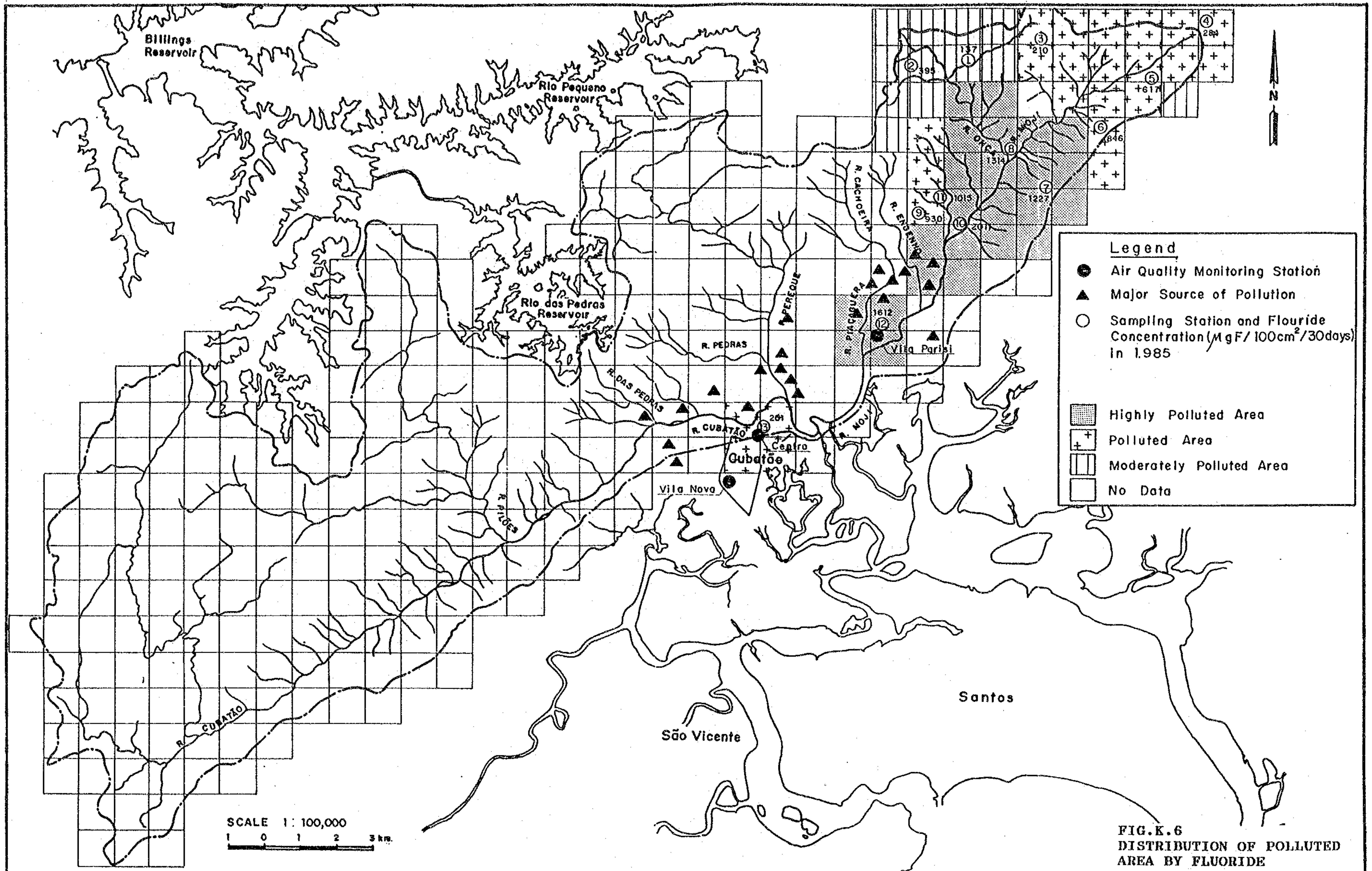

FIG.K.6
DISTRIBUTION OF POLLUTED AREA BY FLUORIDE

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Source: AVALIAÇÃO DA QUALIDADE DO AR NA SERRA DO MAR, 1a. ETAPA LEVANTAMENTO NO VALE DO MOJI, 1986, CETESB

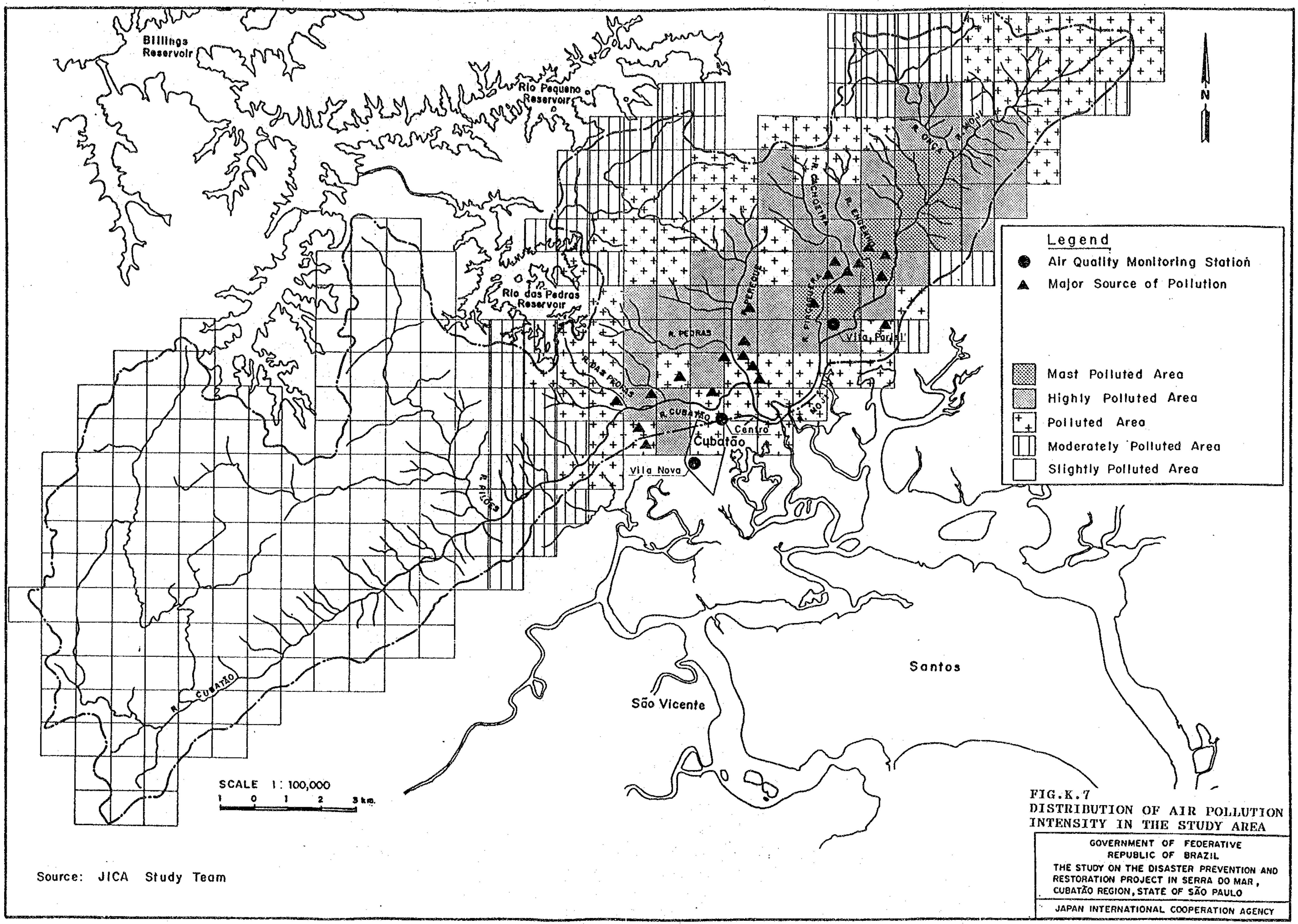

FIG.K.7
DISTRIBUTION OF AIR POLLUTION INTENSITY IN THE STUDY AREA

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO
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Source: JICA Study Team

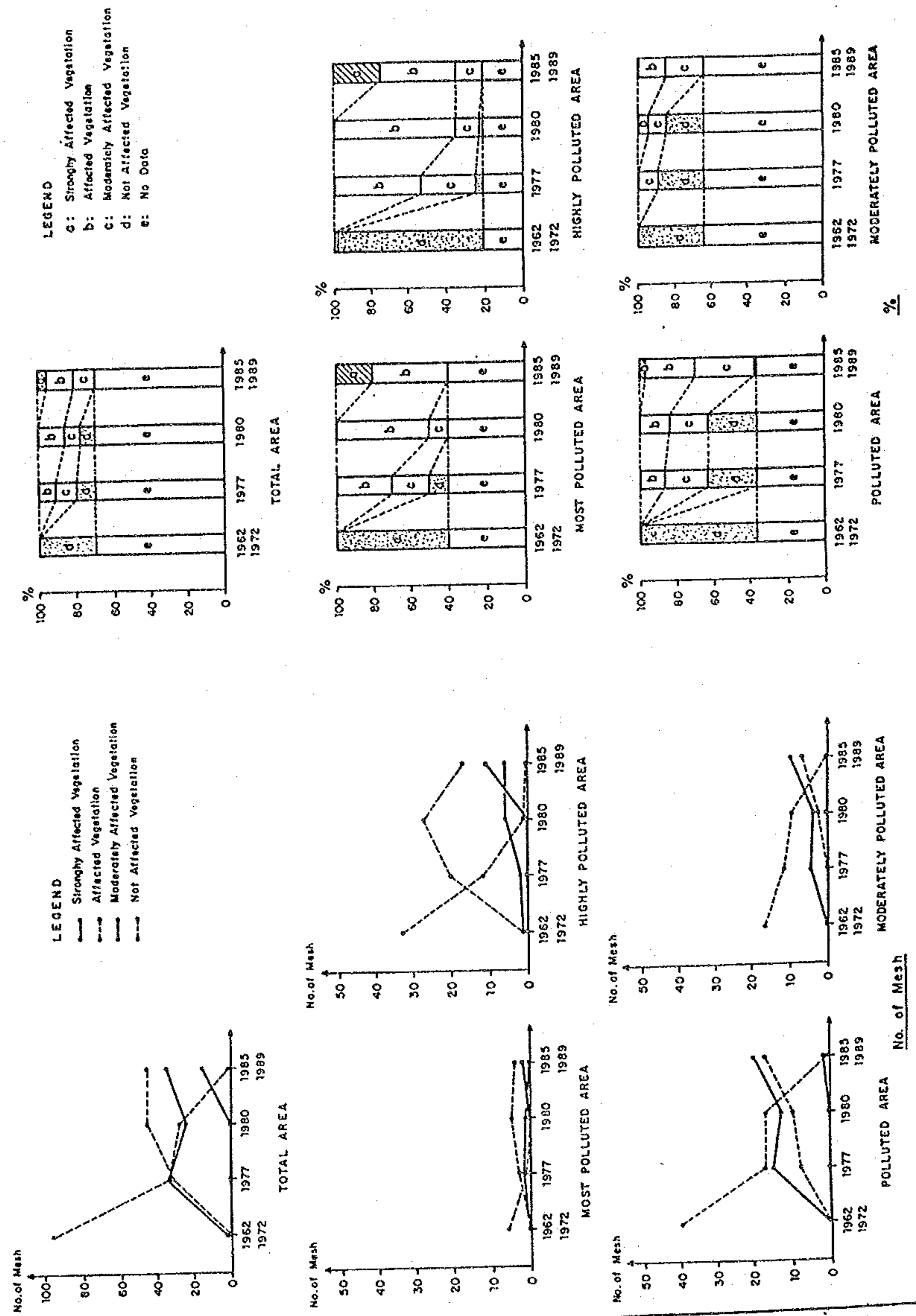

FIG.K.8
ANNUAL CHANGE OF AFFECTED VEGETATION AREA BY EACH POLLUTION INTENSITY AREA

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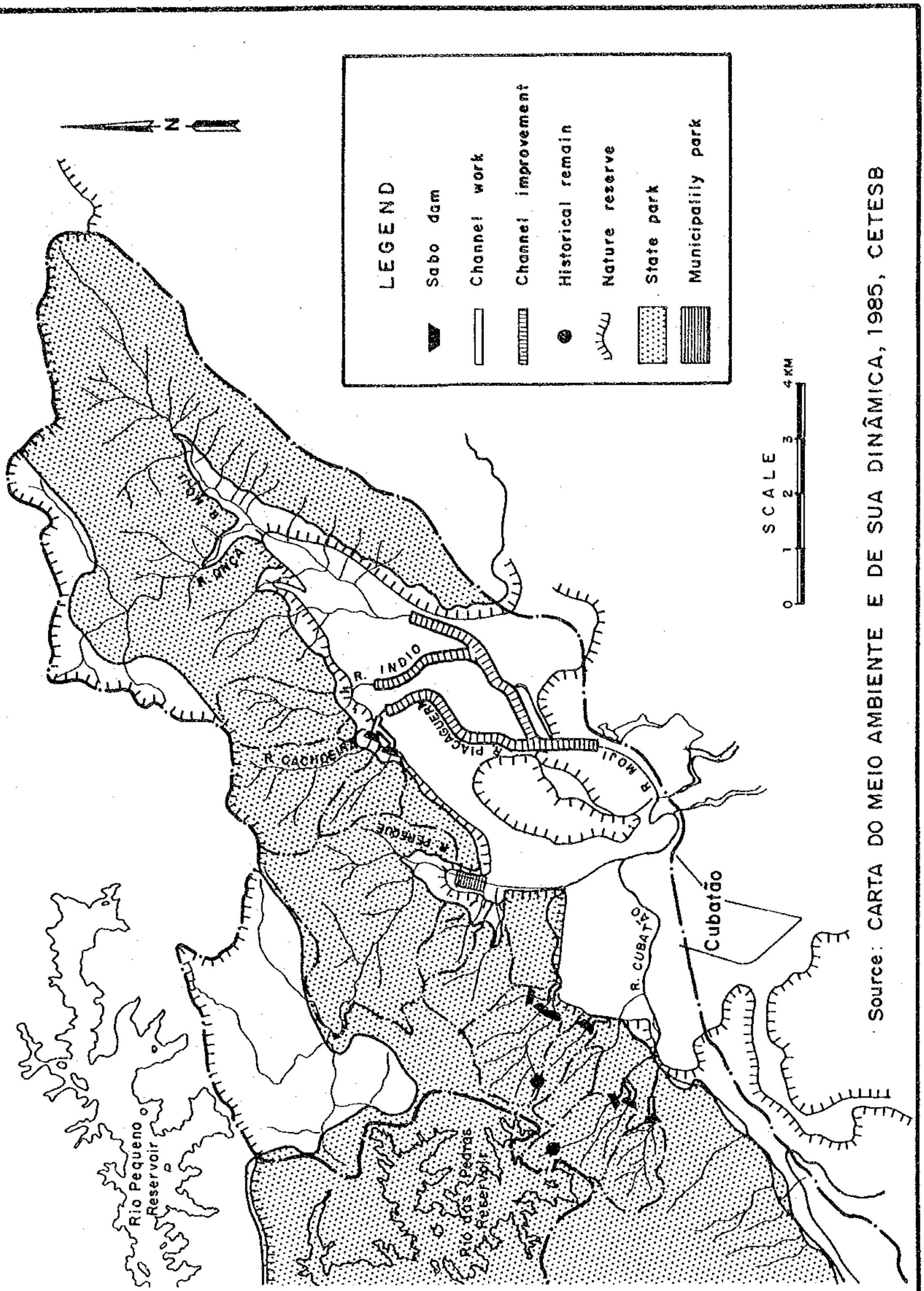

FIG. K.9
ENVIRONMENTAL CONDITIONS AND THE PRIORITY PROJECTS

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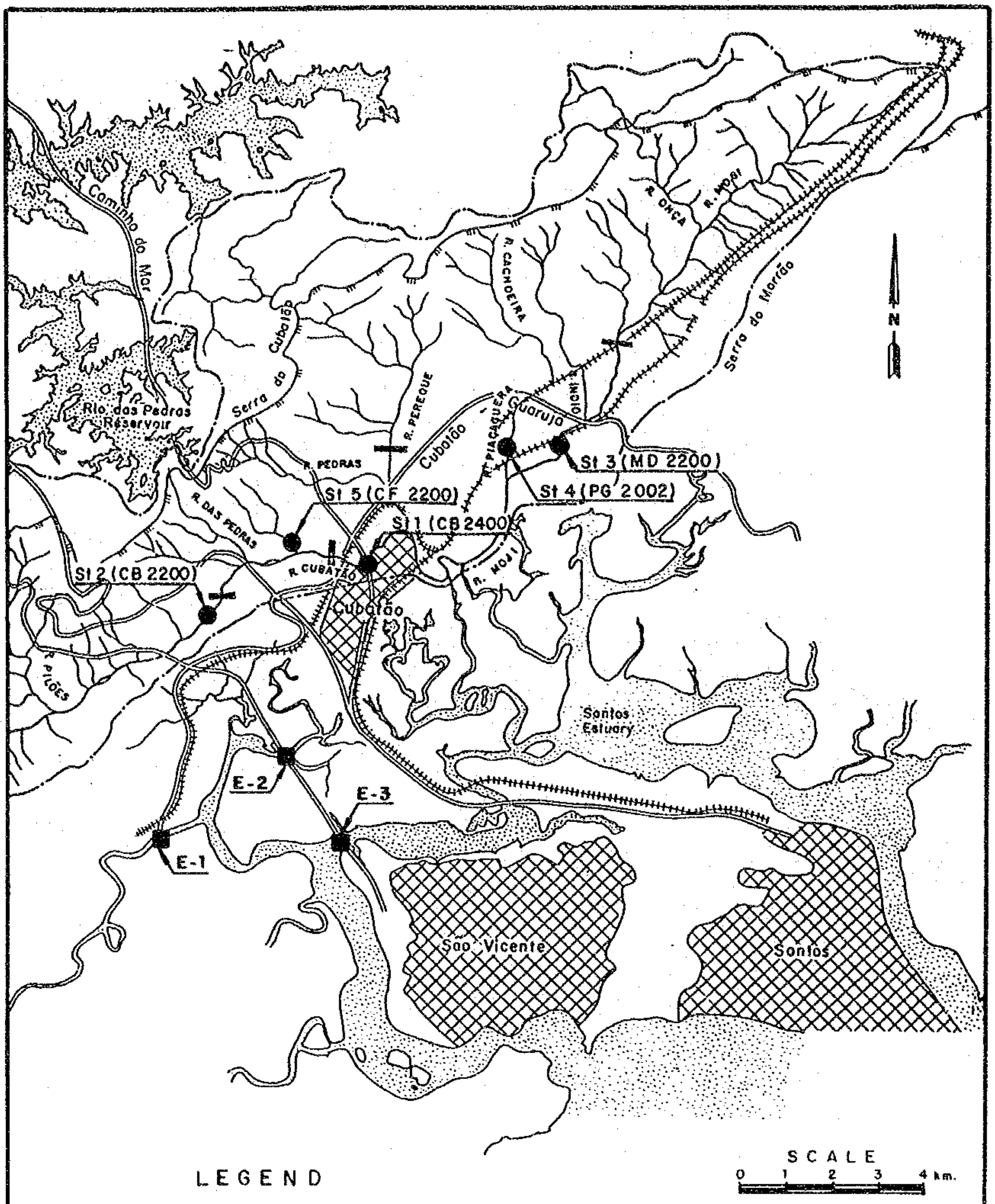

LEGEND

● Water Quality Monitoring Station

■ Water Sampling Station

FIG. K.10
WATER QUALITY MONITORING STATION
AND WATER SAMPLING STATION

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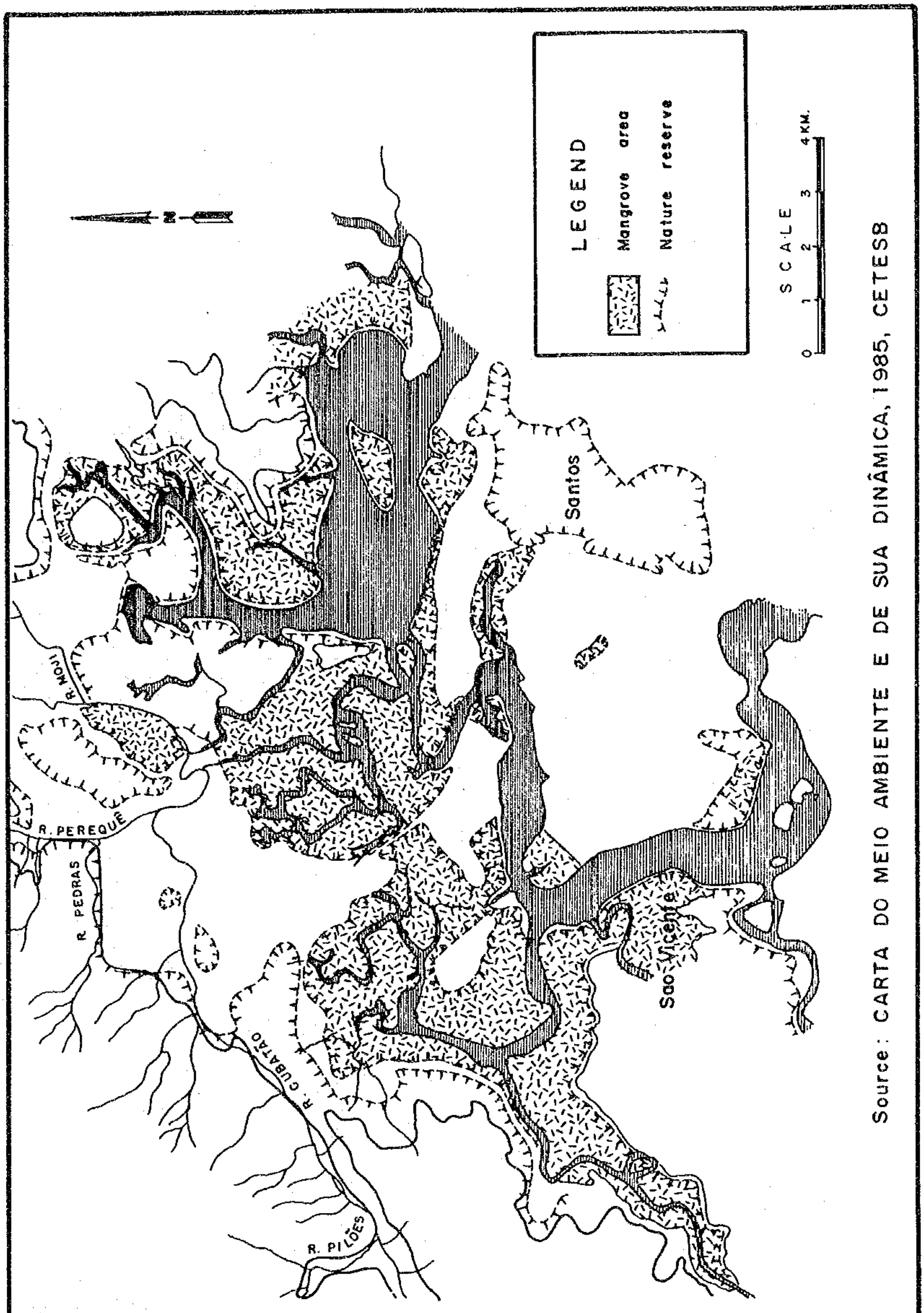

FIG. K.11
DISTRIBUITION OF MANGROVE AREA

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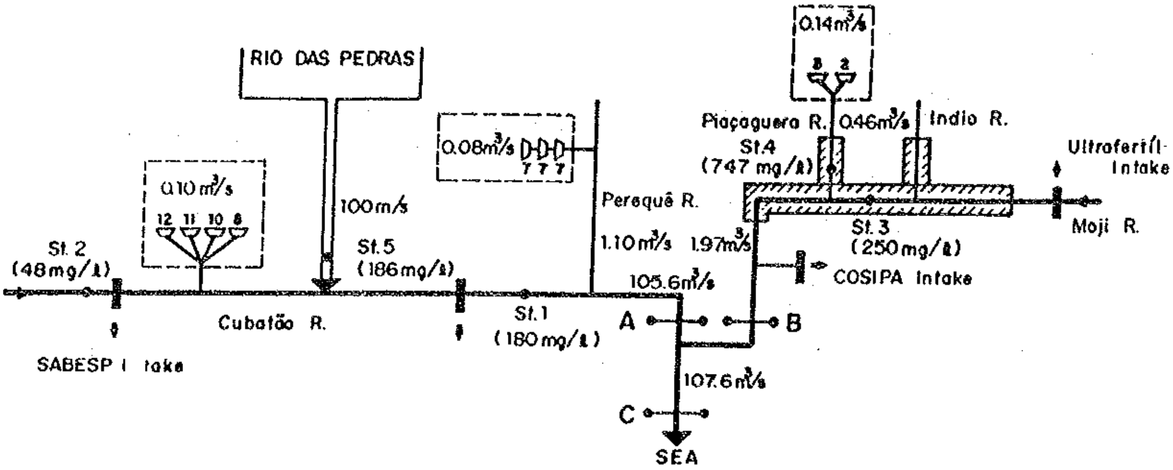

Note: St. 5 .... No. of St.
(186mg/ℓ) .... a value of SS, (1989)
• .... Monitoring St.

▨ Priority channel improvement area

▮ ... Existing intake facility

[0.14m³/s] ...... Mean discharge in the dry season, July-Dec. (Raferto Progress Report ANNEX I, 7 page)

[3 2] ...... No. of sub basin of the priority project

Load and Concentration of SS

Assessment Point	Without Project	With Project
A (Before Moji R.)	$L_A = 105.6\ m^3/s \times 180\ mg/\ell \doteqdot 19.0\ kg/s$ (≒180 mg/ℓ)[2]	$L_A' = (0.10\ m^3/s + 0.08\ m^3/s \times a^{1)}\ mg/\ell + (105.4\ m^3/s \times 180\ mg/\ell) \doteqdot 19.0\ kg/s + 0.18 \times a \times 10^{-3}\ kg/s$
B (Before Cubatão R)	$L_B = (0.46\ m^3/s \times 747\ mg/\ell) + (1.51\ m^3/s \times 250\ mg/\ell) \doteqdot 0.7\ kg/s$ (≒ 355 mg/ℓ)	$L_B' = (0.14\ m^3/s \times a\ mg/\ell) + (0.32\ m^3/s \times 747\ mg/\ell) + (1.51\ m^3/s \times a\ mg/\ell) \doteqdot 0.2\ kg/s + 1.65 \times a \times 10^{-3}\ kg/s$
C (After Moji R.)	$L_C = L_A + L_B = 19.7\ kg/s$ (≒ 183 mg/ℓ)	$L_C' = L_A' + L_B' \doteqdot 19.2\ kg/s + 1.83 \times a \times 10^{-3}\ kg/s$

Note: 1) "A" means a concentration of SS during construction period

2) ( ) Shows the concentration of SS by using a complete - misture formula.

FIG. K.12 CALCULATION METHOD OF SS LOAD AND CONCENTRATION

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

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ANNEX L

PRELIMINARY DESIGN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

The objectives of this study in the final stage are to prepare preliminary design of structures proposed in the priority project and to estimate work quantities of their structures for the sediment run-off and flood disaster prevention in the study area.

This ANNEX-L describes the following four(4) items carried out from the beginning of February upto the end of October in 1990.

(1) To conduct data collection
(2) To undertake field investigations
(3) To estimate preliminary work quantities for master plan
(4) To carry out preliminary design and to estimate work quantities of their structures for priority project

2. DATA COLLECTION

Data collection was conducted related to the data on preliminary design from Departamento de Aguas e Energia Elètrica (DAEE) and other agencies concerned. Some as built drawings of the structures for sediment run-off and flood disaster prevention are available in and around the study area. Data collected is listed in Table L.1.

3. FIELD INVESTIGATIONS

Field investigations were undertaken to identify the conditions of existing and planned structures for the disaster prevention in the study area.

There are two(2) kinds of structures in the area. One is structures for sediment run-off disaster prevention and the other is for flood disaster prevention.

As for structures for sediment run-off disaster prevention, there are three(3) gabion Sabo dams with a height of about 7 to 10 m in the Engenho river located in the mountain area behind the ULTRAFERTIL factory (Refer to No.2 on Fig.L.1) and the nine(9) gabion check dams with a height of about 4 to 5 m in the Pedras river situated in the mountain area behind the PETROBRAS factory (Refer to No. 5 on Fig.L.1).

As-built drawings for the three(3) Sabo dams in the Engenho river mentioned above are shown on Figs.L.3 to Fig.L.6 and nine(9) gabion check dams in the Pedras river are shown on Figs. L.7 to Fig.10. The other structures (No.1, No.3, and No.4 on Fig.L.1) are constructed of simple riprap stone works with a height of less than 1 m.

As for the structures for flood disaster prevention by dike, revetment and culverts in the downstream area, these have been described in Annex C (For locations see Fig.L.2).

4. PRELIMINARY ESTIMATE OF WORK QUANTITIES FOR MASTER PLAN

4.1 Type of Structure

The structures designed for the disaster prevention in the study area are mainly composed of the following two(2) items classified in view of the characteristics of disaster prevention.

(1) Structure for sediment run-off disaster prevention
(2) Structure for flood disaster prevention

4.1.1 Structure for sediment run-off disaster prevention

The structures are divided into the three(3) kinds mainly planned in the middle and/or upper reaches of the objective river basin taking into account the functions necessary for the countermeasures. The typical design of structures are presented on Fig.L.11.

(1) Sabo dam
(2) Channel works
(3) Groundsill

The Sabo dam has the functions of (a) To store and control sediment run-off, (b) To prevent vertical erosion and sediment production in riverbed, (c) To prevent movement of unstable sediment accumulated on riverbed, and (d) To protect river side erosion. It is classified into a prevention structure having a height of more than 5 m and consists of main body, stilling basin and subdam. The main body is generally made by concrete.

The channel works have the objectives to prevent disordered flows, and longitudinal and transverse erosions. It safely handles the flow, fixing the stream course and confining the flow in the channel.

The groundsill has the functions of (a) To make gentle river slope and maintain stable river slope, (b) To prevent vertical erosion and sediment production in riverbed, (c) To prevent movement of unstable sediment accumulated on riverbed, and (d) To prevent river side erosion. It is dam type structure having a height less than 5 m and also made by the concrete.

There are similarity in view of the shape of design between Sabo dam and groundsill. However, there are difference in terms of functions of their structures. The main function of the Sabo dam is to store and control sediment run-off and that of the groundsill is to make a gentle river slope and maintain stable river slope.

4.1.2 Structure for flood disaster prevention

The structures are divided into the three(3) kinds mainly planned in the downstream reaches of the objective river basin. The typical design of structures are illustrated on Fig.L.12.

(1) Dike
(2) Revetment
(3) Diversion tunnel

The dike has the function to pass the design flood flow safely with a certain freeboard.

The revetment has the function to protect the bank against unstable river flow and erosion. It consists of the slope protection, foundation protection and foot protection works.

4.2 Preliminary Estimate of Work Quantities for Master Plan

The preliminary estimate of work quantities for the master plan was undertaken based on the topo-maps in the scale of 1 to 5,000 for sediment run-off disaster prevention works and topo-maps in the scale of 1 to 5,000 and river cross section for flood disaster prevention works.

Sabo dam volume was preliminary estimated by the following equation applying the data of profile at dam axis. Excavation line of foundation and abutment portions for each damsite was determined based on the field investigations.

$$V = 1/2\ BH\ (L_1 + L_2) + 1/6\ (m + n)\ H^2\ (L_1 + 2L_2)$$

where,

- V : dam volume (m^3)
- B : dam crest width (m)
- H : dam Height (m)
- L_1 : dam length at the crest (m)
- L_2 : dam length at the bottom (m)
- m : upstream slope of dam (= 0.6)
- n : downstream slope of dam (= 0.2)

Work quantities of other structures such as channel works, groundsill, dike, revetment, riverbed protection works and diversion works of flood flow by tunnel were estimated by using typical design and cross sections obtained from the topo-maps available. Estimated work quantities for sediment run-off and flood disaster prevention works are summarized in Table L.2.

5. PRELIMINARY DESIGN AND WORK QUANTITIES FOR PRIORITY PROJECT

5.1 Design Criteria

5.1.1 General

As generally recognized, disaster prevention works consist of many kinds of works depending upon site conditions. Therefore, design criteria are needed to apply for the formulation of the works. However, these design criteria for the disaster prevention have not been established in Brazil.

In Japan, such kinds of criteria have been prepared, revised and made by the Ministry of Construction. As for the locality from the view point of disaster prevention works, there is similarity between the locality in the study area and that in the mountain area in Japan. Accordingly, it could be possible to apply the criteria to the design works for the disaster prevention study in this project.

5.1.2 Sediment run-off disaster prevention works

(1) Sabo dam

(a) Main dam

As for crest width of main dam, 3 m is employed from the viewpoint of stability of dam crest and the safety against damage by sediment. For the downslope, the gradient of 1:0.2 is employed and the gradient of the upslope is obtained by stability analysis. The dam body is generally to be embedded more than 1.0 m below the fresh rock line.

Load conditions for stability analysis vary according to the dam height of 15m, more or less, as shown in the following table.

Dam Height	Seismic	Flood
$H < 15$ m	-	Hydrostatic Pressure
$H \geq 15$ m	Hydrostatic Pressure Sediment Pressure Uplift Seismic Load Dynamic Water Pressure	Hydrostatic Pressure Sediment Pressure Uplift

Stability of dam body against tensile stress, sliding, and bearing strength of bedrock are calculated by the following formulas:

Tensile stress : $d = \frac{Mx - My}{V} \geq B/3$

Sliding : $S \leq f \cdot V/H$

Bearing strength of bedrock : $\sigma = V/B \cdot (1 + 6e/B)$

$< $ bearing strength of bedrock

where,

- d : position along dam base where combined force of dam weight and external force act (m)
- f : coefficient of friction
- V : vertical force per unit width (t/m)
- H : horizontal force per unit width (t/m)
- Mx : total moment of vertical forces per unit width at zero point (t·m/m)
- My : total moment of horizontal forces per unit width at zero point (t·m/m)
- B : bottom width of dam body (m)
- S : safety factor
- σ : vertical stress (t/m^2)

Overflow section is provided at such position and direction that overflow water may easily concentrate to the center of the downstream to avoid any river bank erosion. The bottom width of overflow section is usually same as the river width to minimize overflow water depth.

Overflow water depth can be obtained from the equation given below, on the condition that the inverse trapezoid overflow section is assumed.

$$Q = 2/15\ (1 + a)\ C\ (2g)^{1/2}\ (3B_1 + 2B_2)\ h^{3/2}$$

where,

- Q : design flood discharge (100-year return period flood)
- a : percent of sediment volume to discharge (= 0.1)
- C : coefficient of overflow (= 0.6)
- B_1 : bottom width of overflow section (m)
- B_2 : water surface width on the overflow section (m)
- h : overflow depth (m)

(b) Subdam and apron

It is generally needed to provide a subdam and apron at the dowstream of main dam, so that the base of main dam will not be scoured by the impact of water dropped from the overflow section. From the following formulas, apron length (L), height of sidewall (hj), height of subdam (D) and apron thickness (t) are obtained.

$$L \geq lw + X$$
$$hj = h_1 / 2 \{(1 + 8F^2)^{1/2} - 1\}$$
$$D = hj - h_2$$
$$t = 0.2 (0.6h_1 + 3h_3 - 1)$$
$$lw = V_o \{2 (h_1 + 0.5h_3) / g\}^{1/2}$$
$$V_o = q_o / h_3$$
$$X = 4.5hj$$
$$h_1 = q_1 / V_1$$
$$F = V_1 / (gh_1)^{1/2}$$

where,

- L : apron length (m)
- lw : distance between dam axis and point of water drop (m)
- X : distance of hydraulic jump (m)
- hj : depth of hydraulic jump (m)
- h_1 : super-critical flow depth before hydraulic jump (m)
- h_2 : depth of overflow section of subdam (m)
- h_3 : depth of overflow section of main dam (m)
- F : Froude number before hydraulic jump
- V_o : overflow velocity at main dam (m/s)
- V_1 : flow velocity before hydraulic jump (m/s)
- q_o : discharge per unit width at main dam crest ($m^3/s \cdot m$)
- q_1 : discharge per unit width before hydraulic jump ($m^3/s \cdot m$)
- D : height of subdam (m)
- t : apron thickness (m)

(2) Channel works

(a) Channel alignment

Channel alignment is generally designed to be straight as much as possible. If it is difficult, the value of radius divided by channel width is determined by the following equation.

$$R / B \geqq 5$$

where,

- R : radius (m)
- B : channel width (m)

(b) Channel Slope

Channel slope is normally designed to be less or equall to the half of original riverbed slope. Changing ratio of channel slope between the upstream and downstream is determined by the following equations.

$$Ia / Ib \leqq 2 \quad (\text{if } Ia \geqq 1/30)$$
$$Ia / Ib \leqq 1.5 \quad (\text{if } Ia < 1/30)$$

where,
  Ia : upstream slope
  Ib : downstream slope

(c) Channel cross section

Channel cross section is decided by uniform flow or non-uniform flow calculation method. Manning formula is adopted to estimate mean flow velocity. Flow carrying capacity is generally designed below the ground level at the right and left sides. Channel width can be obtained taking into account the present river width, and relationships between the existing channel width and catchment area in Japan. Revetment with a wet stone masonry having a slope of 1 to 0.5 is employed at the both sides.

(3) Groundsill

Height of groundsill should be designed at less than 5 m. Crest width is normally planned to be 1.0 m to 2.0 m. Downslope of groundsill is determined based on the stability analysis when a height of groundsill is greater than 3.5 m. It will be the vertical when a height of grounsill is less than 3.5 m. Length of apron is obtained by the following equation.

$$L = 2 * (H + h)$$

where,
  L : length of apron (m)
  H : height of groundsill from apron surface (m)
  h : overflow depth (m)

5.1.3 Flood disaster prevention works

Design of river plan, profile and cross sections are made based on the planning criteria in Annex-I. Side slope of new channel in the Moji river, which is one of the major works for flood disaster prevention plan was designed to be 1 to 2.0, because the slope of present river channel having a side slope of about 1 to 2.0 is stable even though N value of lowflow channel portion is less than 1 from the available geological investigation results near this area.

Revetment by a wet stone masonry is designed in the bending portion, the area where river flow is concentrated and the area close to the planned related facilities such as culvert, Ultrafertil intake weir and railway bridge.

5.2 Preliminary Design and Work Quantities

5.2.1 Sediment run-off disaster prevention works

The preliminary design for the priority project was carried out based on the topo-maps in the scale of 1 to 500 for Sabo dam, and topo-maps in the scale of 1 to 5,000 and river cross sections for channel works and groundsill.

The design for Sabo dam, channel works and groundsill in each basin are illustrated on Fig.L.13 and Fig.L.14. General feature of Sabo dam is listed in Table L.3. Excavation line of foundation and abutment portions for each damsite was determined based on the preliminary results of geological investigations.

The work quantities of Sabo dam, channel works and groundsill were estimated by using typical sections obtained from the topo-maps available. Estimated work quantities for the sediment run-off disaster prevention works are summarized in Table L.4.

5.2.2 Flood disaster prevention works

The preliminary design for the priority project was conducted based on the topo-maps in the scale of 1 to 5,000 and river cross sections.

The design for plan of river alignment, river profile, river cross sections and related structures such as culvert, intake weir, road bridge and railway bridge are illustrated on Figs.L.15 to L.20.

The work quantities for the flood disaster prevention works were estimated by using typical sections obtained from the topo-maps available as shown in Table L.5.

TABLES

TABLE L.1 LIST OF DATA COLLECTED

No.	TITLE	SOURCE
1.	As built Drawings of eight (8) gabion dams in the Pedras River; 6 sheets	PETROBRAS
2.	As built Drawings of three (3) gabion daws in the Engenho River; 5 sheets	ULTRA FERTIL
3.	PLANEJAMENTO (Drainage Manual)	DAEE/CETESB (1980)
4.	NO TITLE List of Project in SERRA DO MAR	
5.	AMPLIAÇAO DA CALHA DO RIO TIETE ENTRE AS BARRAGENS DA PENHA E EDGARD DE SOUZA (Enlargement of the channel works in the Tietê River between the Penha and Edgard de Souza Dams)	DAEE
6.	SISTE HIDRAULICO PARA APROVEITAMENTO HIDROELETRICO DA USINA DA USTINA HENRY BORDEN	ELETROPAULO

TABLE L.2 PRELIMINARY ESTIMATE OF WORK QUANTITY FOR MASTER PLAN

(1) Sediment Run-off Disaster Prevention Works

No.	Basin No.	Dam No.	Sabo dam (m3)	Channel works (m2)	Groundsill (m3)
1	1	1 - 1	1,900	9,600	-
2	2	2 - 1	19,900	8,700	-
3		2 - 2	6,000		
4		2 - 3	1,400		
5	3	3 - 1	10,400	5,900	-
6		3 - 2	3,500		
7	4	4 - 1	13,200	9,500	1,000
8		4 - 2	7,300		
9	5	5 - 1	7,500	4,500	-
10		5 - 2	1,700		
11	6	6 - 1	6,900	11,100	-
12		6 - 2	4,300		
13		6 - 3	3,700		
14	7	7 - 1	5,700	4,200	-
15		7 - 2	5,200		
16		7 - 3	4,900		
17		7 - 4	2,300		
18		7 - 5	3,900		
19		7 - 6	3,200		
20	8	8 - 1	5,300	4,000	-
21		8 - 2	2,700		
22	9	9 - 1	5,400	2,000	-
23		9 - 2	4,300		
24		9 - 3	3,900		
25	10	10 - 1	2,500	-	-
26		10 - 2	2,900		
27	11	11 - 1	12,300	4,700	-
28		11 - 2	5,500		
29		11 - 3	1,900		
30	12	12 - 1	10,300	6,600	700
31		12 - 2	3,300		
32		12 - 3	6,400		
Total			179,600	70,800	1,700

(2) Flood Disaster Prevention Works

	Cubatão Basin	Moji Basin
(a) Dike	157,000 m^3	250,000 m^3
(b) Excavation	256,000 m^3	846,000 m^3
(c) Dredging	256,000 m^3	584,000 m^3
(d) Revetment	6,700 m^2	24,800 m^2
(e) Riverbed protection	1 No.	3 Nos.
(f) Diversion tunnel	600m X 2 Nos.	-

TABLE L.3 GENERAL FEATURE OF SABO DAM (1/2)

Item		2-1	3-1	7-1	7-3	7-4
Catchment Area	(km2)	3.79	1.29	2.64	0.75	1.34
Slope of Riverbed		1/30	1/20	1/14	1/9	1/11
River Name		Cachoeira	Cachoeira	Pedras	Pedras	Pedras
Dam Type		Concrete	Concrete	Concrete	Concrete	Concrete
Upstream Slope		0.55	0.50	0.55	0.50	0.55
Downstream Slope		0.20	0.20	0.20	0.20	0.20
Crest Elevation	(EL.m)	44.80	45.50	72.40	91.30	94.10
Crest Length	(m)	250.00	102.00	68.00	59.00	53.00
Crest Width	(m)	3.0	3.0	3.0	3.0	3.0
Riverbed Elevation	(EL.m)	33.3	32.5	58.9	77.3	79.7
Height from Riverbed	(m)	7.0	10.0	10.0	10.0	10.0
Dam Bottom Elevation	(EL.m)	27.3	28.5	56.9	73.3	77.7
Dam Height	(m)	13.0	14.0	12.0	14.0	12.0
Dam Volume	(10^3m3)	22.0	9.8	3.6	3.8	2.0
1/100 Design Flood	(m3/s)	124.0	42.0	87.0	25.0	44.0
Overflow Width	(m)	15.0	10.0	10.0	5.0	5.0
Overflow Depth	(m)	2.9	1.9	2.9	2.0	2.8
Overflow Elevation	(EL.m)	40.3	42.5	68.9	87.3	89.7
High Water Level	(EL.m)	43.2	44.4	71.3	89.7	92.5
Free Board	(m)	0.6	0.6	0.6	0.6	0.6
Length of Apron	(m)	20.00	24.00	-	-	-
Slope of Apron Bed		1/30	1/20	-	-	-
Thickness of Apron.	(m)	2.40	2.20	-	-	-
Length of Subdam	(m)	2.40	2.20	-	-	-
Crest Width of Subdam	(m)	140.00	70.00	-	-	-
Design Bed of Subdam		32.80	30.50	-	-	-

TABLE L.3 GENERAL FEATURE OF SABO DAM (2/2)

Item		8-1	10-1	11-1	12-1
Catchment Area	(km2)	0.41	1.26	0.62	1.11
Slope of Riverbed		1/10	1/12	1/6	1/10
River Name		-	-	-	-
Dam Type		Concrete	Concrete	Concrete	Concrete
Upstream Slope		0.45	0.45	0.50	0.55
Downstream Slope		0.20	0.20	0.20	0.20
Crest Elevation	(EL.m)	52.10	46.87	111.40	111.40
Crest Length	(m)	68.00	26.00	85.00	69.00
Crest Width	(m)	3.0	3.0	3.0	3.0
Riverbed Elevation	(EL.m)	42.1	35.2	97.1	98.3
Height from Riverbed	(m)	7.0	8.0	10.0	9.0
Dam Bottom Elevation	(EL.m)	38.1	34.2	93.1	94.3
Dam Height	(m)	11.0	9.0	14.0	13.0
Dam Volume	(10^3m3)	3.7	1.1	7.3	4.9
1/100 Design Flood	(m3/s)	14.0	42.0	20.0	37.0
Overflow Width	(m)	5.0	5.0	5.0	5.0
Overflow Depth	(m)	1.4	2.7	1.7	2.5
Overflow Elevation	(EL.m)	49.1	43.2	107.1	107.3
High Water Level	(EL.m)	50.5	45.9	108.8	109.8
Free Board	(m)	0.6	0.6	0.6	0.6
Length of Apron	(m)	22.00	-	27.00	26.00
Slope of Apron Bed		1/10	-	1/6	1/10
Thickness of Apron	(m)	1.80	-	2.30	2.60
Length of Subdam	(m)	1.80	-	2.30	2.60
Crest Width of Subdam	(m)	22.00	-	22.00	28.00
Design Bed of Subdam		39.90	-	91.30	94.30

TABLE L.4 WORK QUANTITIES FOR SEDIMENT RUN-OFF DISASTER PREVENTION WORKS

Unit : m3

Dam No.	Item	Dam	Channel	Groundsill	Total
2-1	V	22,000	(530 m)	1,200	23,200
	Ve	35,200	70,800	15,700	121,700
3-1	V	9,800	(490 m)	200	10,200
	Ve	8,500	31,200	100	39,800
7-1	V	3,600	(250 m)	1,000	4,600
	Ve	10,300	39,400	10,500	60,200
7-3	V	3,800	(0 m)	-	3,800
	Ve	2,400	-	-	2,400
7-4	V	2,000	(0 m)	-	2,000
	Ve	1,200	-	-	1,200
Sub-total	V	9,400	(250 m)	1,000	10,400
	Ve	13,900	39,400	10,500	63,800
8-1	V	3,700	(440 m)	400	4,100
	Ve	6,400	23,200	4,000	33,600
10-1	V	1,100	(0 m)	-	1,100
	Ve	600	-	-	600
11-1	V	7,300	(410 m)	1,100	8,400
	Ve	4,400	12,300	15,700	32,400
12-1	V	4,900	(750 m)	900	5,800
	Ve	3,900	64,000	19,000	86,900
Total	V	58,200	(2,870 m)	4,800	63,000
	Ve	72,900	240,900	65,000	378,800

Note : V ; volume of structure
Ve ; excavation volume

TABLE L.5 WORK QUANTITIES FOR FLOOD DISASTER PREVENTION WORKS

Item		Unit	Quantity
(1)	Dike (L=9.3km)		
	1) Gravel metalling	m3	6,600
	2) Excavation	m3	329,000
	3) Dredging	m3	141,000
	4) Embankment	m3	255,000
	5) Sod Facing	m2	111,600
(2)	Revetment (L=1.45km)		
	1) Wet stone masonry	m2	9,800
	2) Concrete block	m3	170
	3) Berm concrete	m3	120
	4) Gabion	m3	2,900
(3)	Culvert (6 Sites)		
	1) Excavation	m3	2,300
	2) Concrete	m3	550
	3) Reinforcement bar	ton	30
	4) Form	m2	960
	5) RC pile	m	136
	6) Gate	ton	8
(4)	Intake Weir (1 Site)		
	1) Excavation	m3	2,000
	2) Concrete	m3	270
	3) Wet stone masonry	m2	460
	4) Concrete block	m3	840
(5)	Parapet wall (1 Site)		
	1) Excavation	m3	680
	2) Concrete	m3	310
	3) Reinforcement bar	ton	25
	4) Form	m2	870
(6)	Road Bridge (1 Site)		
	1) Embankment	m3	5,100
	2) Super structure (Steel)	ton	74
	3) Sub structure (Concrete)	m3	350
	4) Steel pile	m	450
(7)	Railway Bridge (1 Site)		
	1) Embankment	m3	5,240
	2) Ballast	m3	550
	3) Super structure (Steel)	ton	270
	4) Sub structure (Concrete)	m3	440
	5) Steel pile	m	620

FIGURES

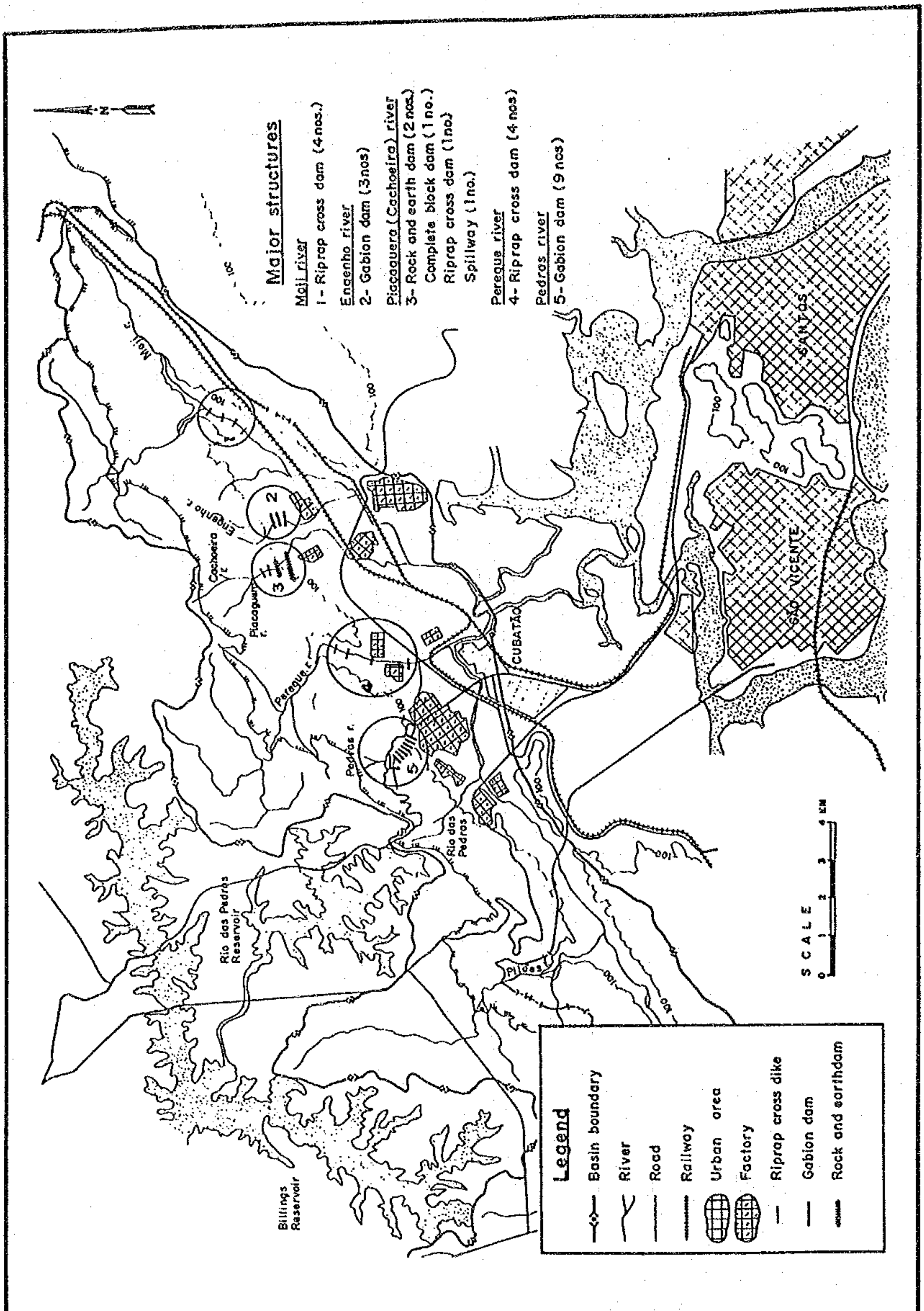


FIG. L.1
LOCATION MAP OF EXISTING STRUCTURES FOR SEDIMENT RUN-OFF DISASTER PREVENTION

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

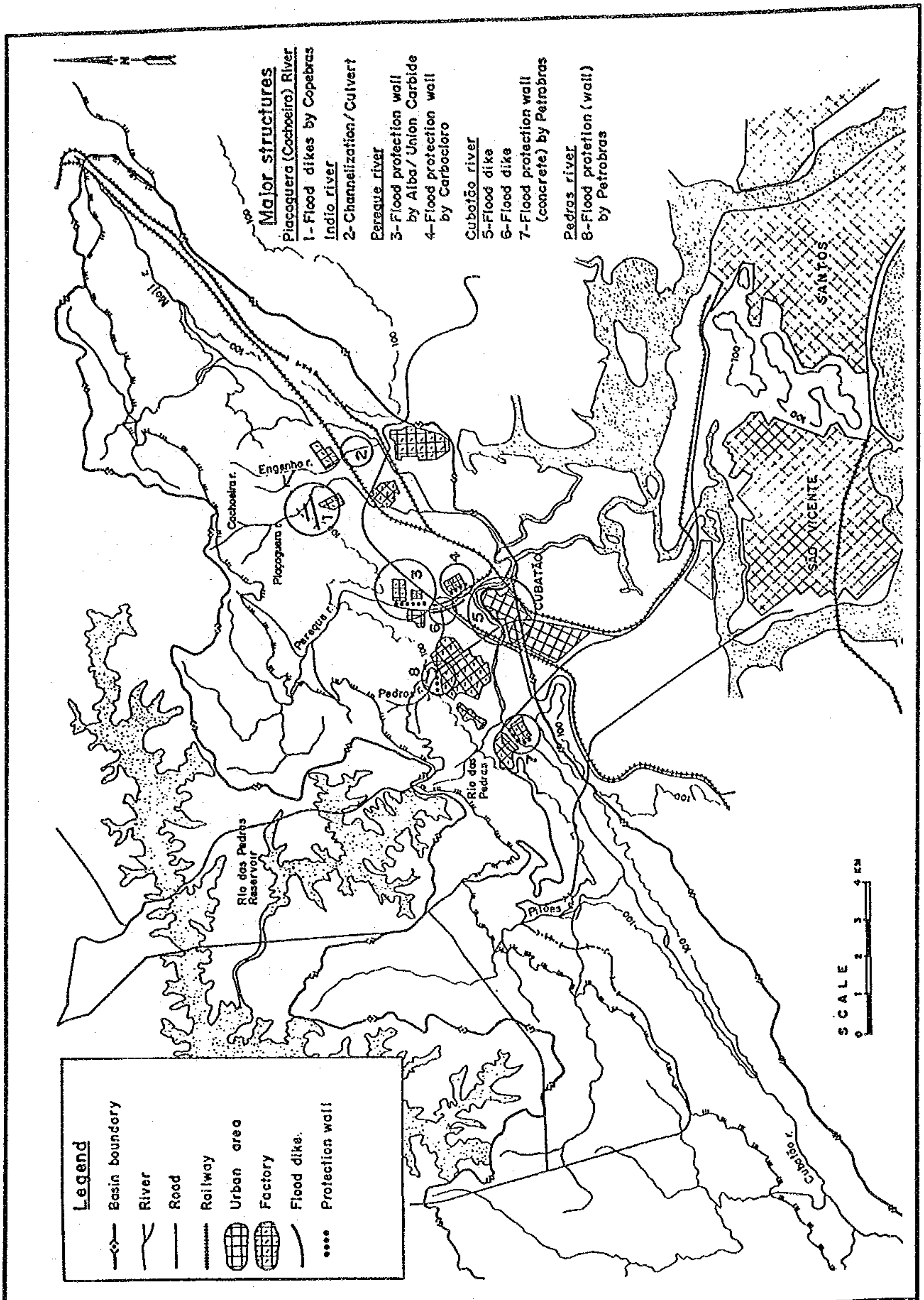


FIG. L.2
LOCATION MAP OF EXISTING STRUCTURES FOR FLOOD DISASTER PREVENTION

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

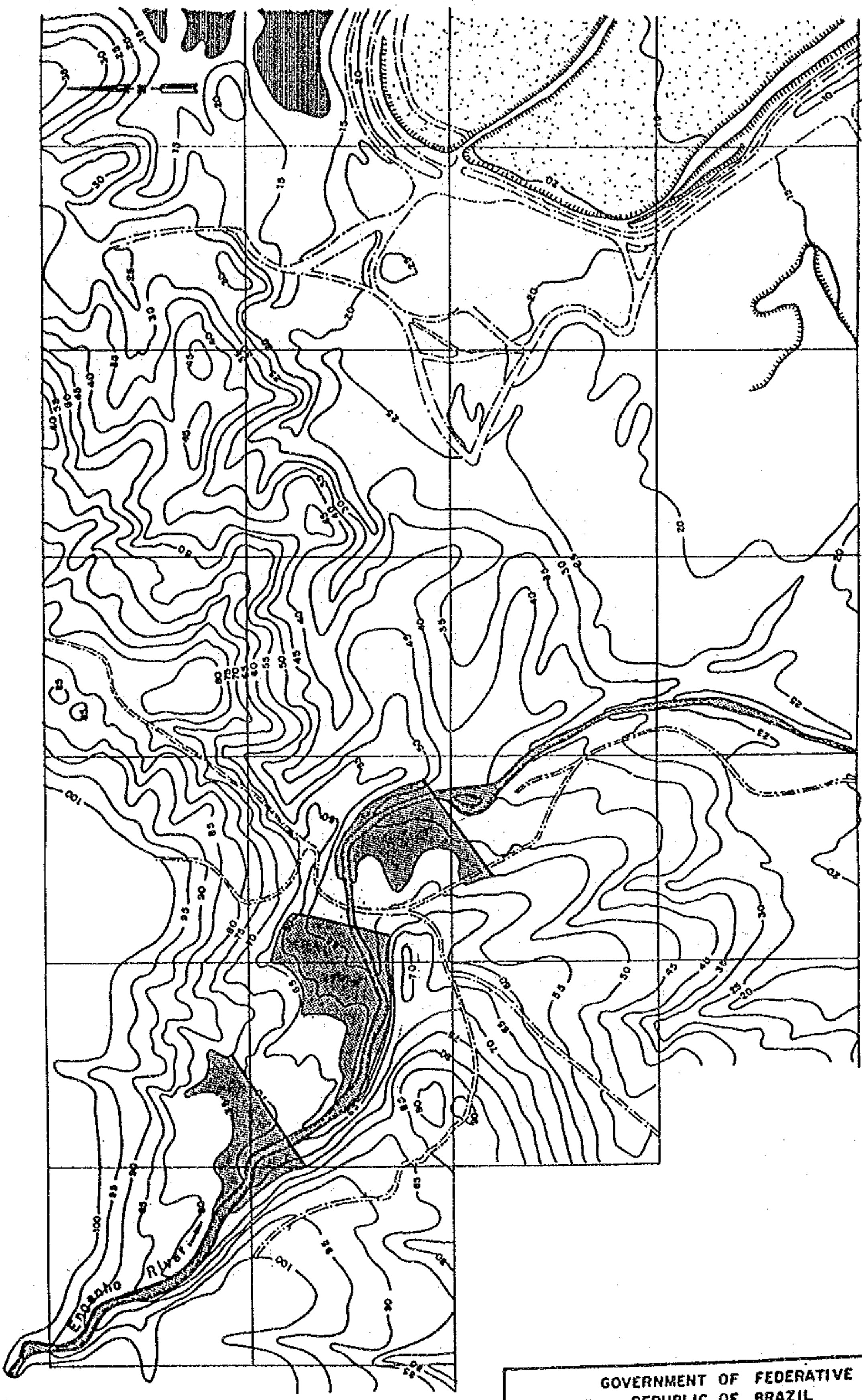


FIG. L.3
LOCATION MAP OF GABION DAM
IN THE ENGENHO RIVER

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

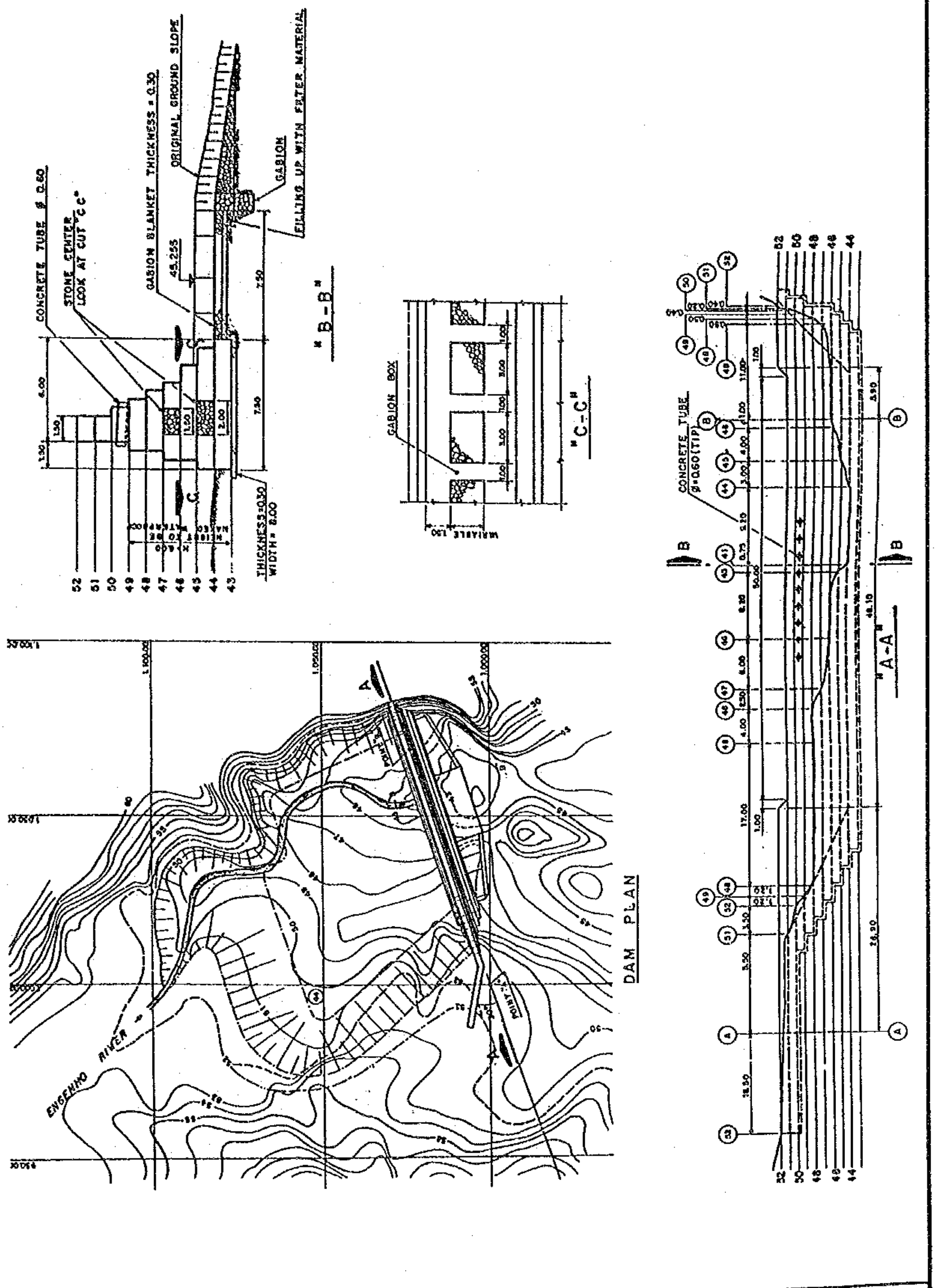


FIG. L.4
STRUCTURE DESIGN OF GABION DAM
IN THE ENGENHO RIVER (DOWNSTREAM)

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

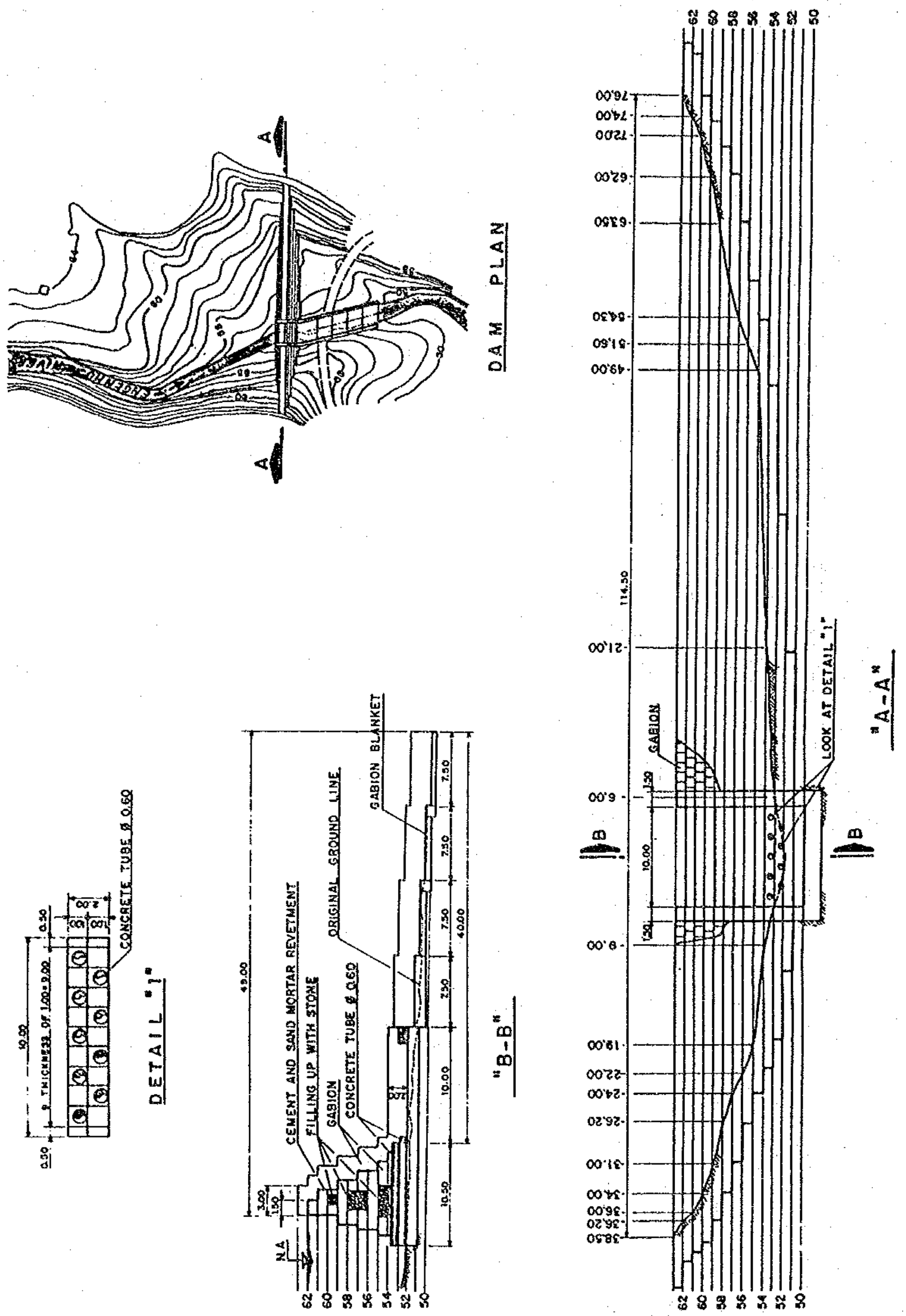


FIG. L.5
STRUCTURE DESIGN OF GABION DAM
IN THE ENGENHO RIVER

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

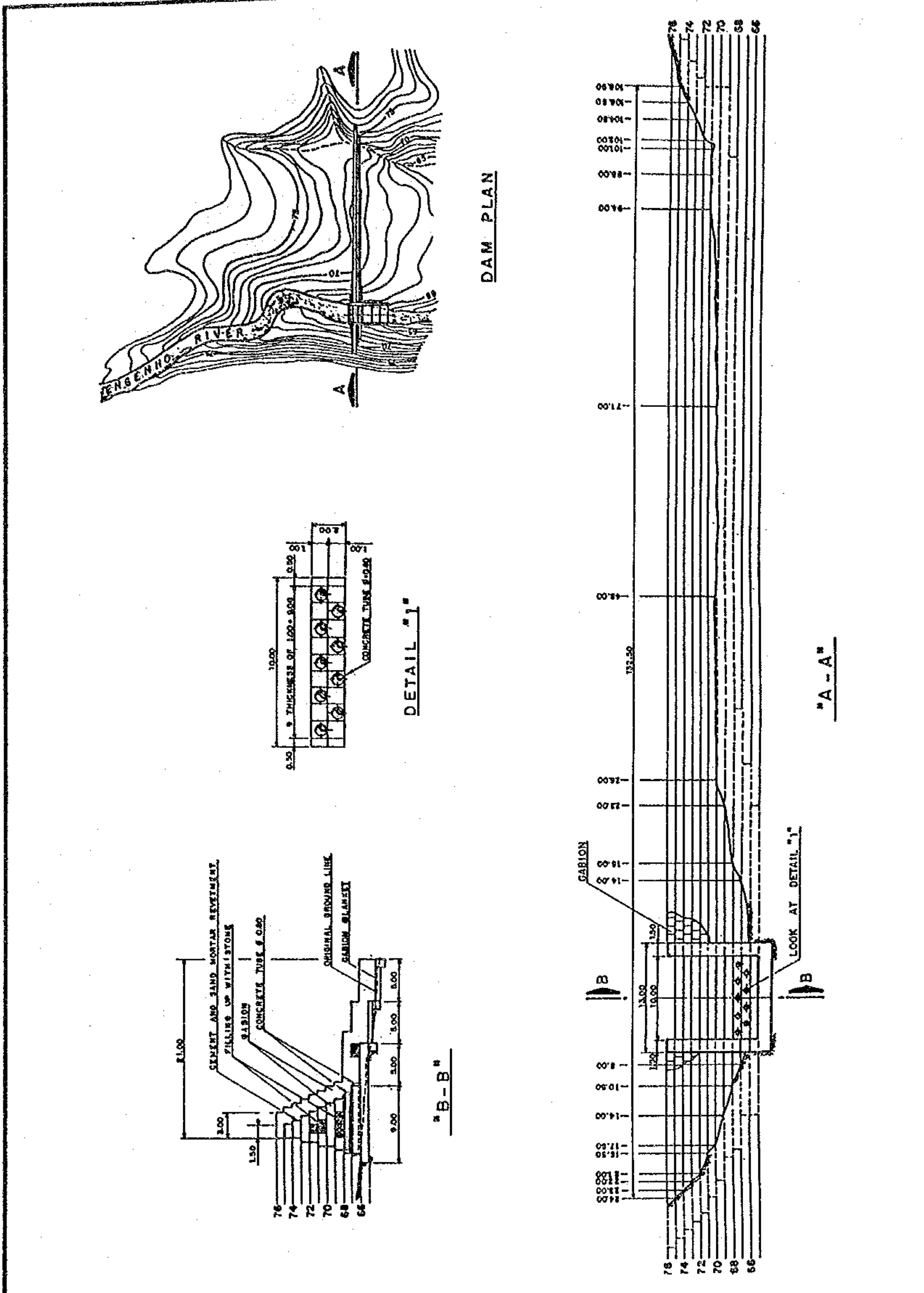
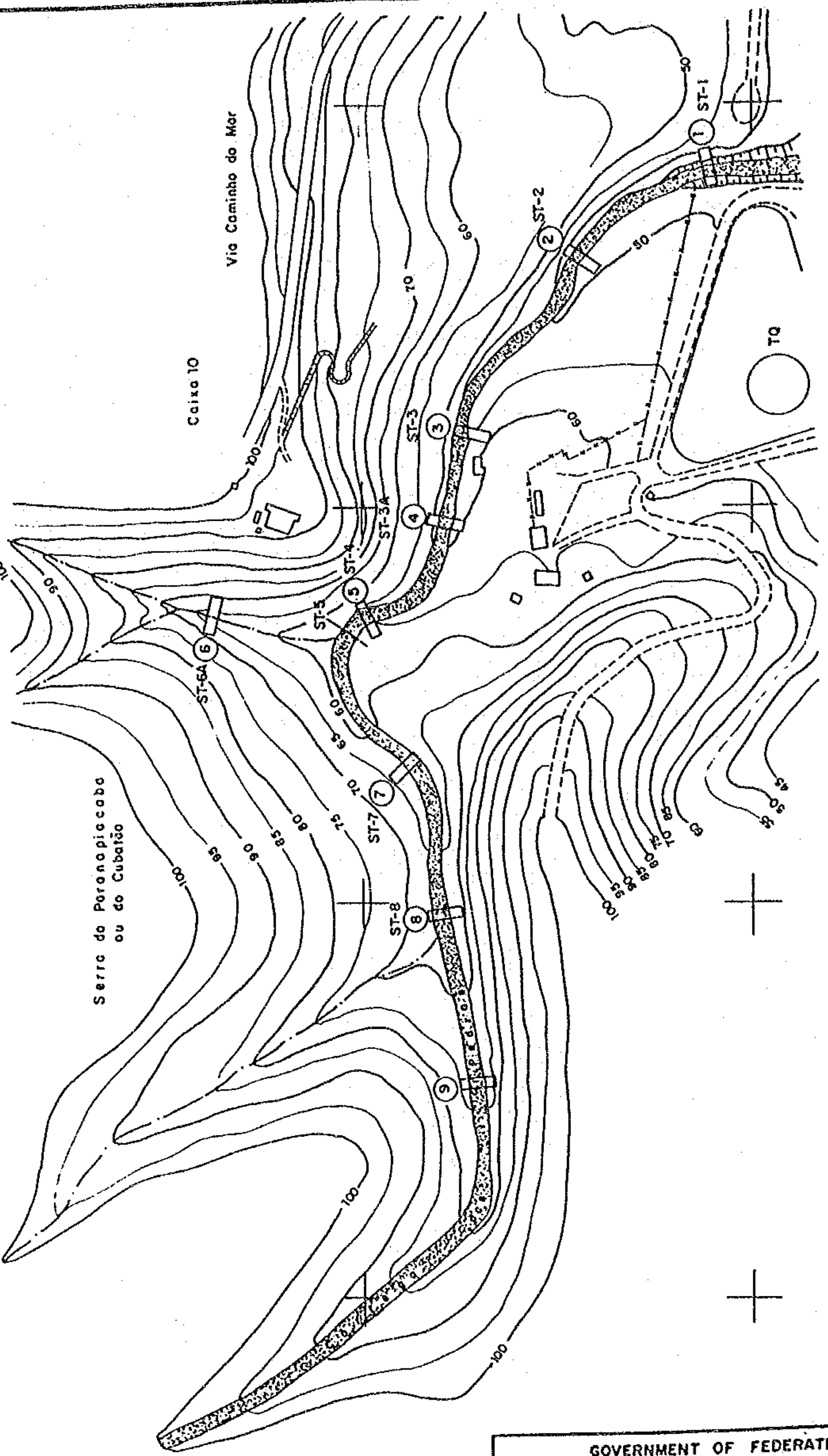


FIG. L.6
STRUCTURE DESIGN OF GABION DAM
IN THE ENGENHO RIVER (UPSTREAM)

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY



Source : Petrobras, Barragem do Corrego das Pedras

FIG. L.7
LOCATION MAP OF GABION DAM
IN THE PEDRAS RIVER

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO
JAPAN INTERNATIONAL COOPERATION AGENCY

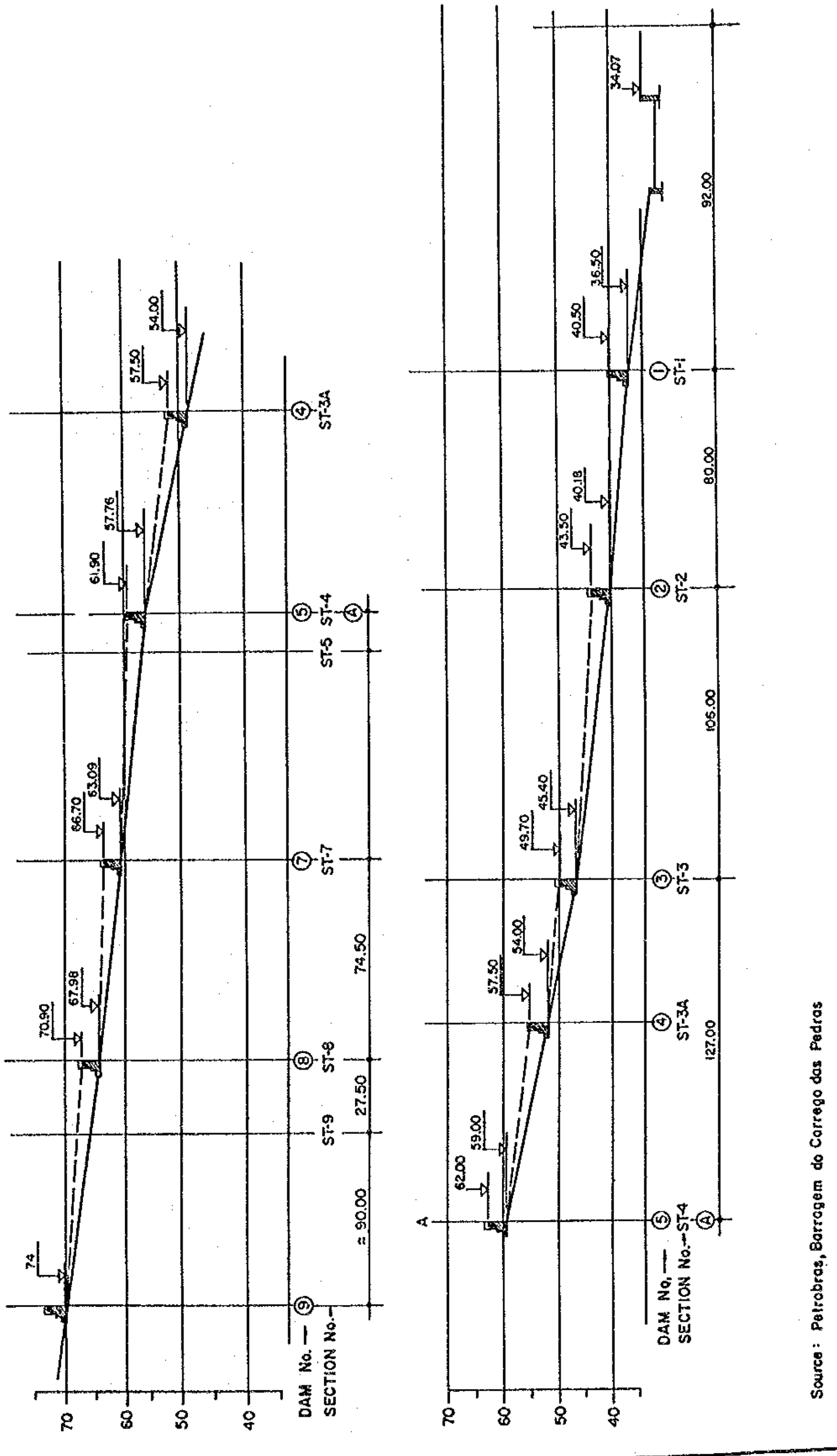
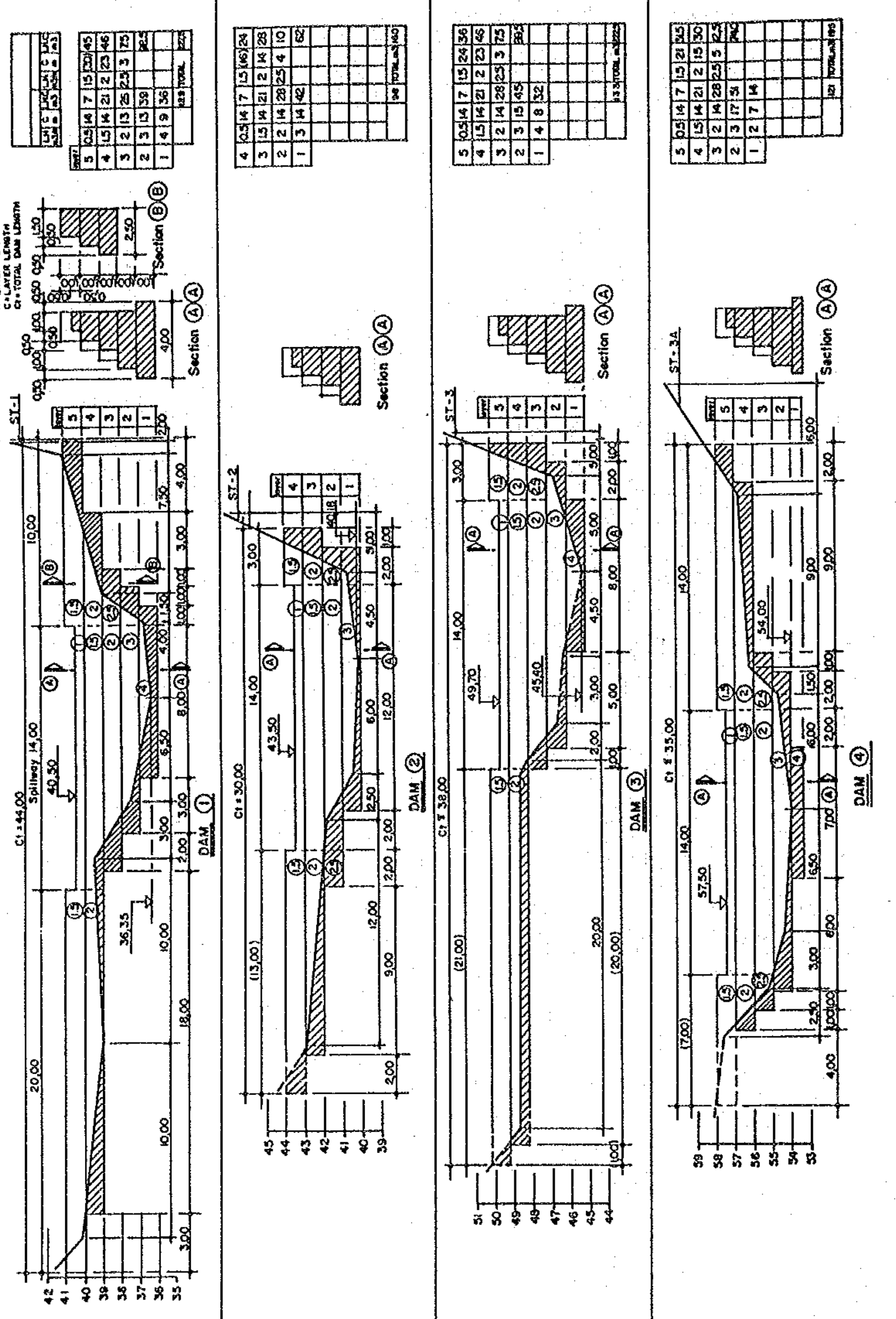


FIG. L.8
LONGITUDINAL PROFILE OF
GABION DAM IN THE PEDRAS RIVER

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR ,
CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY



Source : Petrobrás, Barragem do Córrego das Pedras

FIG. L.9
STRUCTURE DESIGN OF GABION DAM
IN THE PEDRAS RIVER (1/2)

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

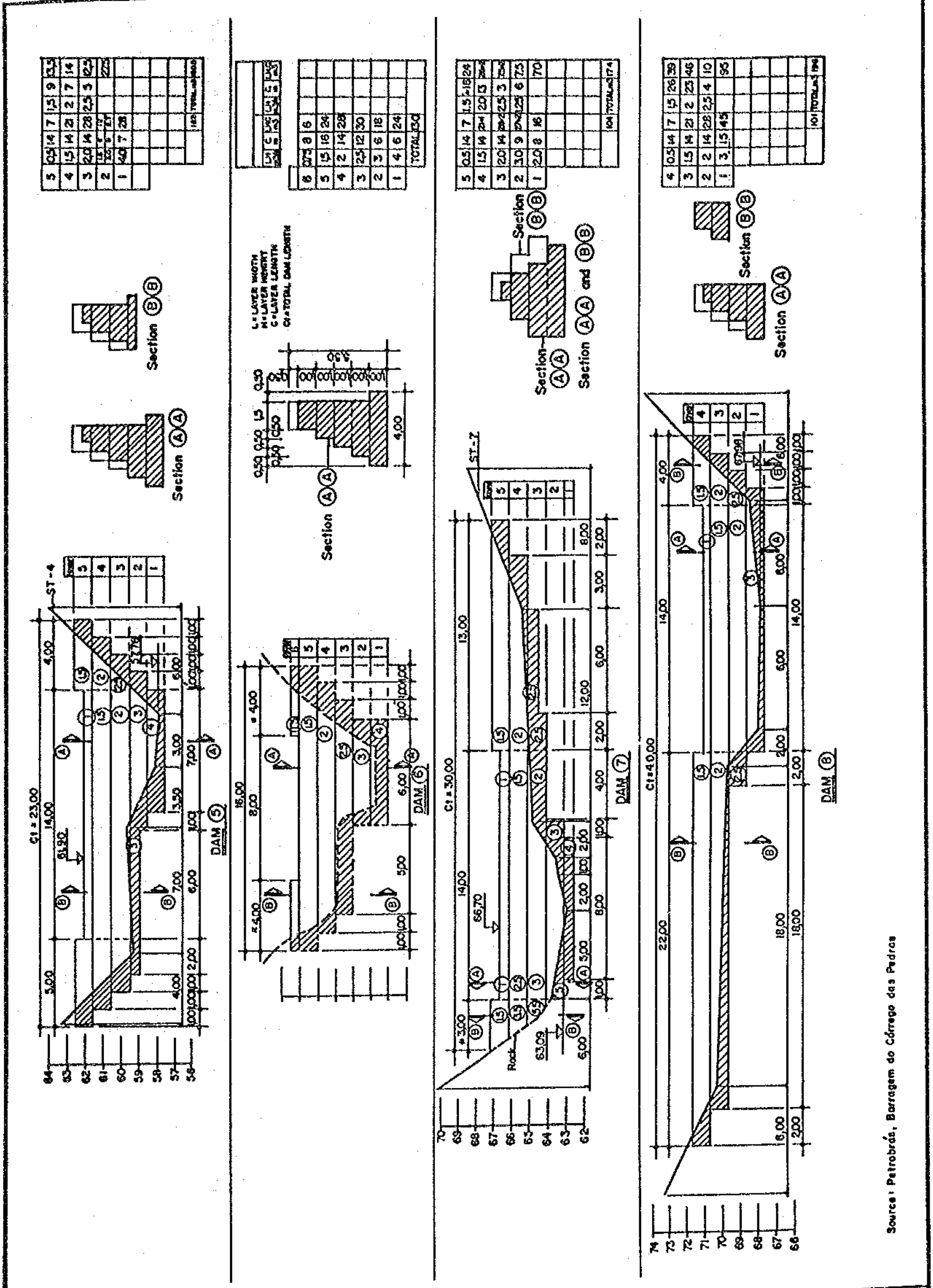


FIG. L.9
STRUCTURE DESIGN OF GABION DAM
IN THE PEDRAS RIVER (2/2)

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

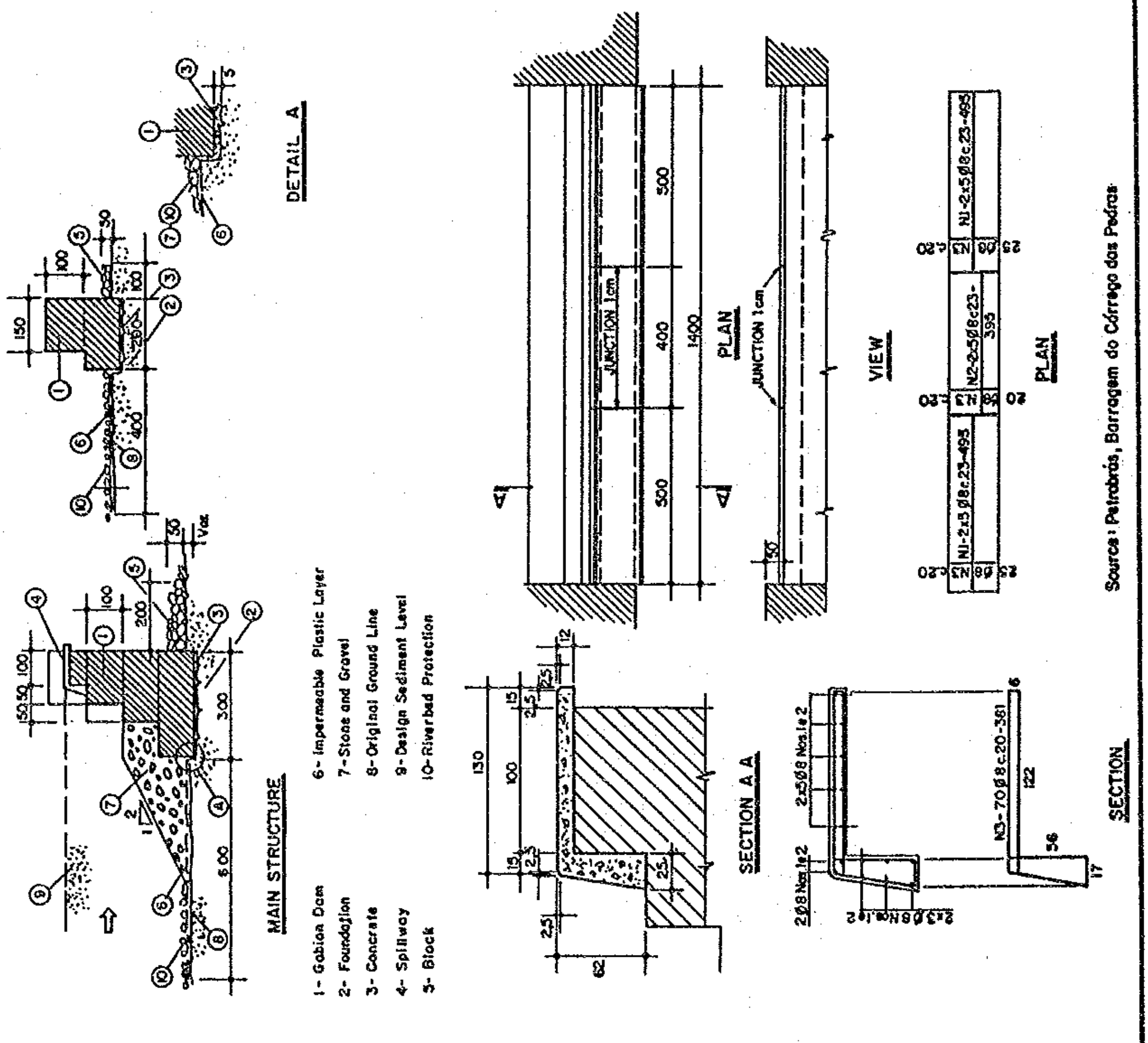


FIG. L.10
DETAILED STRUCTURE OF GABION DAM IN THE PEDRAS RIVER

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO
JAPAN INTERNATIONAL COOPERATION AGENCY

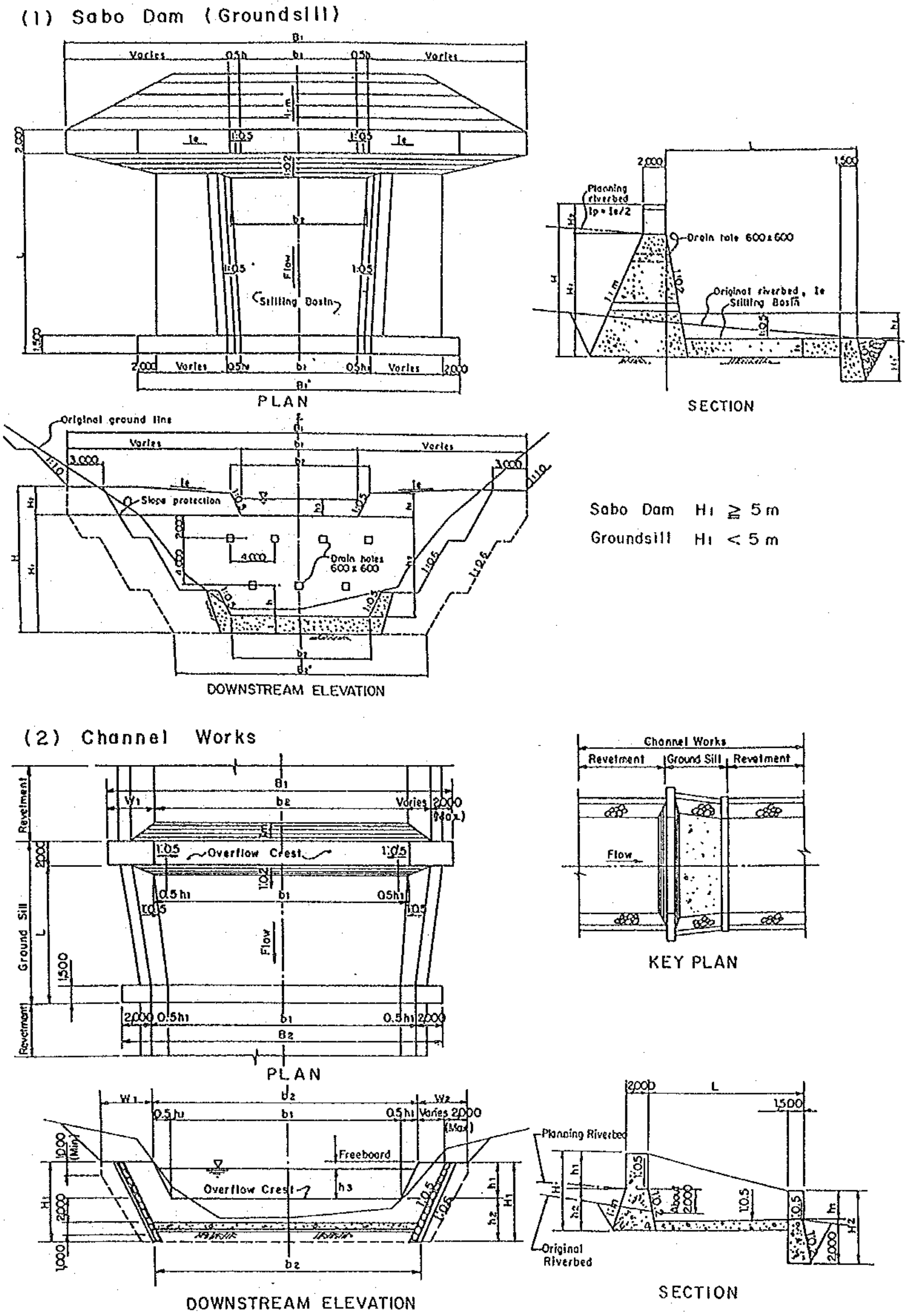
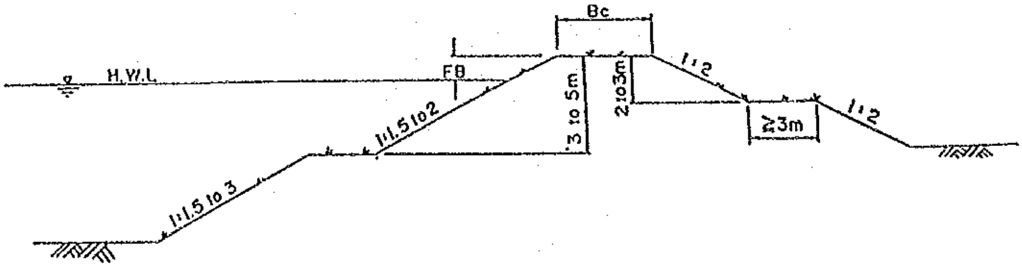


FIG. L.11
TYPICAL DESIGN OF STRUCTURES
FOR SEDIMENT RUN-OFF
DISASTER PREVENTION WORKS

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

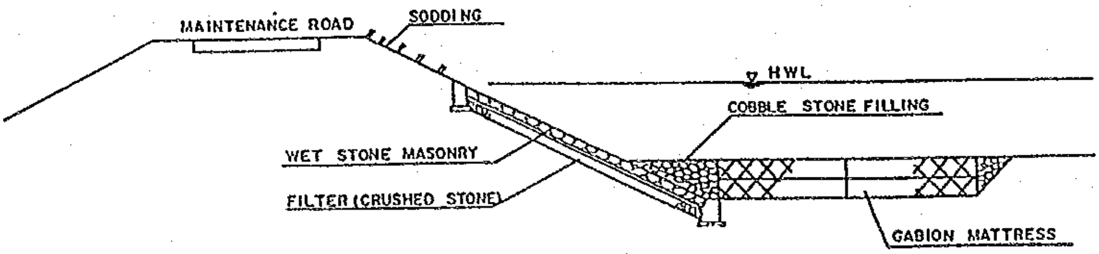
JAPAN INTERNATIONAL COOPERATION AGENCY

(1) Dike



Designed Discharge Q (m^3/s)	Free-board FB (m) not less than	Crownwidth Bc(m) not less than
less than 200	0.6	3
200 to 500	0.8	3
500 to 2,000	1.0	4

(2) Revetment



(3) Diversion Tunnel

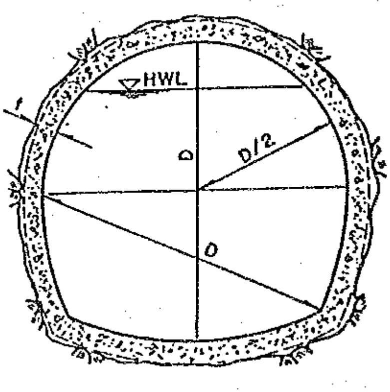
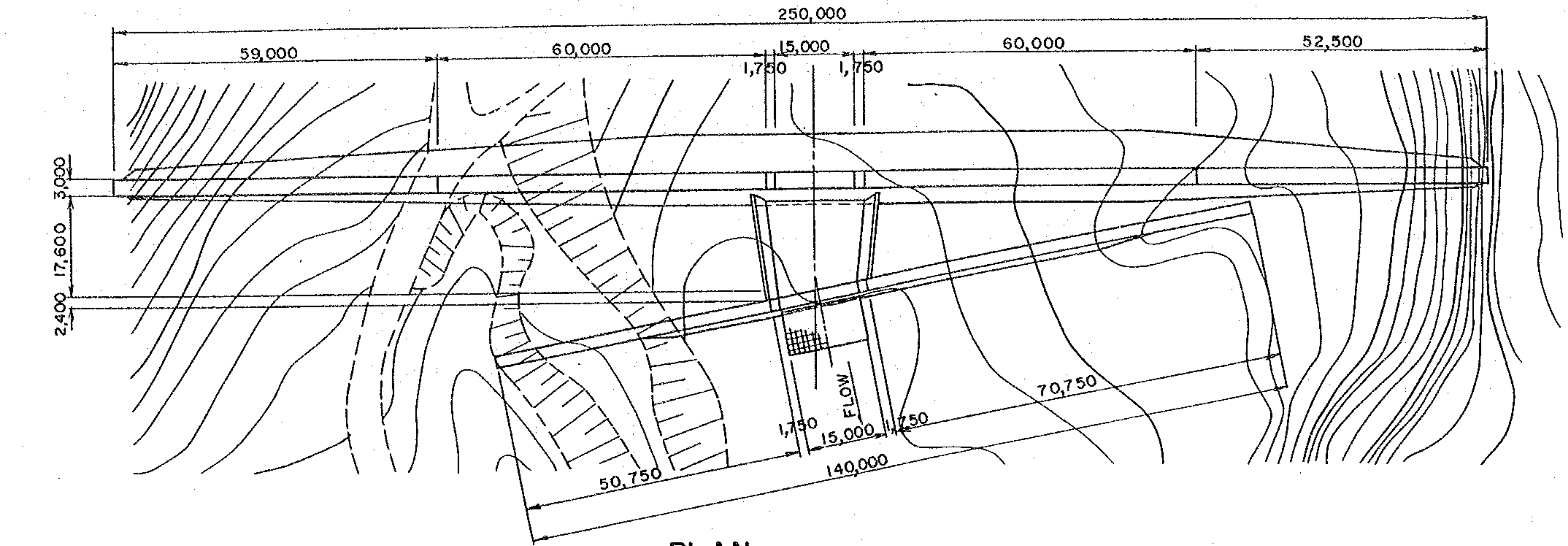


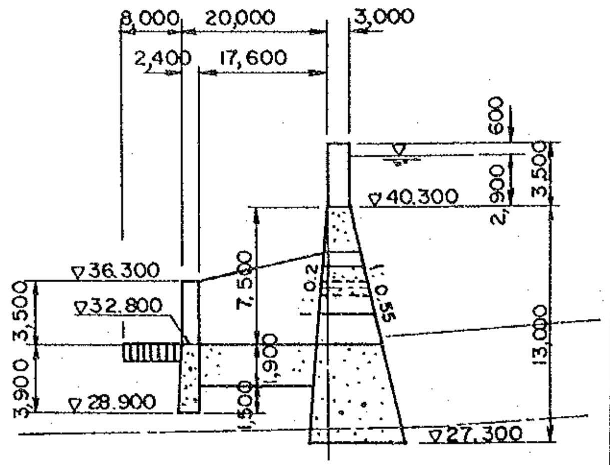
FIG. L.12
TYPICAL DESIGN OF STRUCTURES FOR FLOOD DISASTER PREVENTION WORKS

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

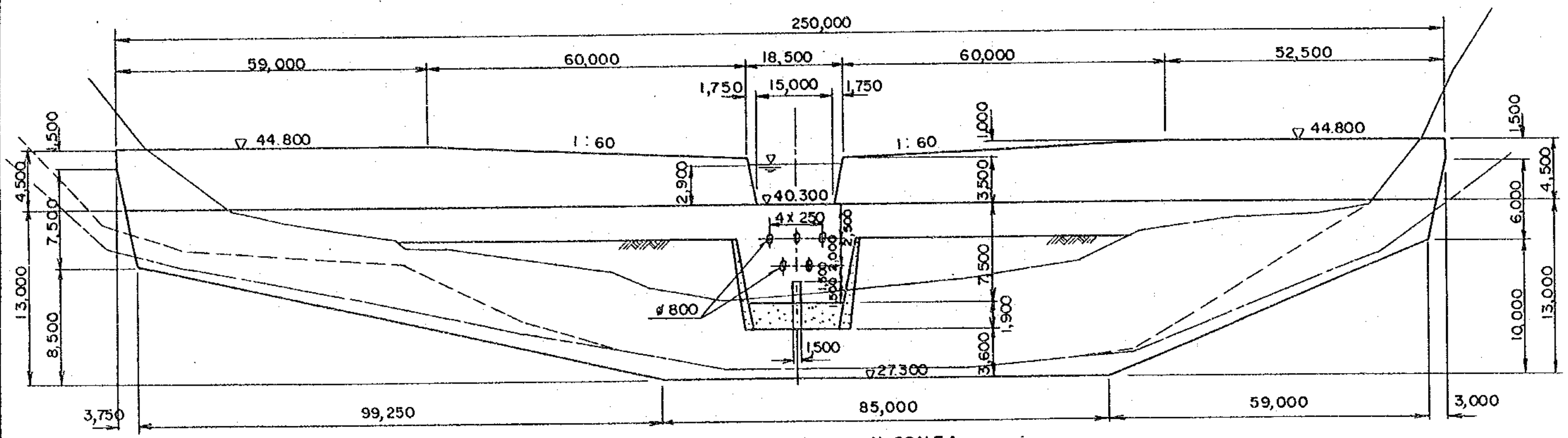
JAPAN INTERNATIONAL COOPERATION AGENCY



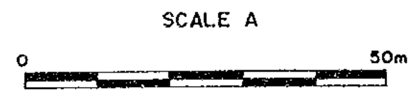
PLAN SCALE A

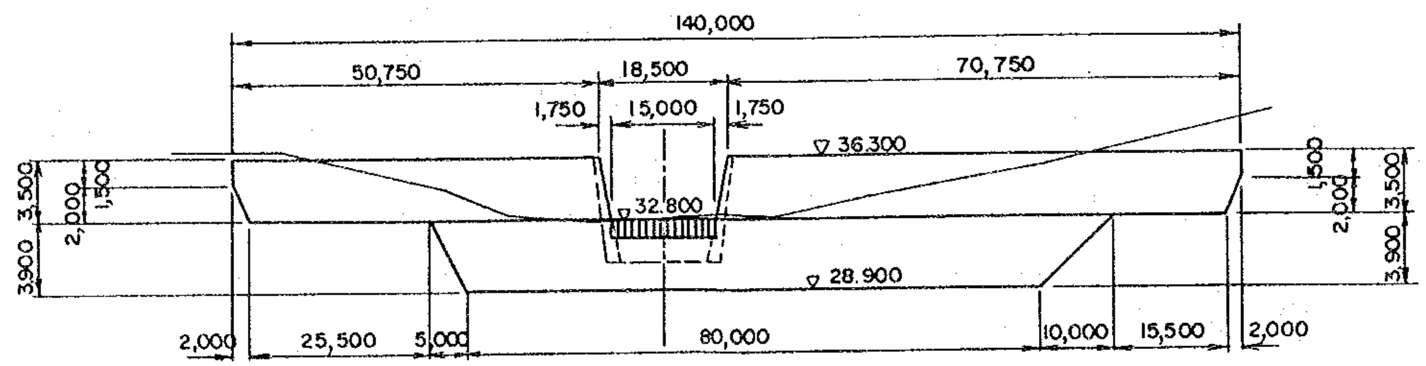


STANDARD CROSS SECTION
SCALE A



FRONT VIEW H : SCALE A
V : SCALE B



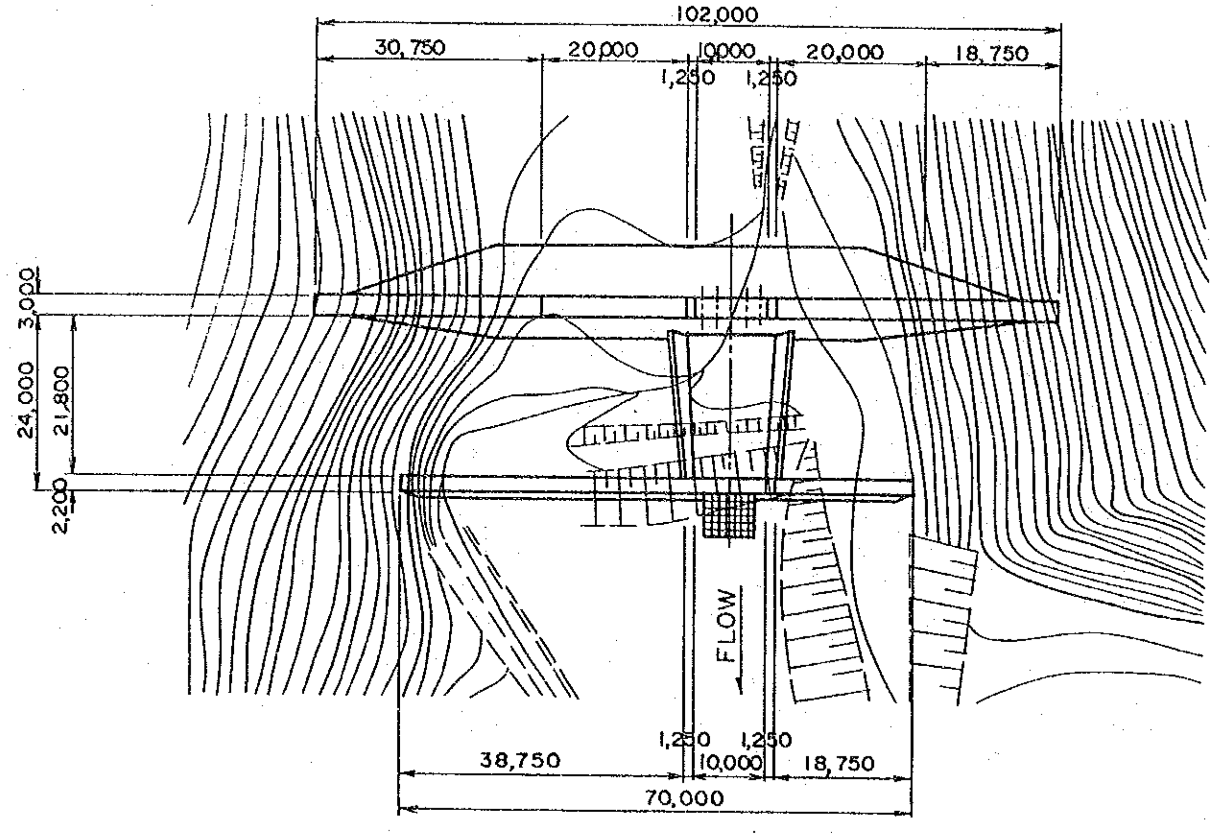


FRONT VIEW OF SUB DAM SCALE A

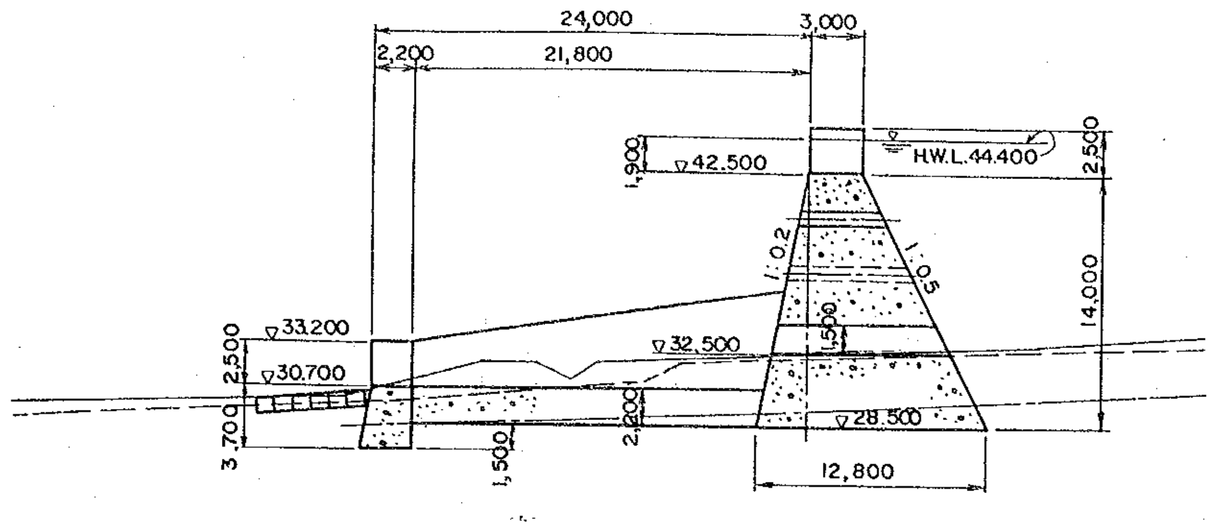
FIG. L.13
PRELIMINARY DESIGN OF SABO DAM (1/9)
(DAM NO.2-1)

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

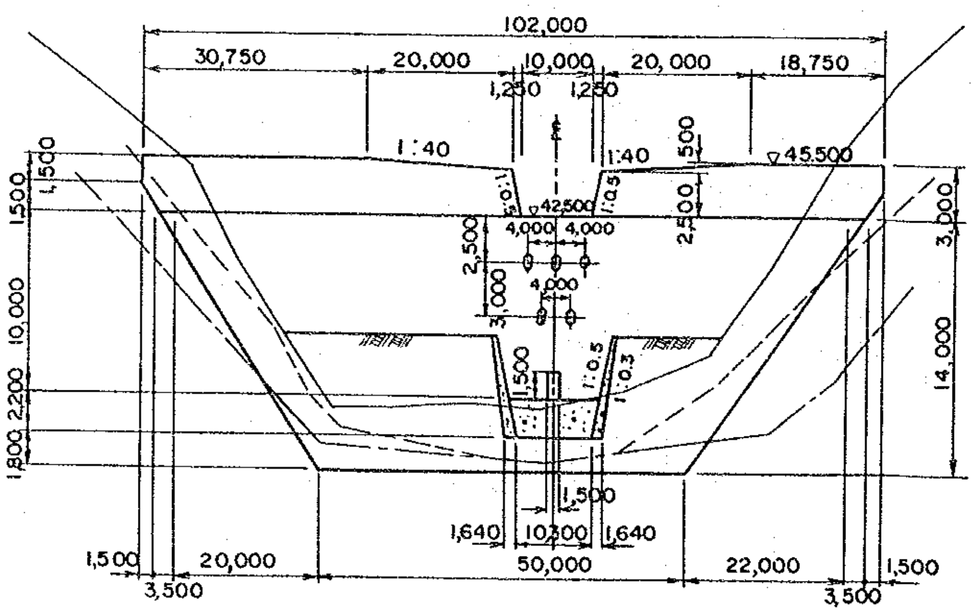
JAPAN INTERNATIONAL COOPERATION AGENCY



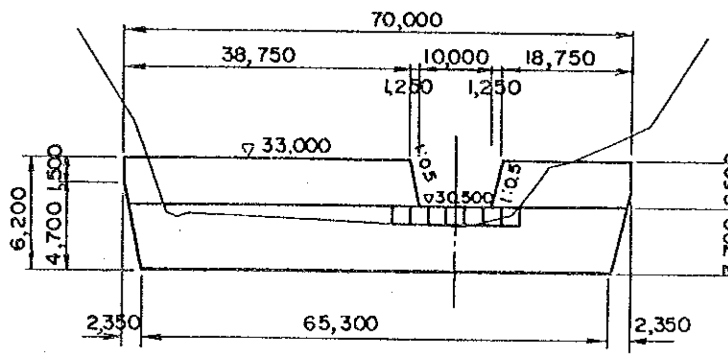
PLAN SCALE A



STANDARD CROSS SECTION SCALE B



FRONT VIEW H: SCALE A V: SCALE B



FRONT VIEW OF SUB DAM H: SCALE A V: SCALE B

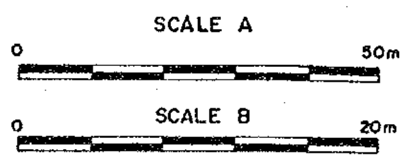


FIG. L.13
PRELIMINARY DESIGN OF SABO DAM (2/9)
(DAM NO.3-1)

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

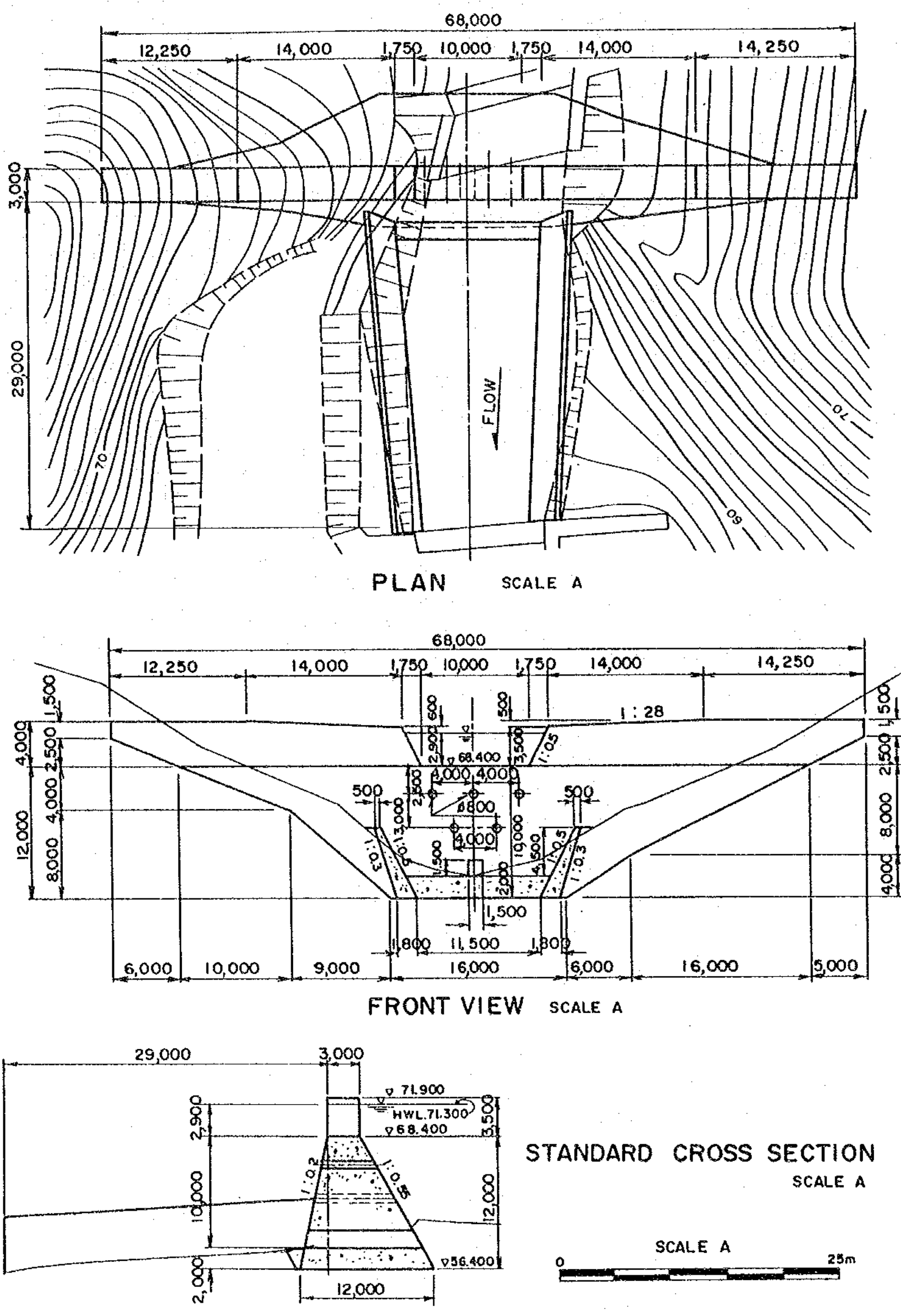
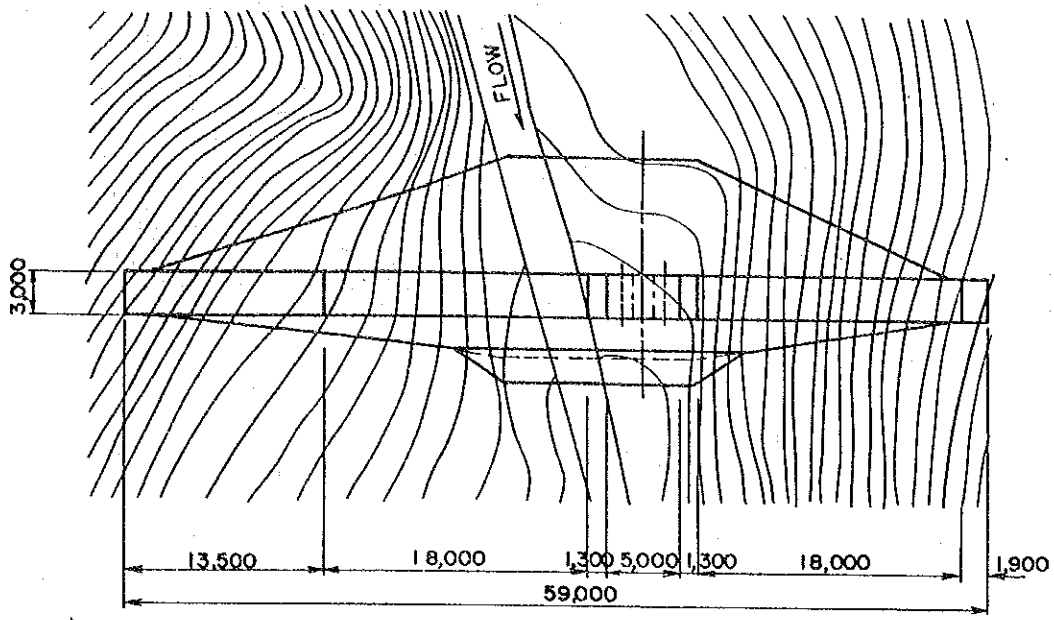


FIG. L.13
PRELIMINARY DESIGN OF SABO DAM (3/9)
(DAM NO.7-1)

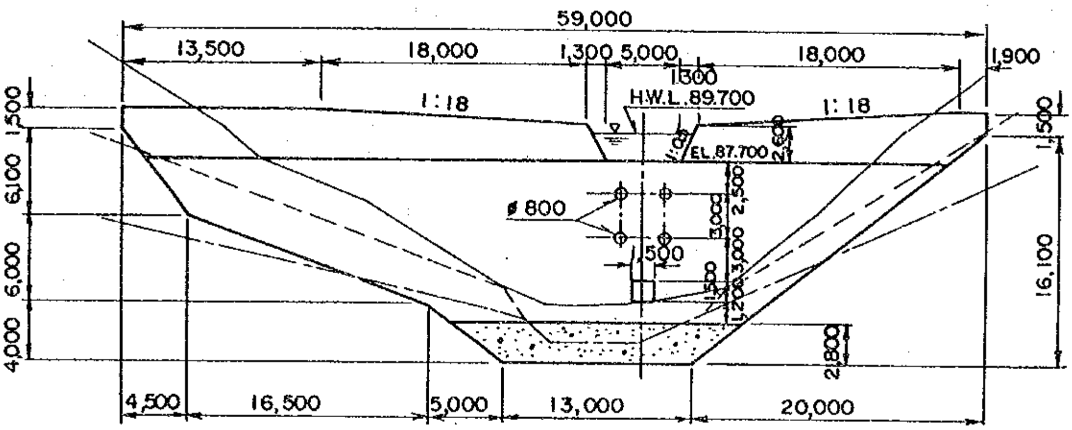
GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

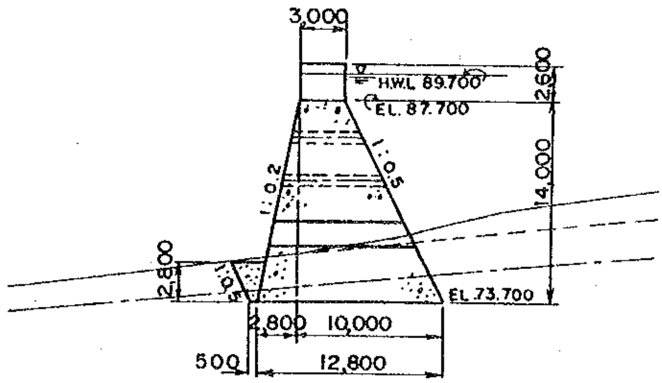
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN SCALE A



FRONT VIEW SCALE A



STANDARD CROSS SECTION SCALE A

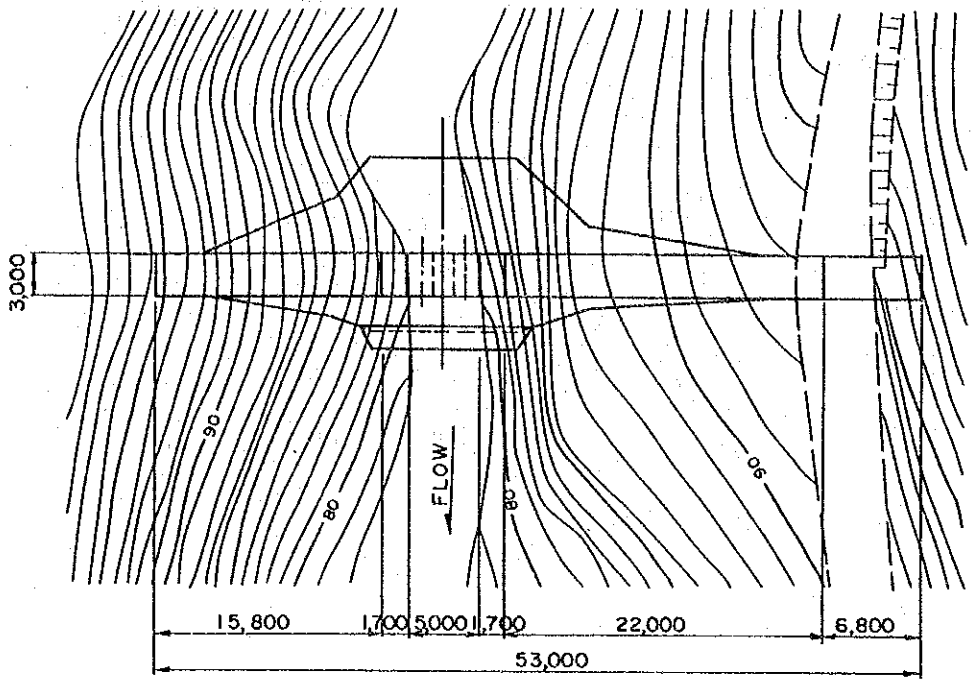
SCALE A

FIG. L.13
PRELIMINARY DESIGN OF SABO DAM (4/9)
(DAM NO.7-3)

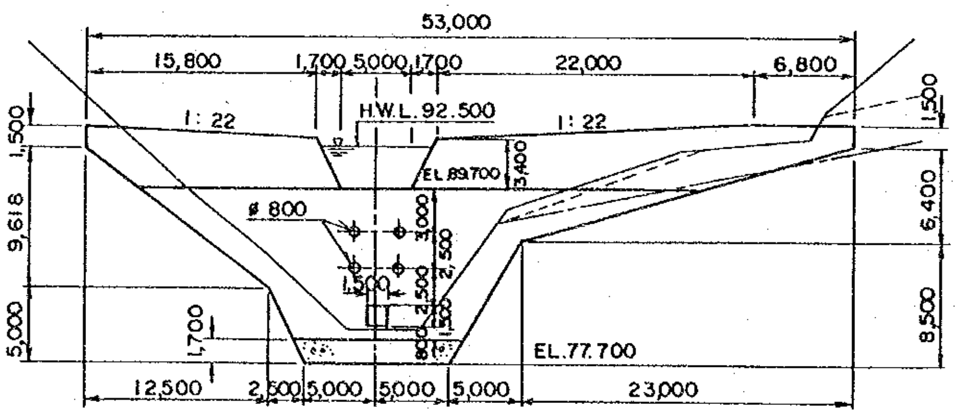
GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

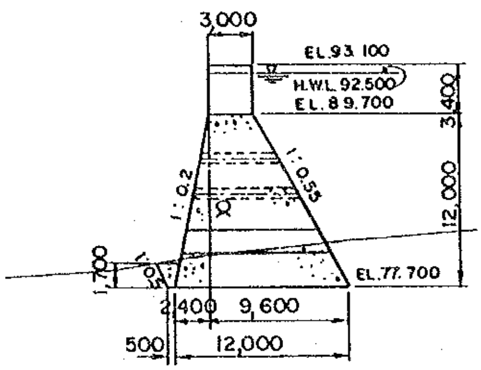
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN SCALE A



FRONT VIEW SCALE A

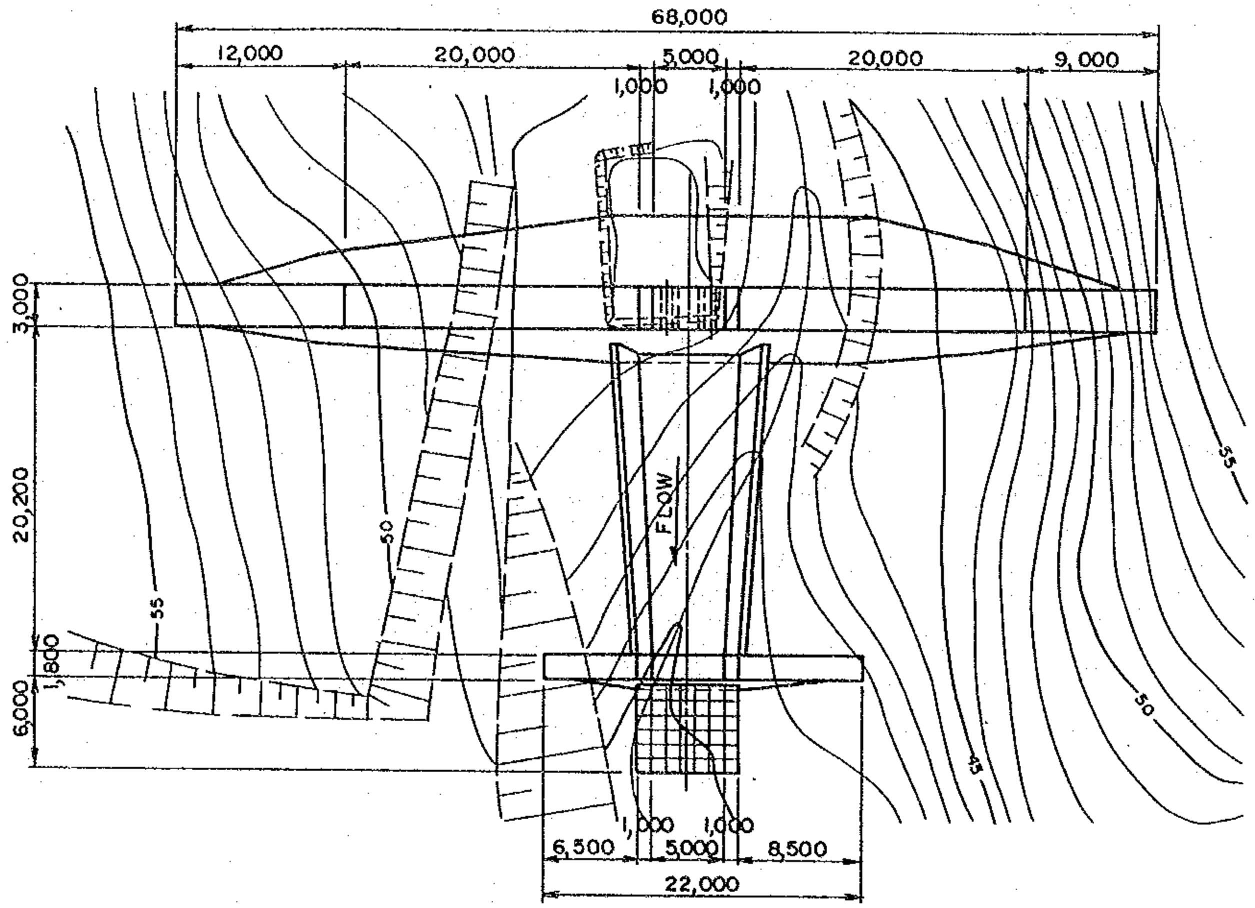


STANDARD CROSS SECTION SCALE A

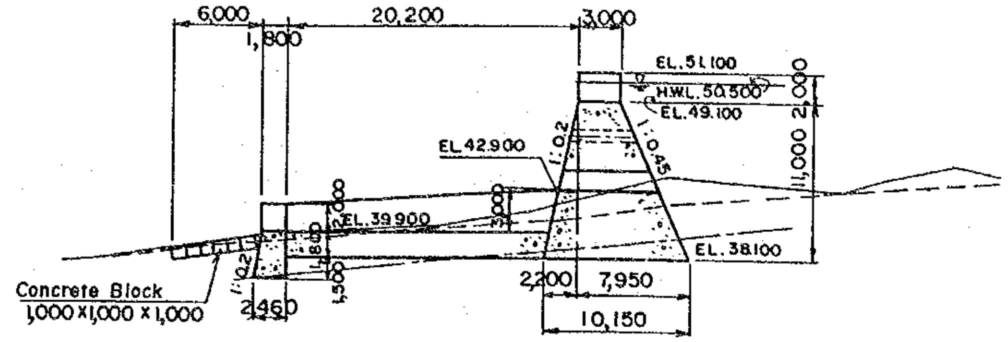
SCALE A
0 25m

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO
JAPAN INTERNATIONAL COOPERATION AGENCY

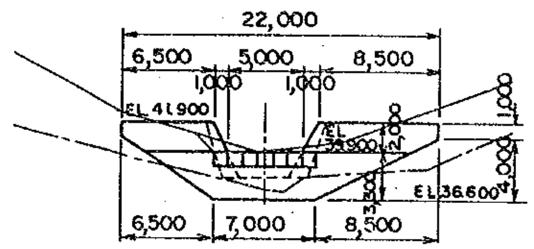
FIG. L.13
PRELIMINARY DESIGN OF SABO DAM (5/9)
(DAM NO.7-4)



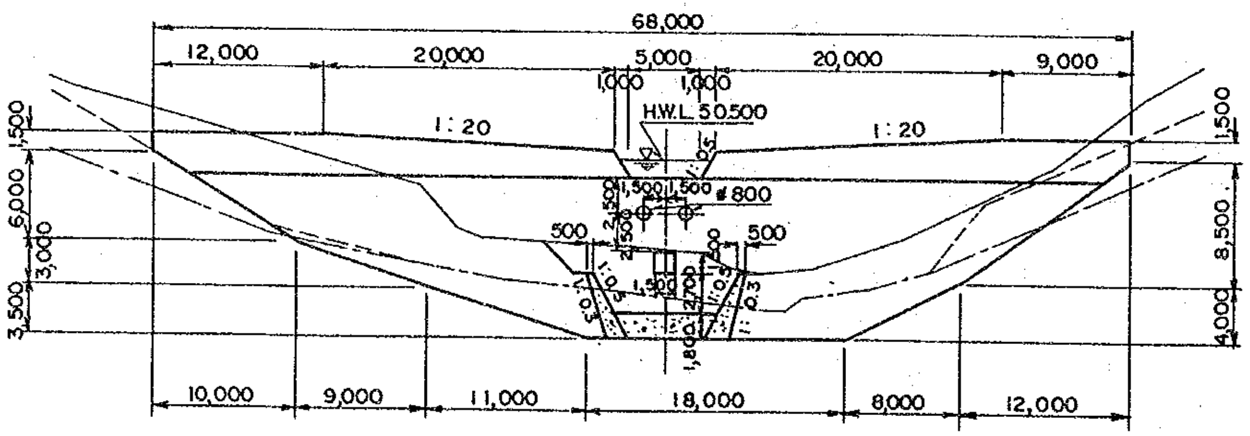
PLAN SCALE A



STANDARD CROSS SECTION SCALE A



FRONT VIEW OF SUB DAM SCALE A



FRONT VIEW SCALE A

SCALE A
0 25m

FIG. L.13
PRELIMINARY DESIGN OF SABO DAM (6/9)
(DAM NO.8-1)

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

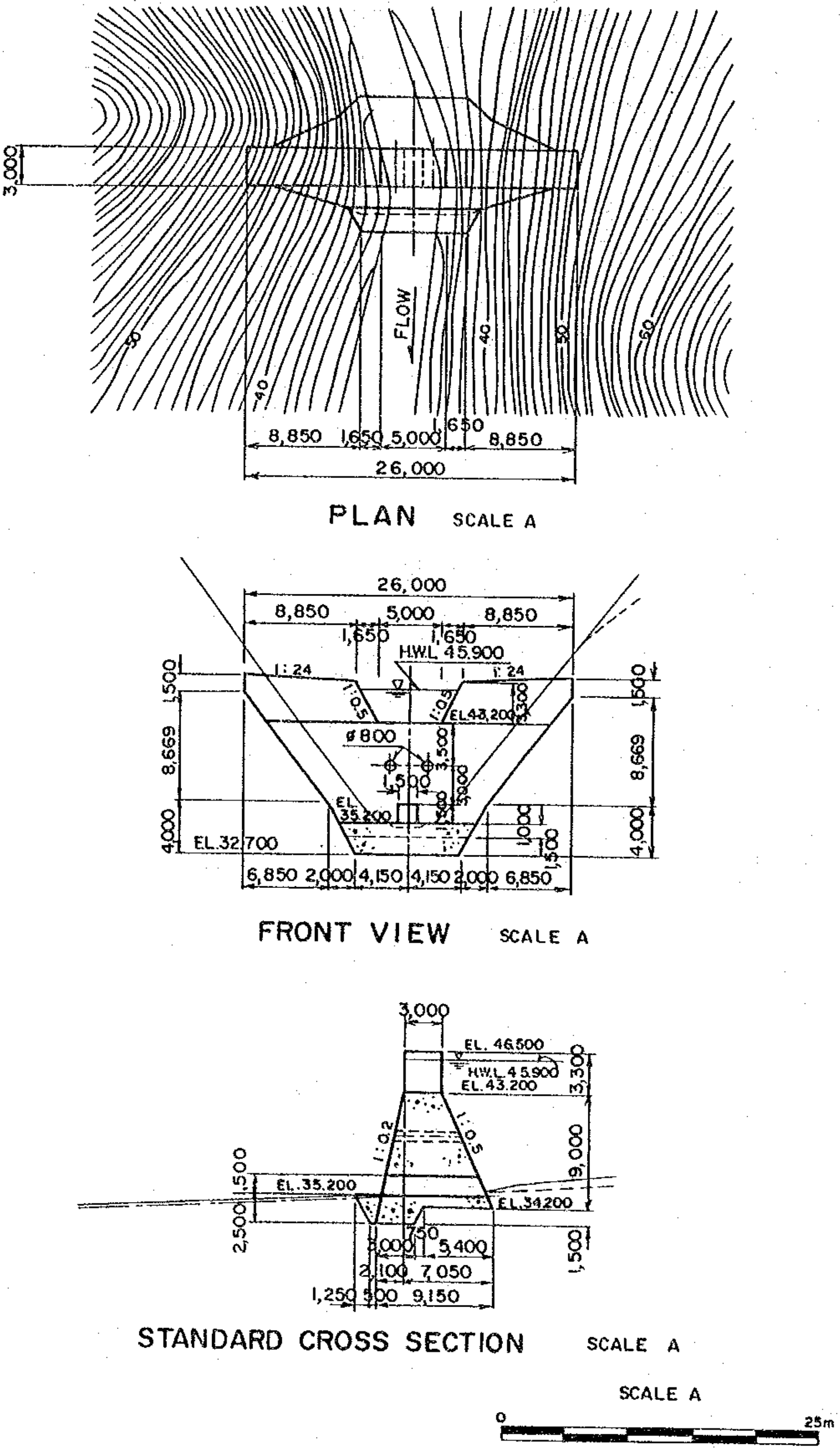
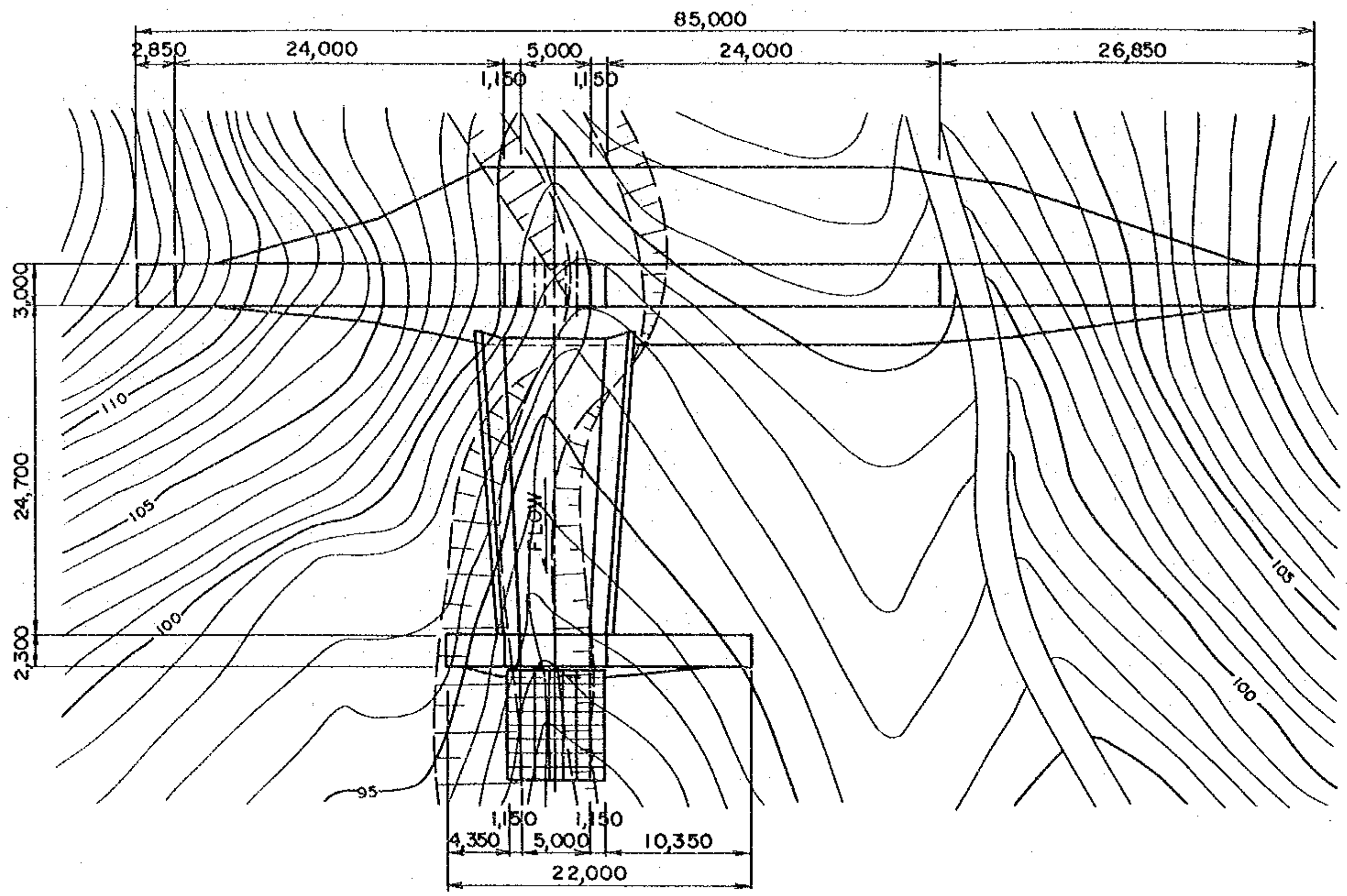


FIG. L.13
PRELIMINARY DESIGN OF SABO DAM (7/9)
(DAM NO.10-1)

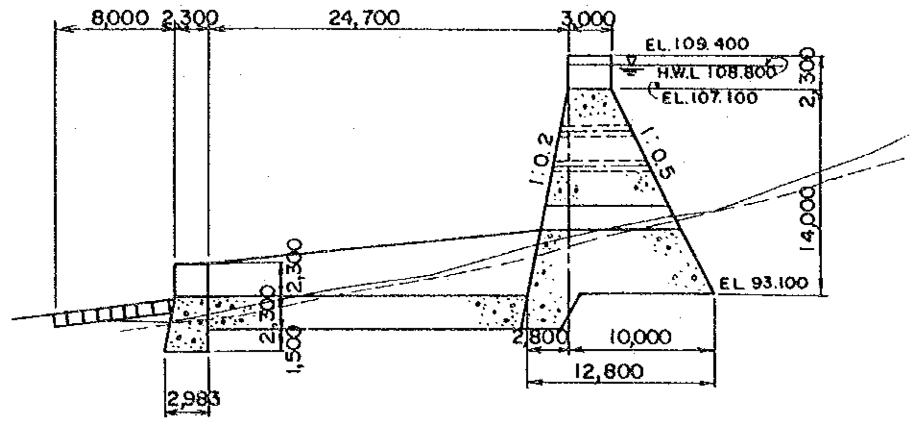
GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

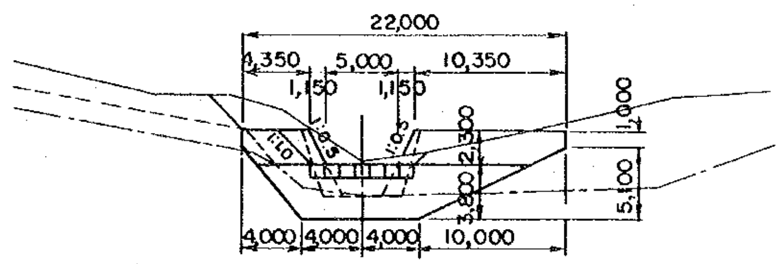
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN SCALE A

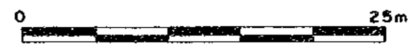


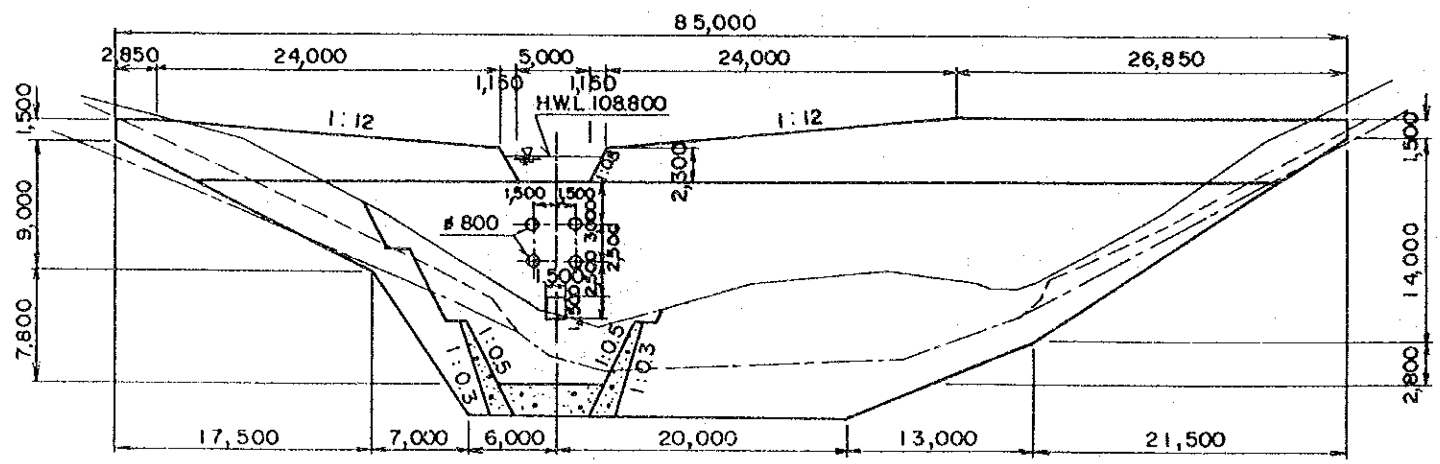
STANDARD CROSS SECTION SCALE A



FRONT VIEW OF SUB DAM SCALE A

SCALE A





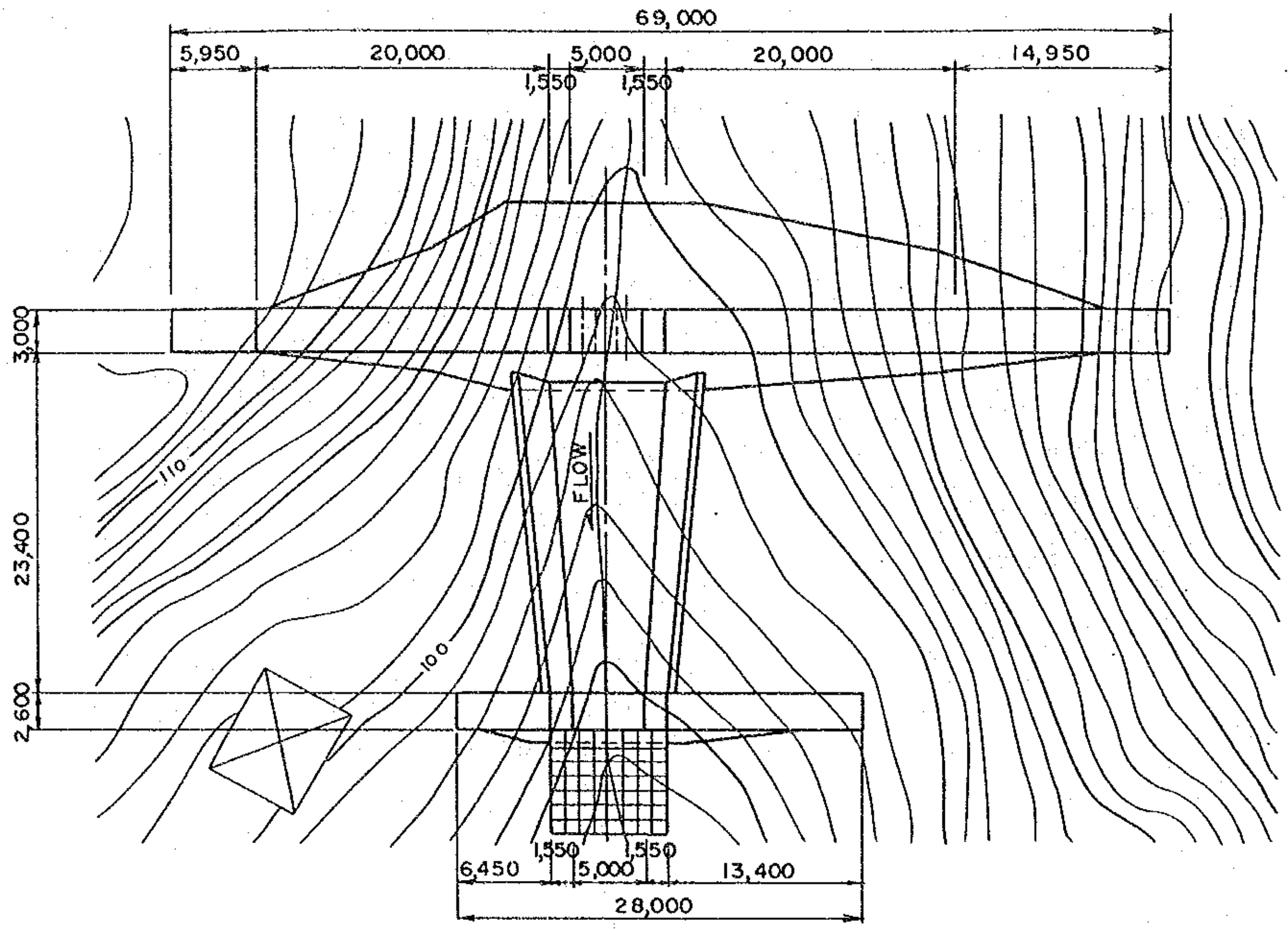
FRONT VIEW SCALE A

FIG. L.13
PRELIMINARY DESIGN OF SABO DAM (8/9)
(DAM NO.11-1)

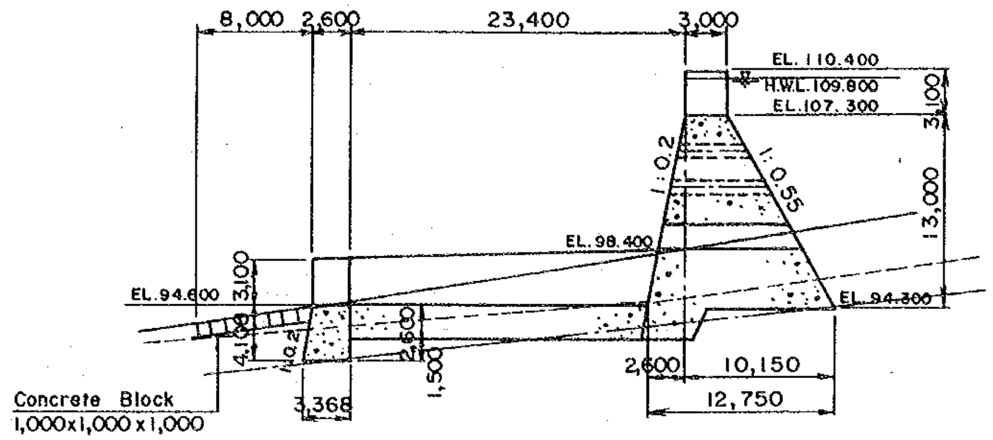
GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

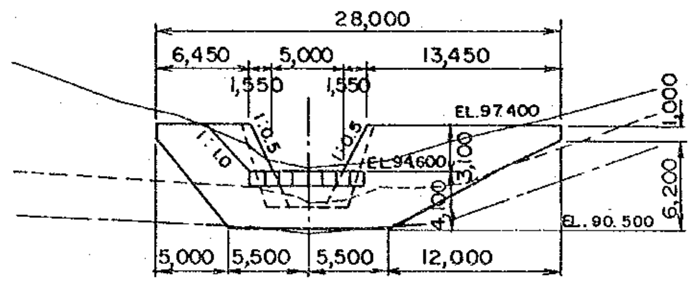
JAPAN INTERNATIONAL COOPERATION AGENCY



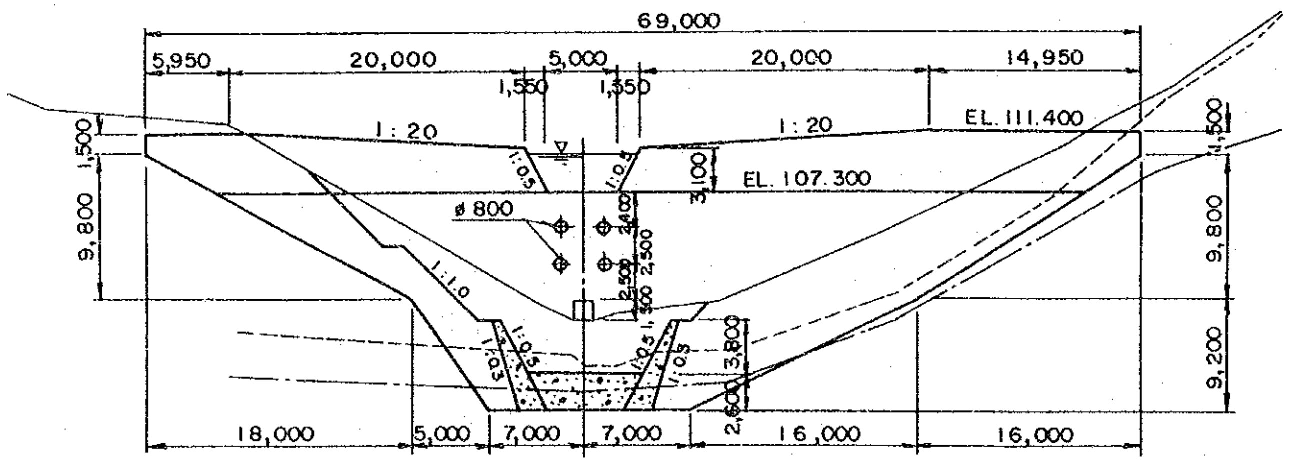
PLAN SCALE A



STANDARD CROSS SECTION SCALE A



FRONT VIEW OF SUB DAM SCALE A

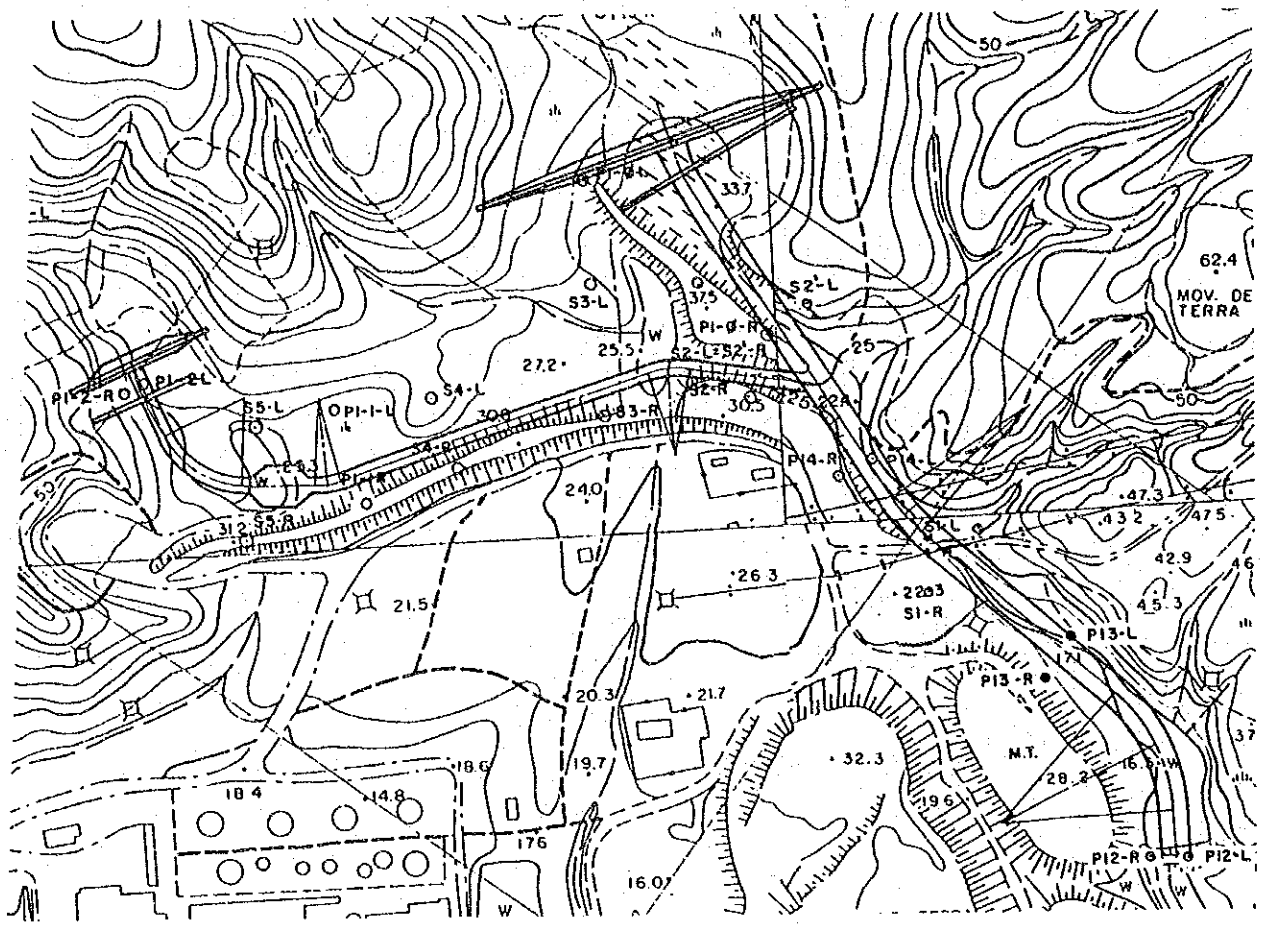


FRONT VIEW SCALE A

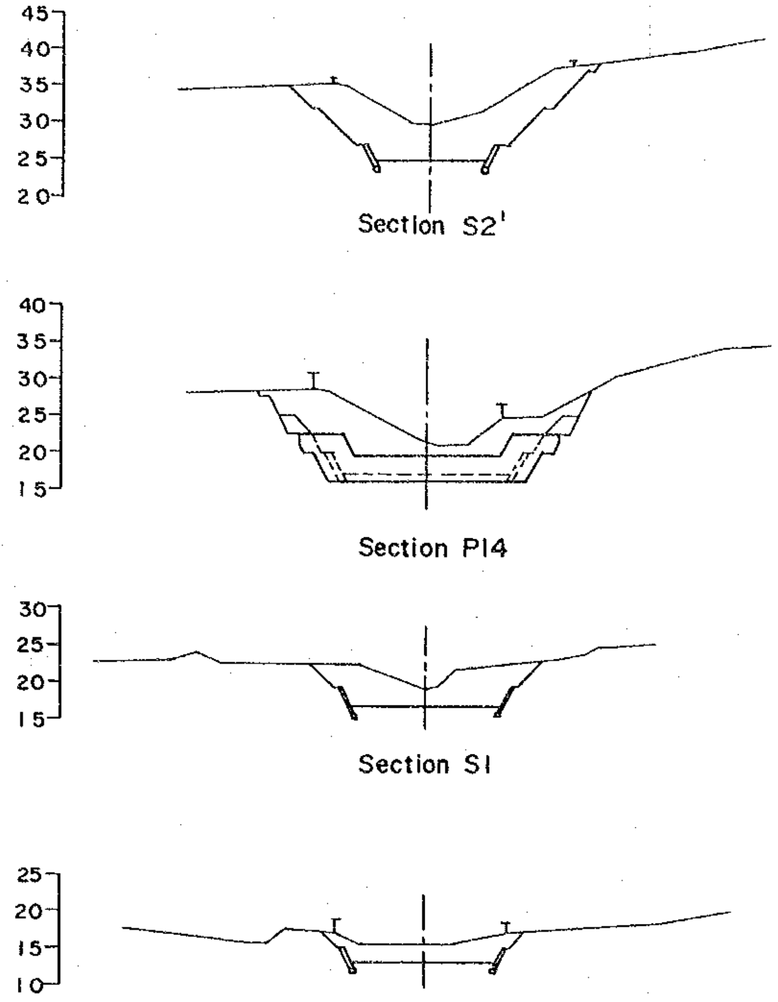
SCALE A

FIG. L.13
PRELIMINARY DESIGN OF SABO DAM (9/9)
(DAM NO.12-1)

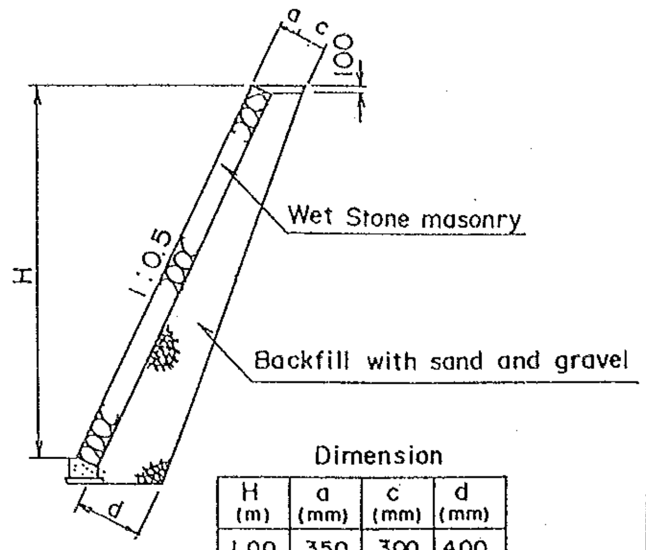
GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN SCALE A



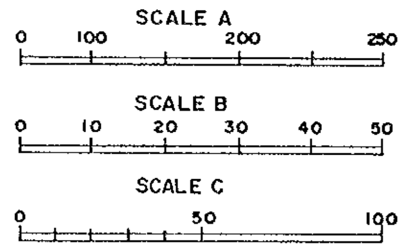
CROSS SECTION SCALE B

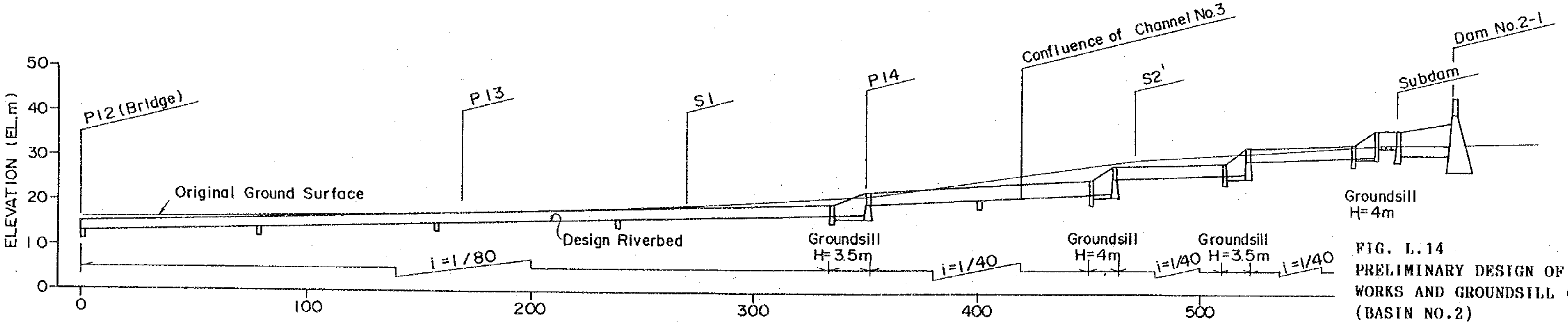


Dimension

H (m)	a (mm)	c (mm)	d (mm)
1.00	350	300	400
2.00	350	300	500
3.00	350	300	600
4.00	350	300	700
5.00	350	300	800

TYPICAL CROSS SECTION





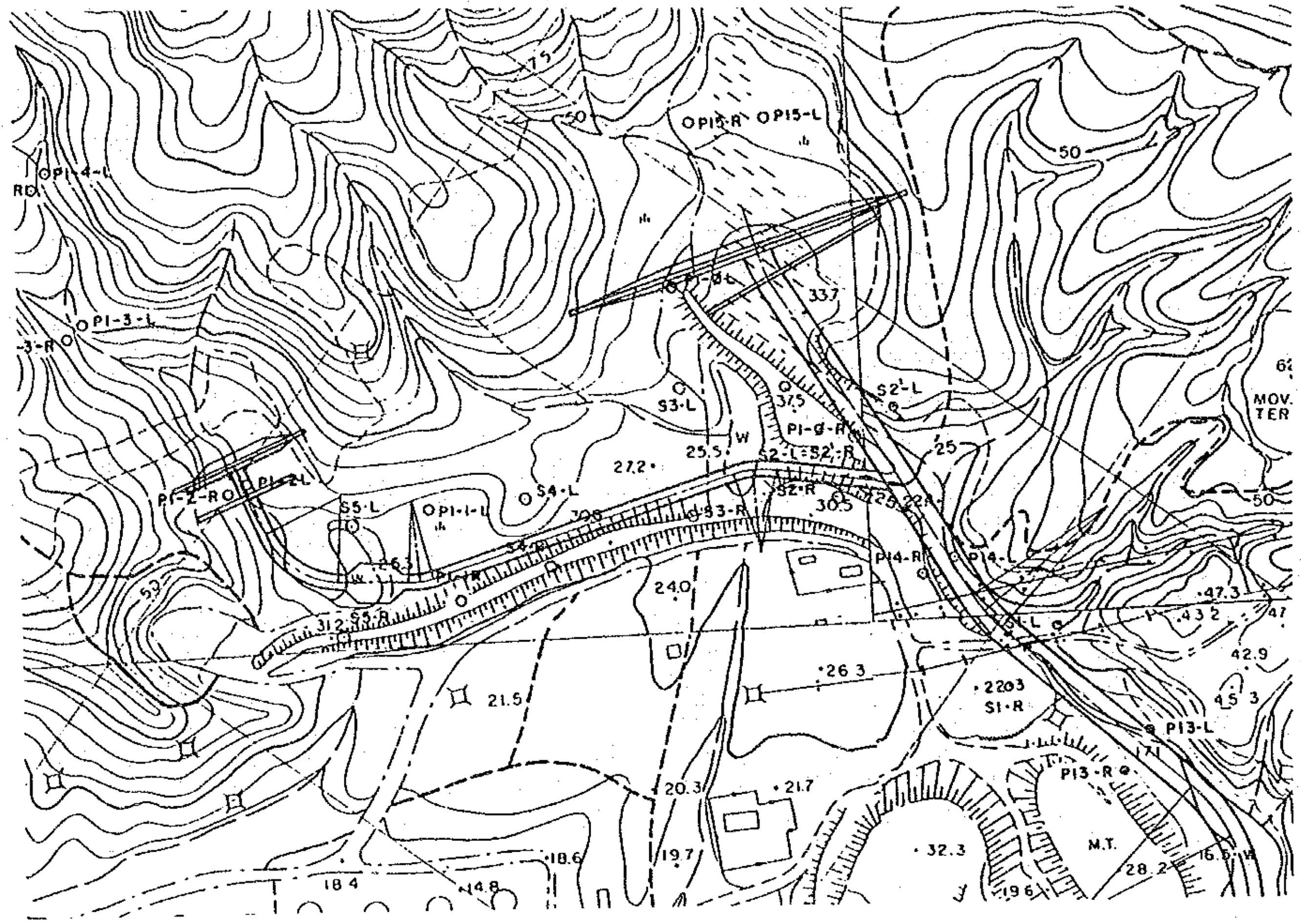
PROFILE H: SCALE B V: SCALE C

FIG. L.14 PRELIMINARY DESIGN OF CHANNEL WORKS AND GROUNDSILL (1/6) (BASIN NO.2)

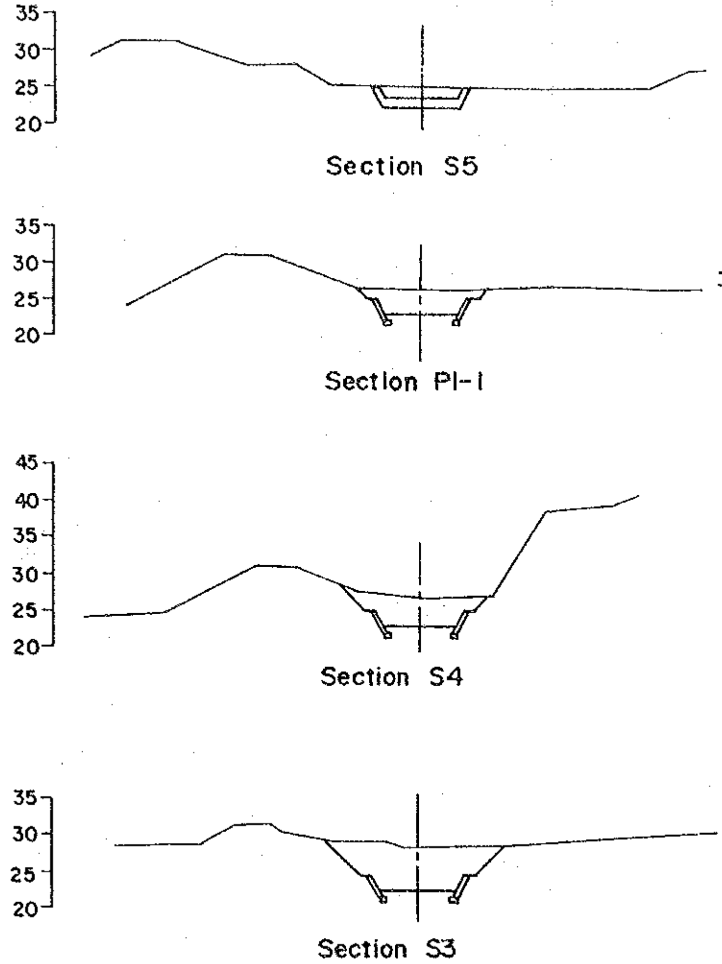
GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

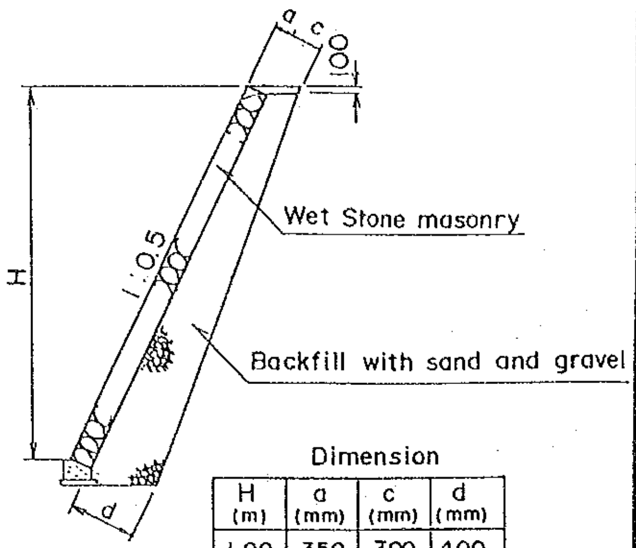
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN SCALE A



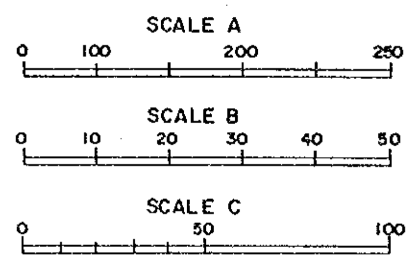
CROSS SECTION SCALE B

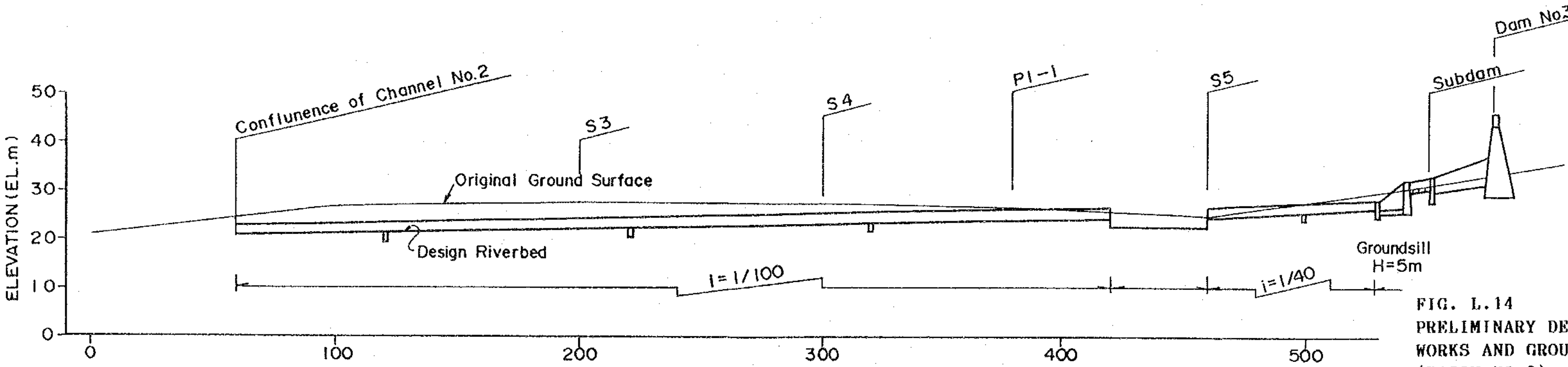


Dimension

H (m)	a (mm)	c (mm)	d (mm)
1.00	350	300	400
2.00	350	300	500
3.00	350	300	600
4.00	350	300	700
5.00	350	300	800

TYPICAL CROSS SECTION

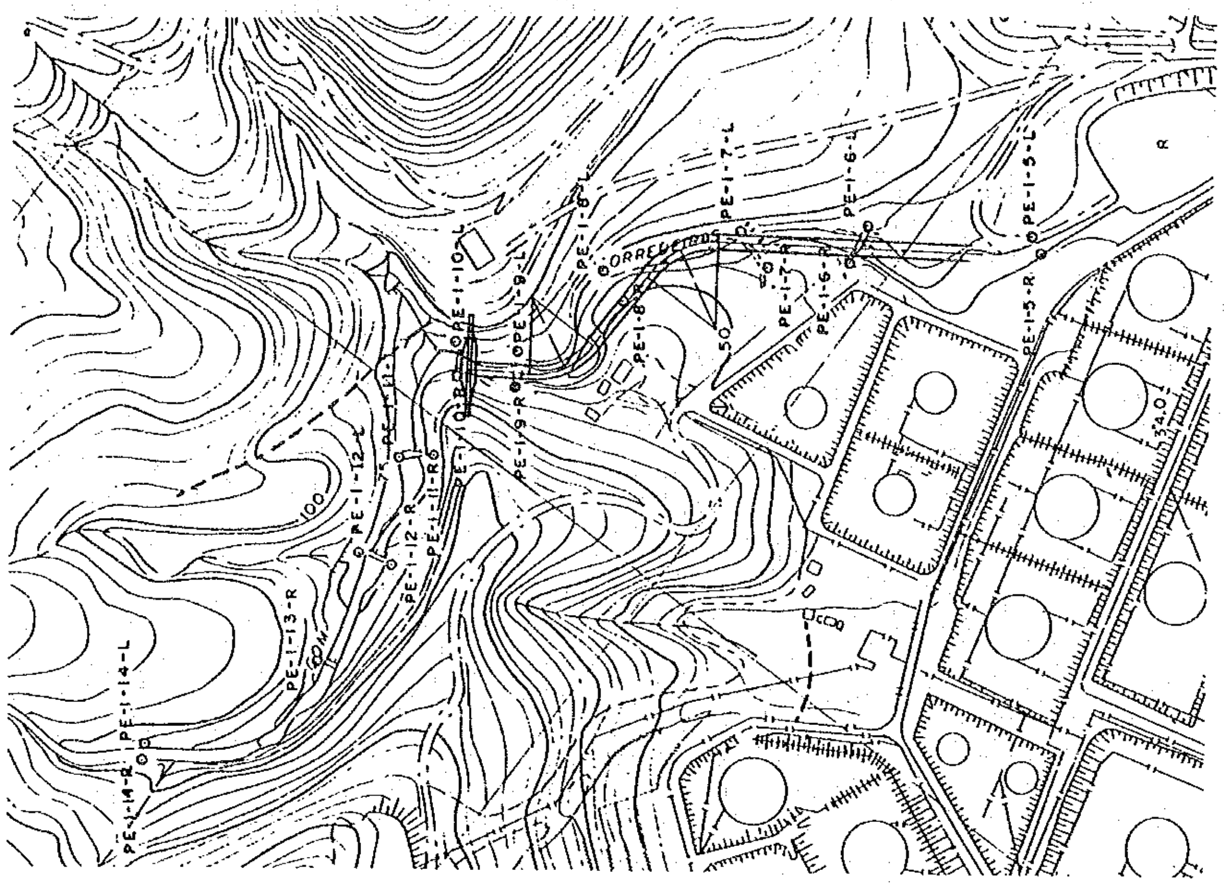




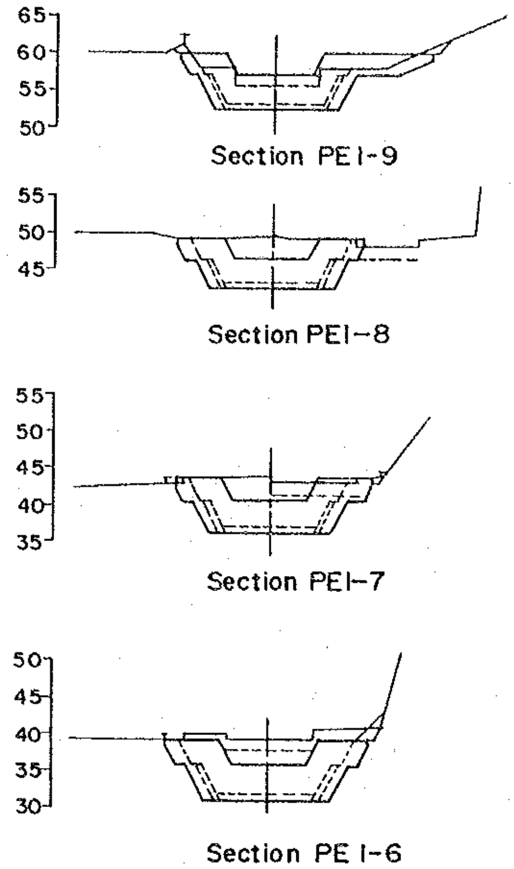
PROFILE H : SCALE B V : SCALE C

FIG. L.14
PRELIMINARY DESIGN OF CHANNEL WORKS AND GROUNDSILL (2/6) (BASIN NO.3)

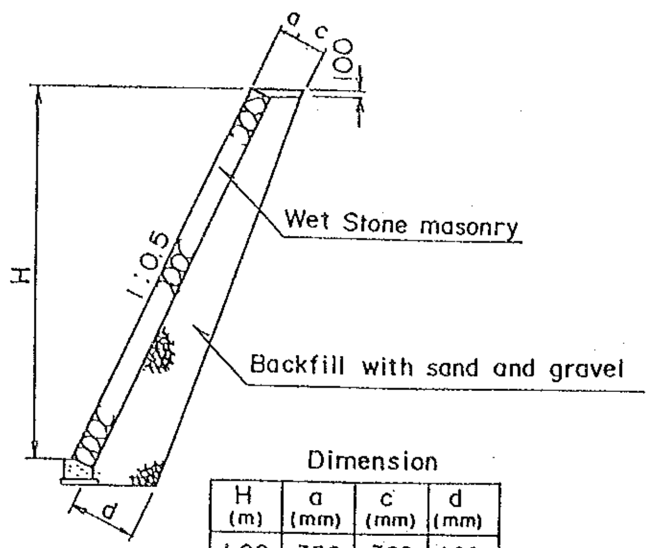
GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN SCALE A



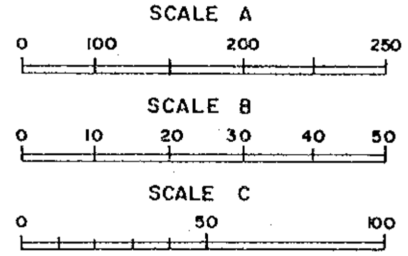
CROSS SECTION SCALE B

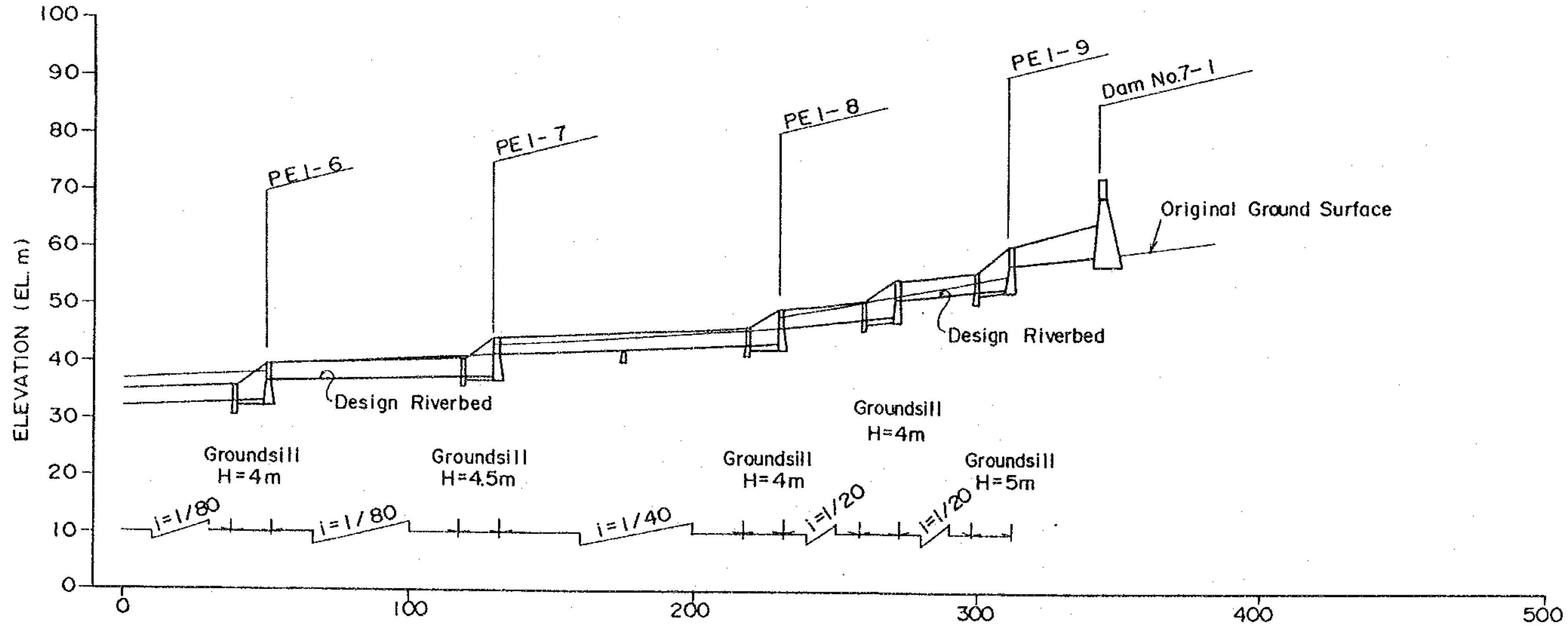


Dimension

H (m)	a (mm)	c (mm)	d (mm)
1.00	350	300	400
2.00	350	300	500
3.00	350	300	600
4.00	350	300	700
5.00	350	300	800

TYPICAL CROSS SECTION

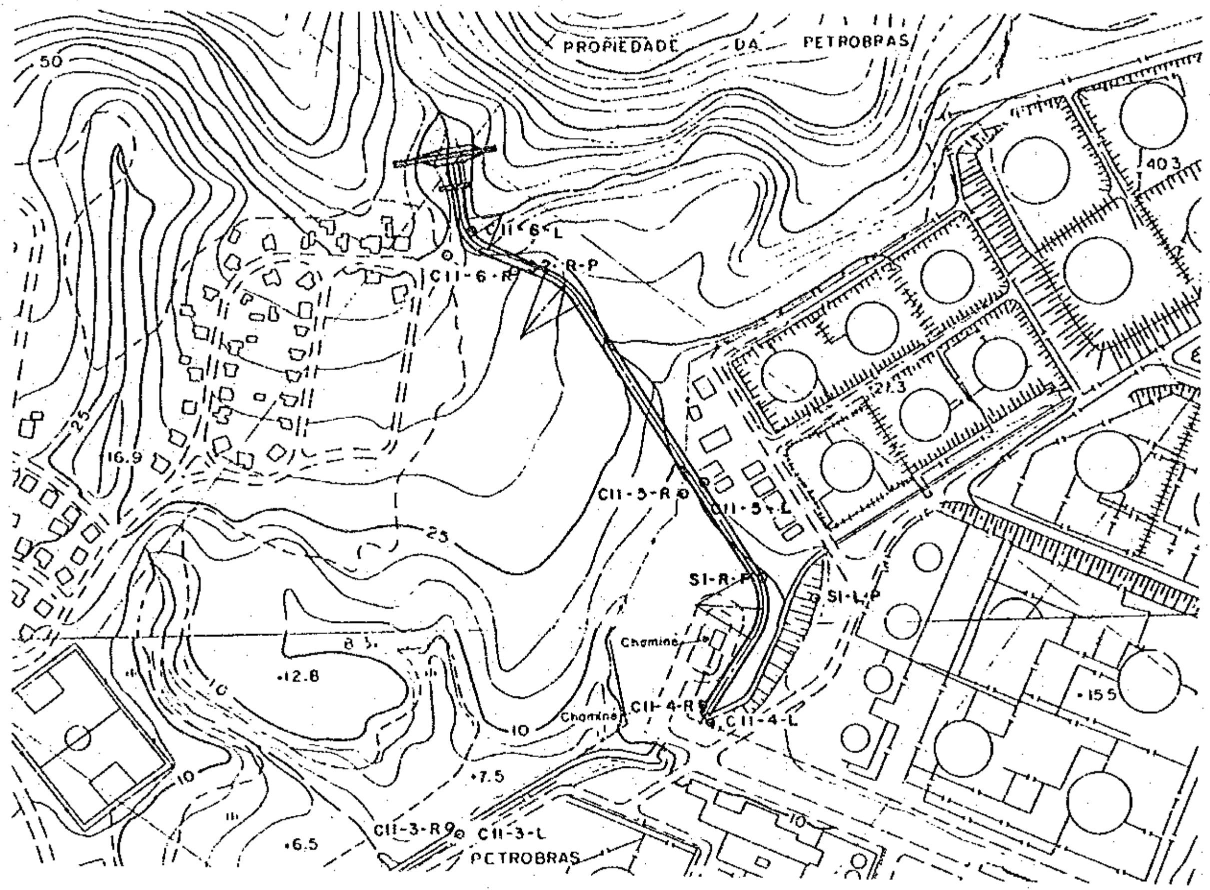




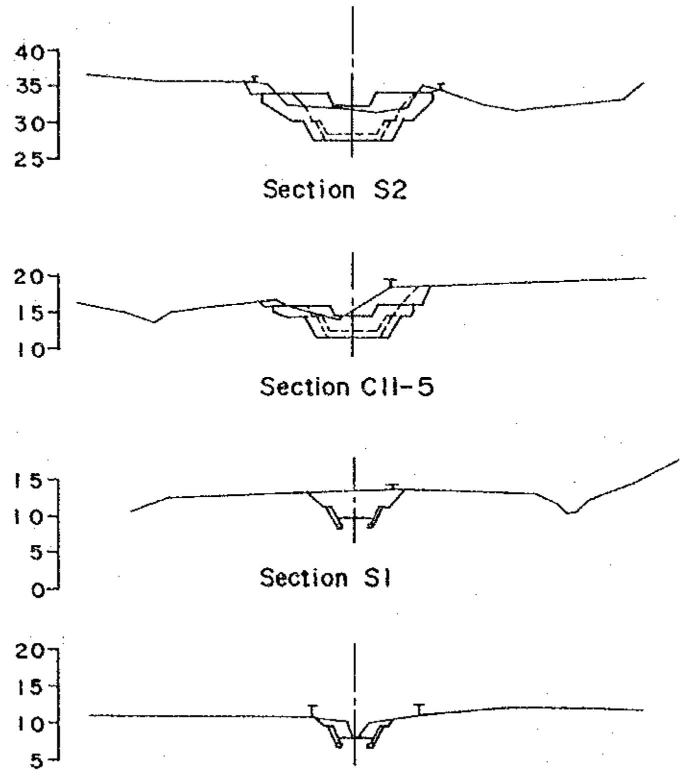
PROFILE H : SCALE B V : SCALE C

FIG. L.14
PRELIMINARY DESIGN OF CHANNEL WORKS AND GROUNDSILL (3/6) (BASIN NO.7)

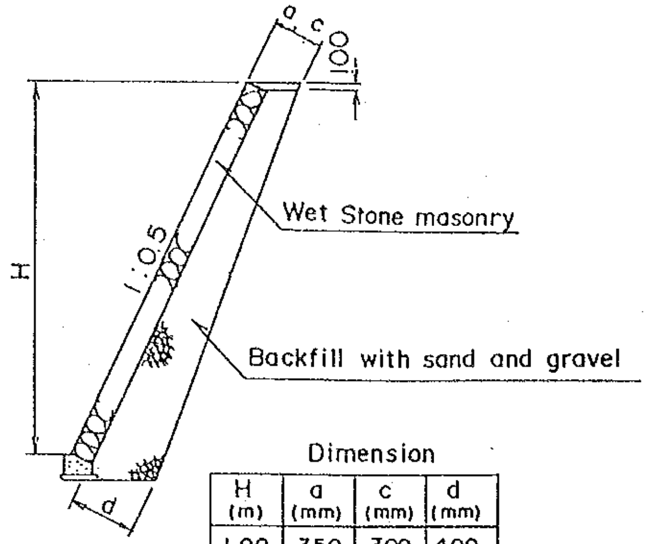
GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN SCALE A



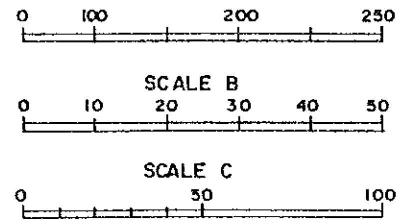
CROSS SECTION SCALE B

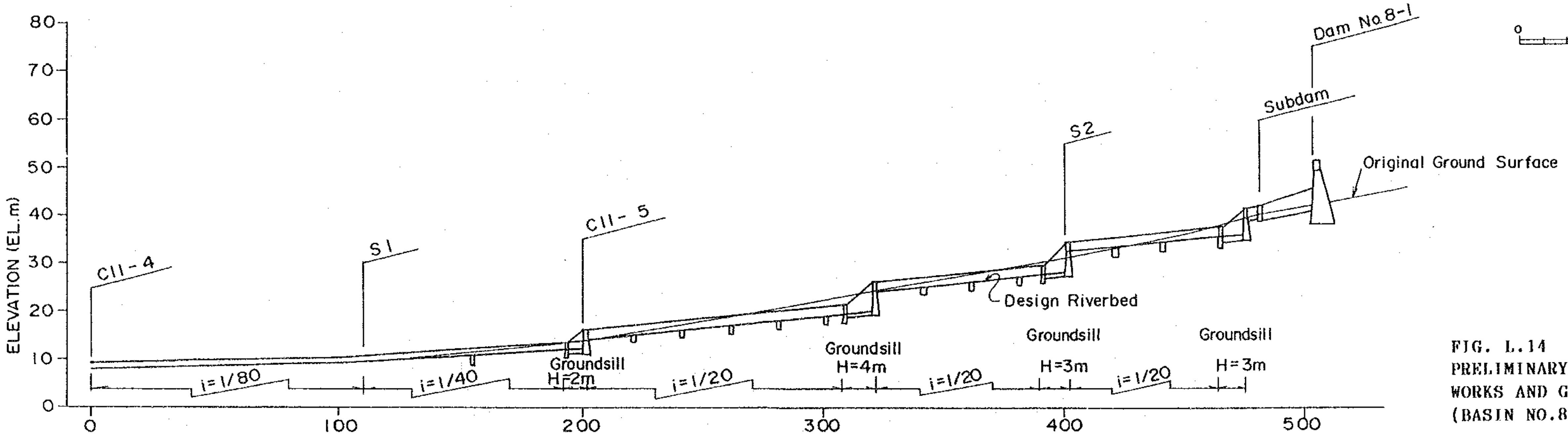


Dimension

H (m)	a (mm)	c (mm)	d (mm)
1.00	350	300	400
2.00	350	300	500
3.00	350	300	600
4.00	350	300	700
5.00	350	300	800

TYPICAL CROSS SECTION



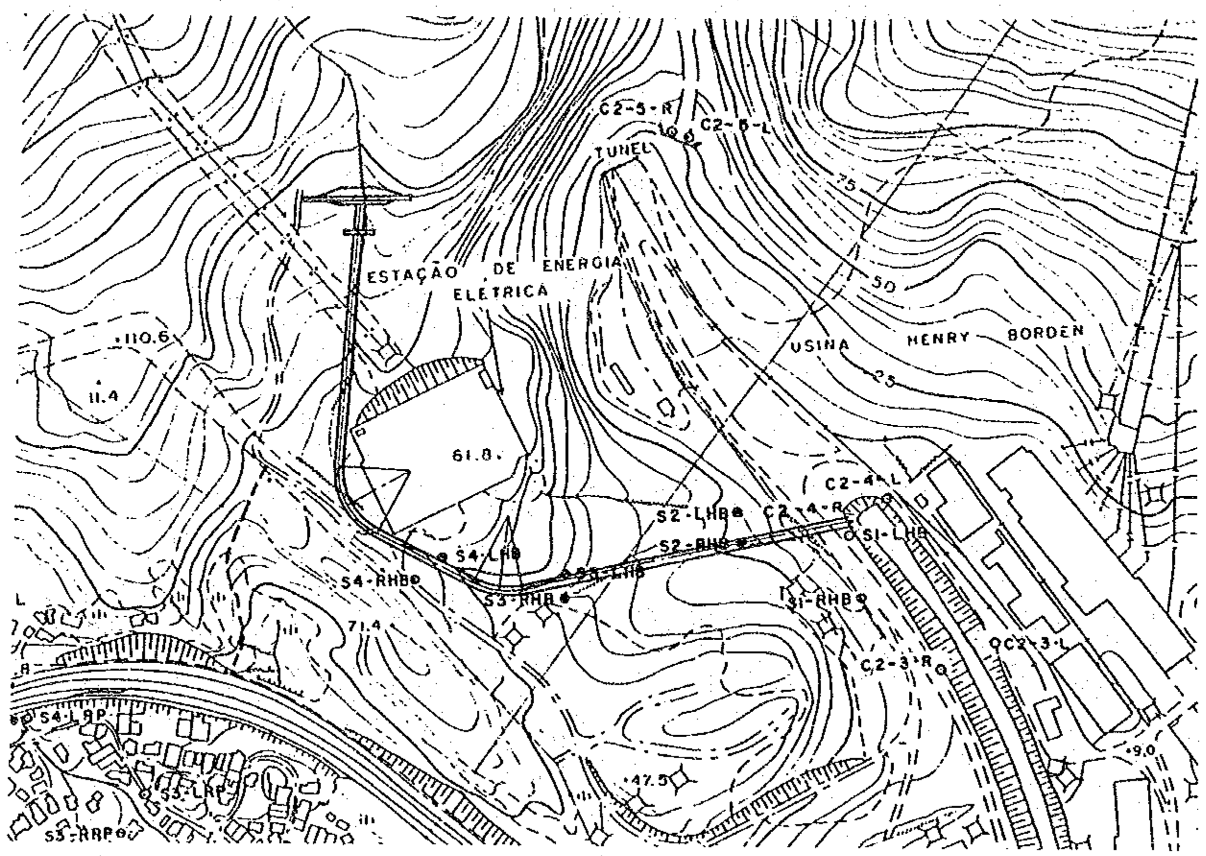


PROFILE H : SCALE B V : SCALE C

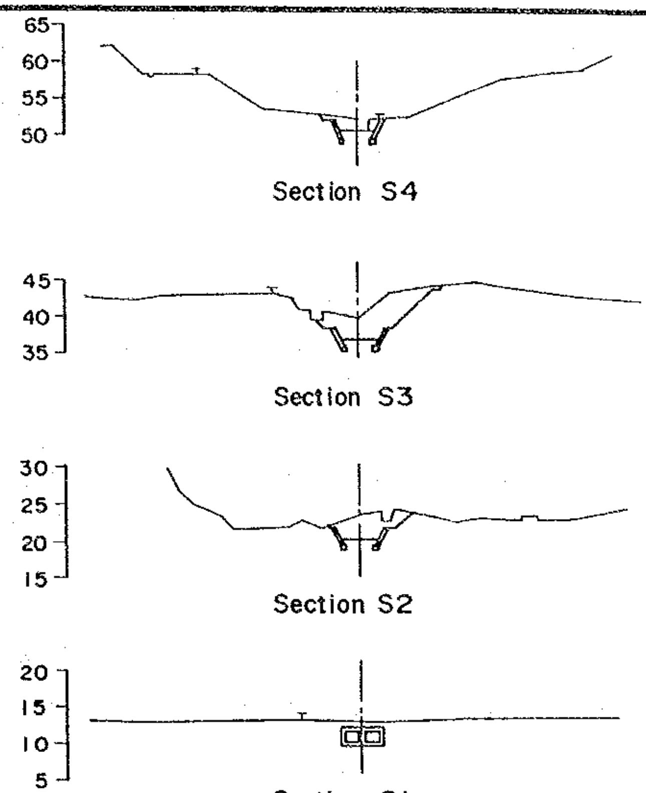
FIG. L.14
PRELIMINARY DESIGN OF CHANNEL WORKS AND GROUNDSILL (4/6) (BASIN NO.8)

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

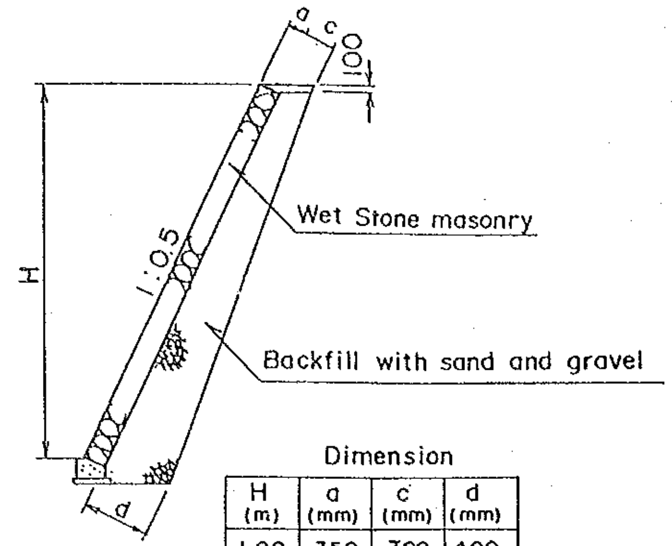
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN SCALE A



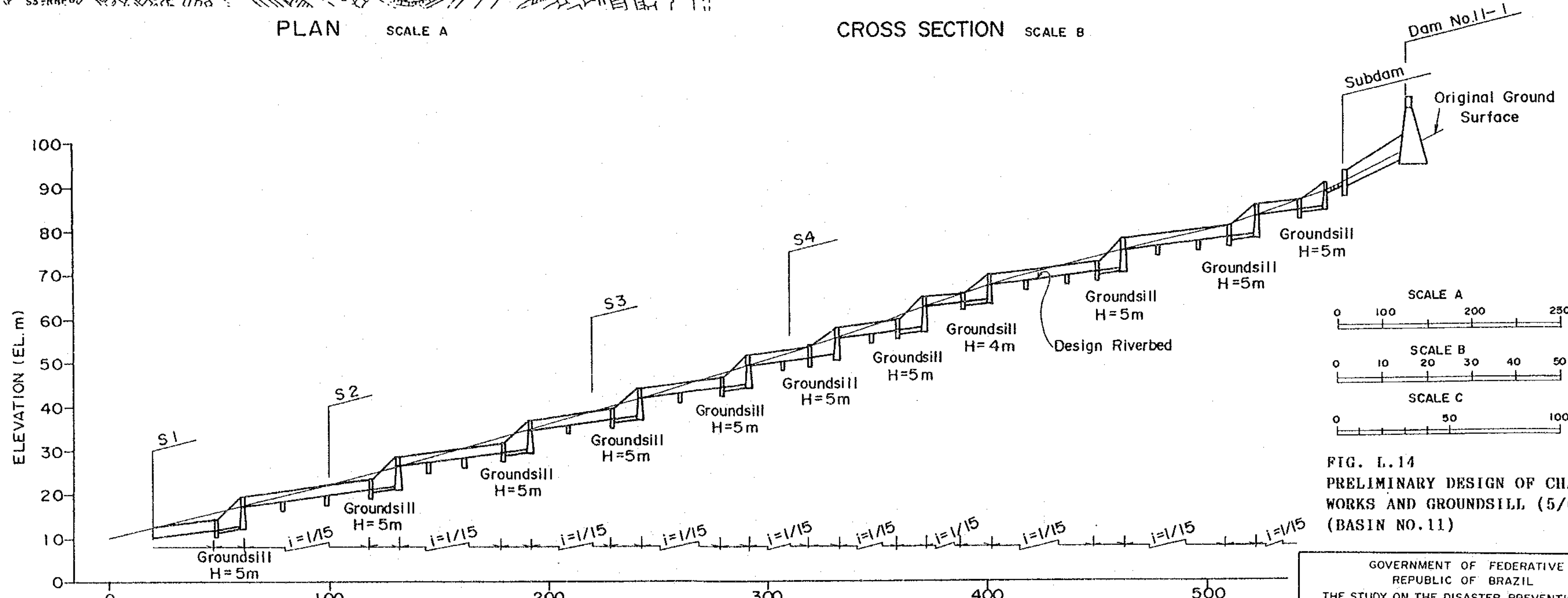
CROSS SECTION SCALE B



Dimension

H (m)	a (mm)	c (mm)	d (mm)
1.00	350	300	400
2.00	350	300	500
3.00	350	300	600
4.00	350	300	700
5.00	350	300	800

TYPICAL CROSS SECTION

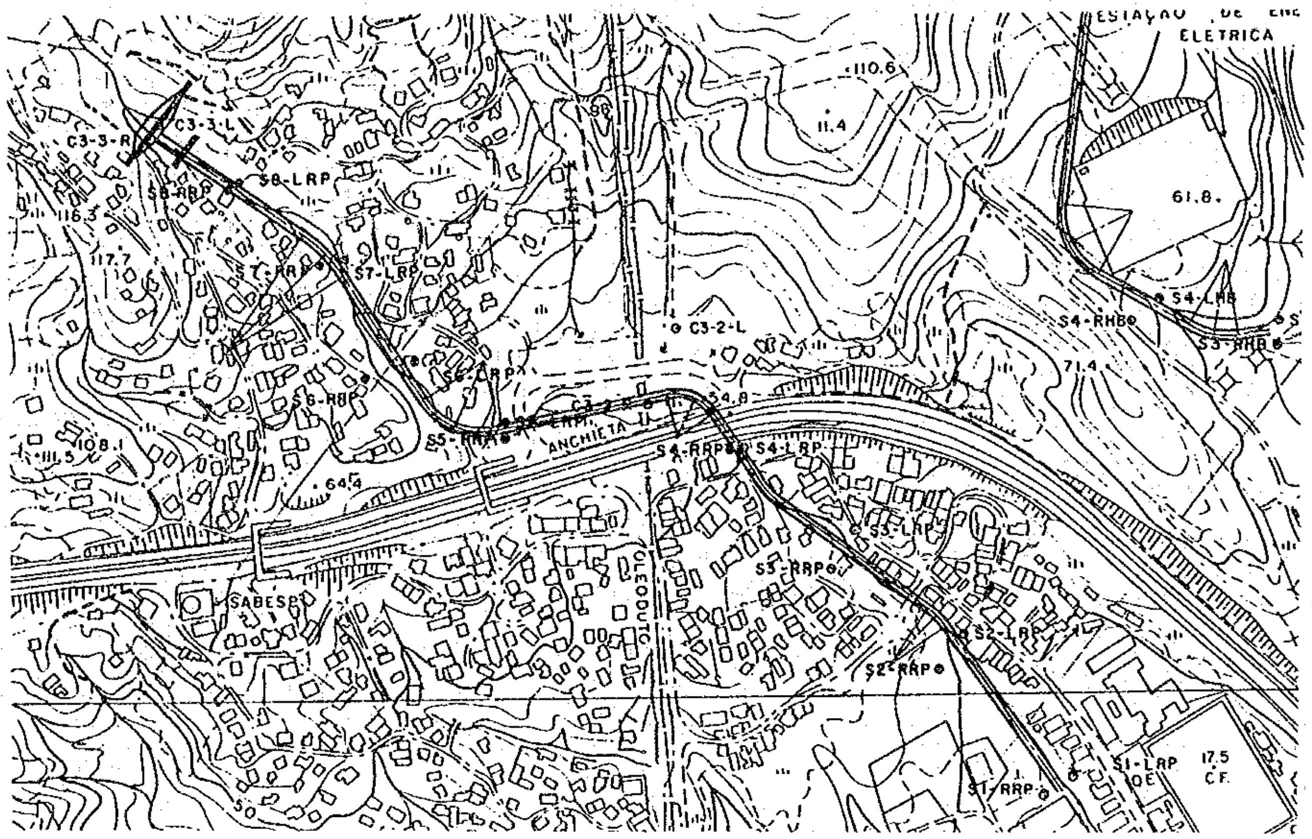


PROFILE H: SCALE B V: SCALE C

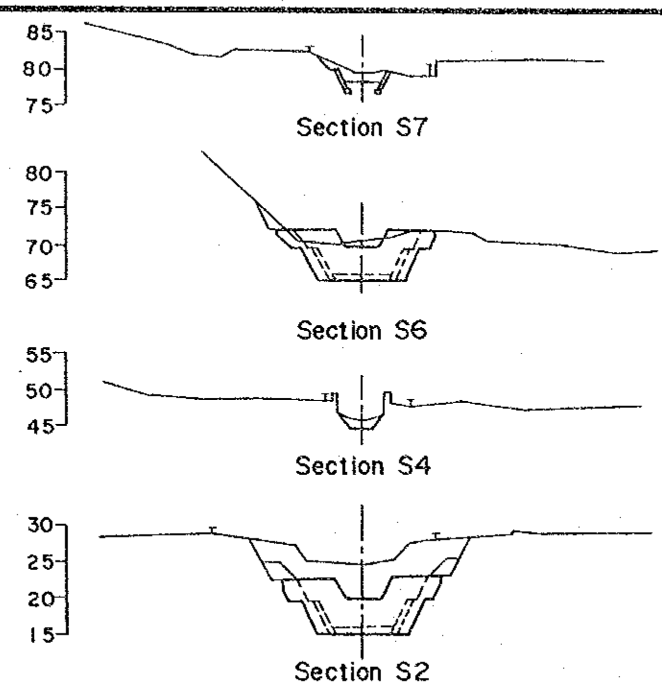
FIG. L.14
PRELIMINARY DESIGN OF CHANNEL WORKS AND GROUNDSILL (5/6) (BASIN NO.11)

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

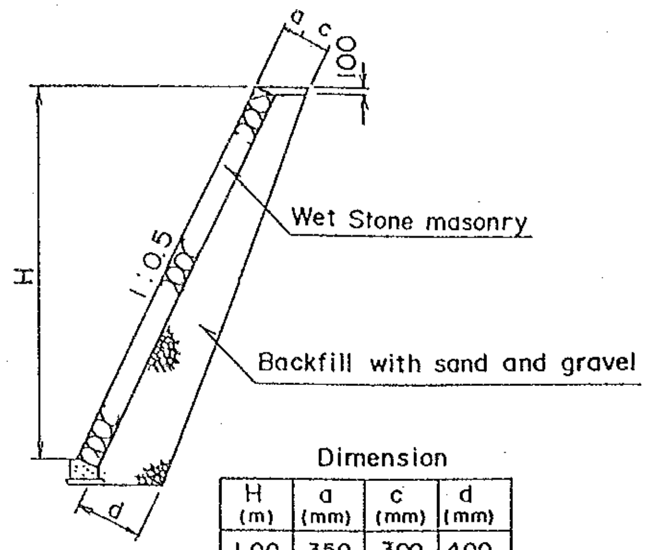
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN SCALE A



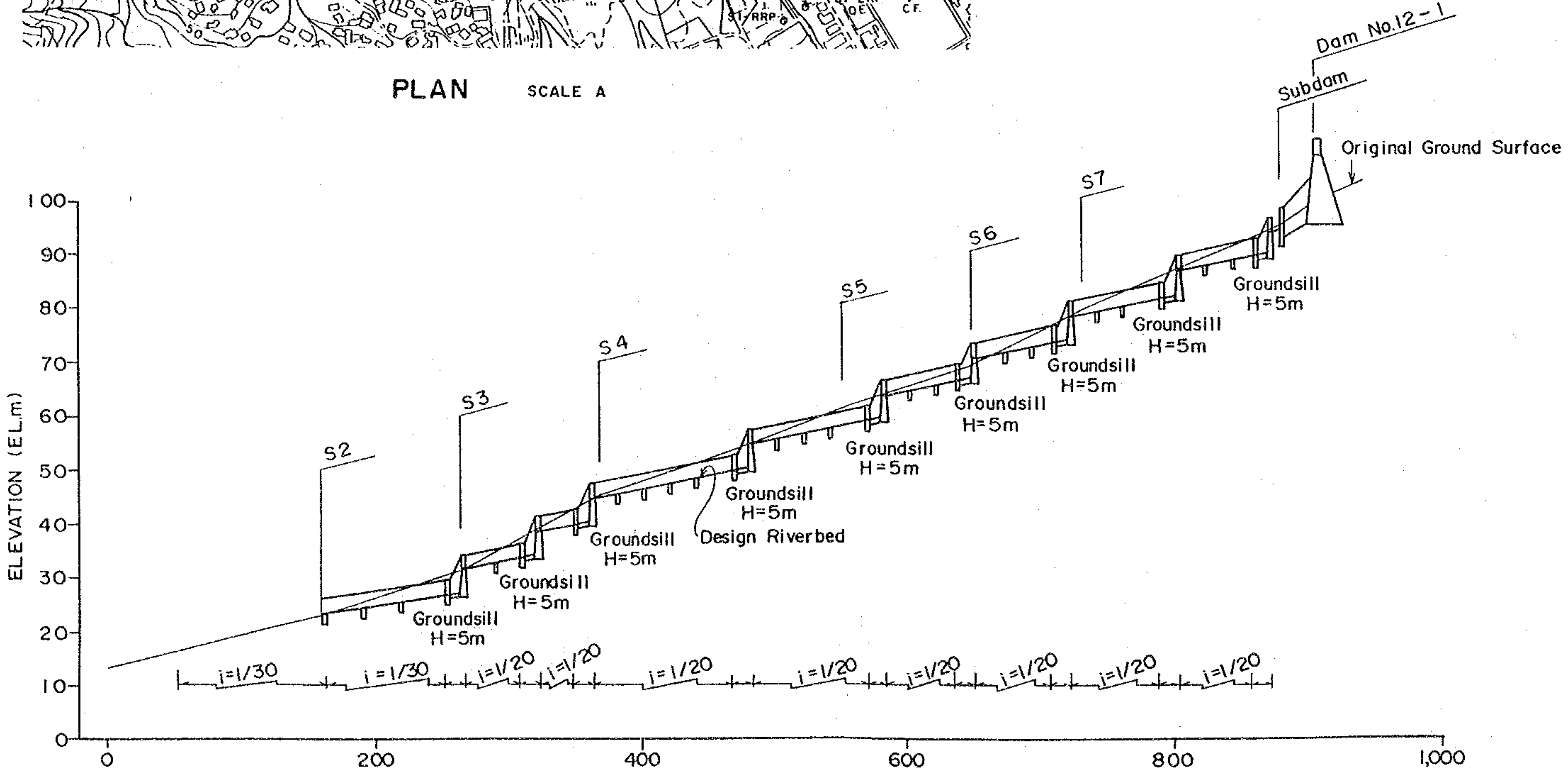
CROSS SECTION SCALE B



Dimension

H (m)	a (mm)	c (mm)	d (mm)
1.00	350	300	400
2.00	350	300	500
3.00	350	300	600
4.00	350	300	700
5.00	350	300	800

TYPICAL CROSS SECTION



PROFILE H : SCALE B V : SCALE C

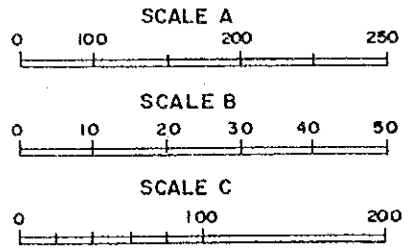


FIG. L.14
PRELIMINARY DESIGN OF CHANNEL WORKS AND GROUNDSILL (6/6)
(BASIN NO.12)

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

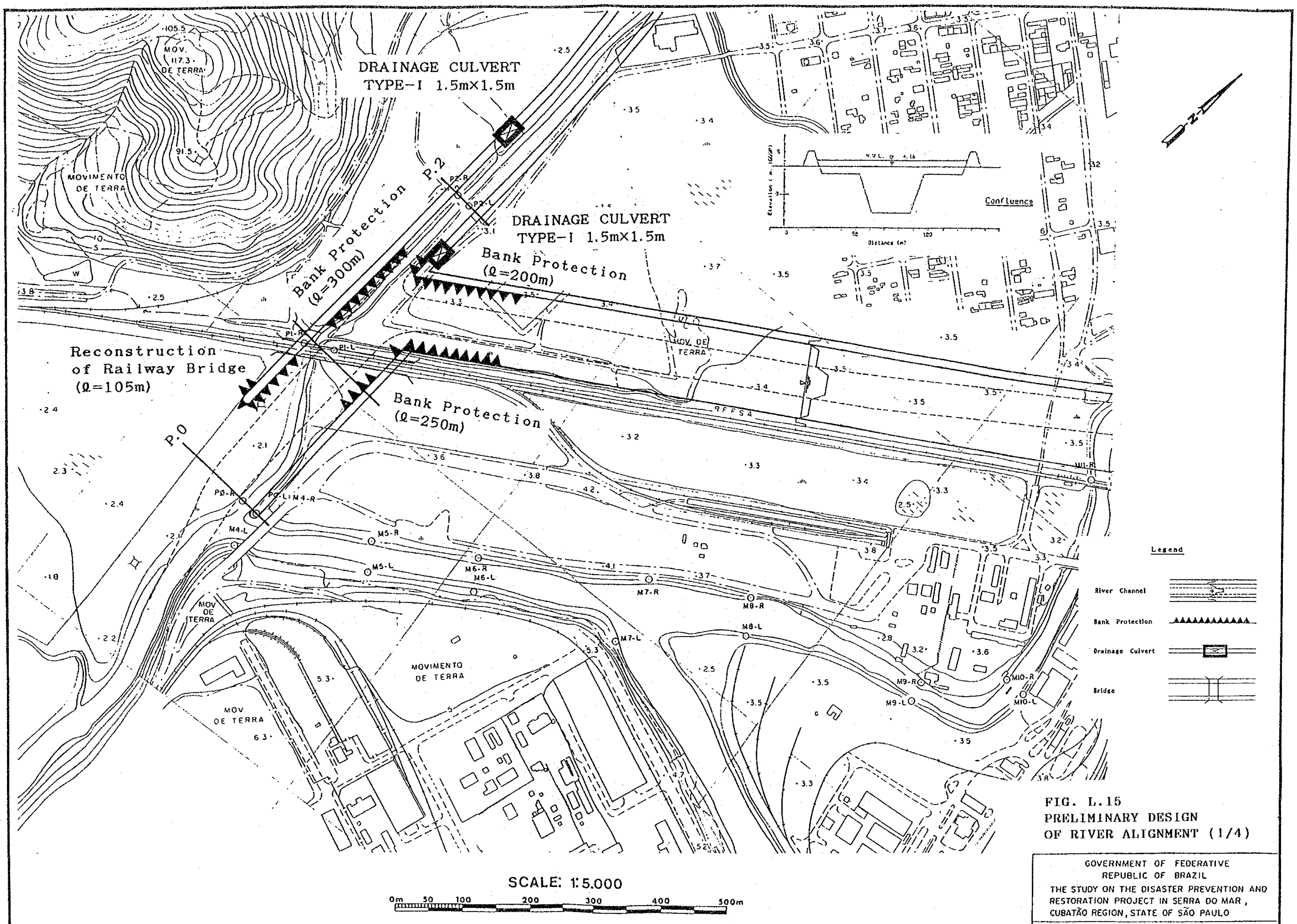


FIG. L.15
PRELIMINARY DESIGN
OF RIVER ALIGNMENT (1/4)

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

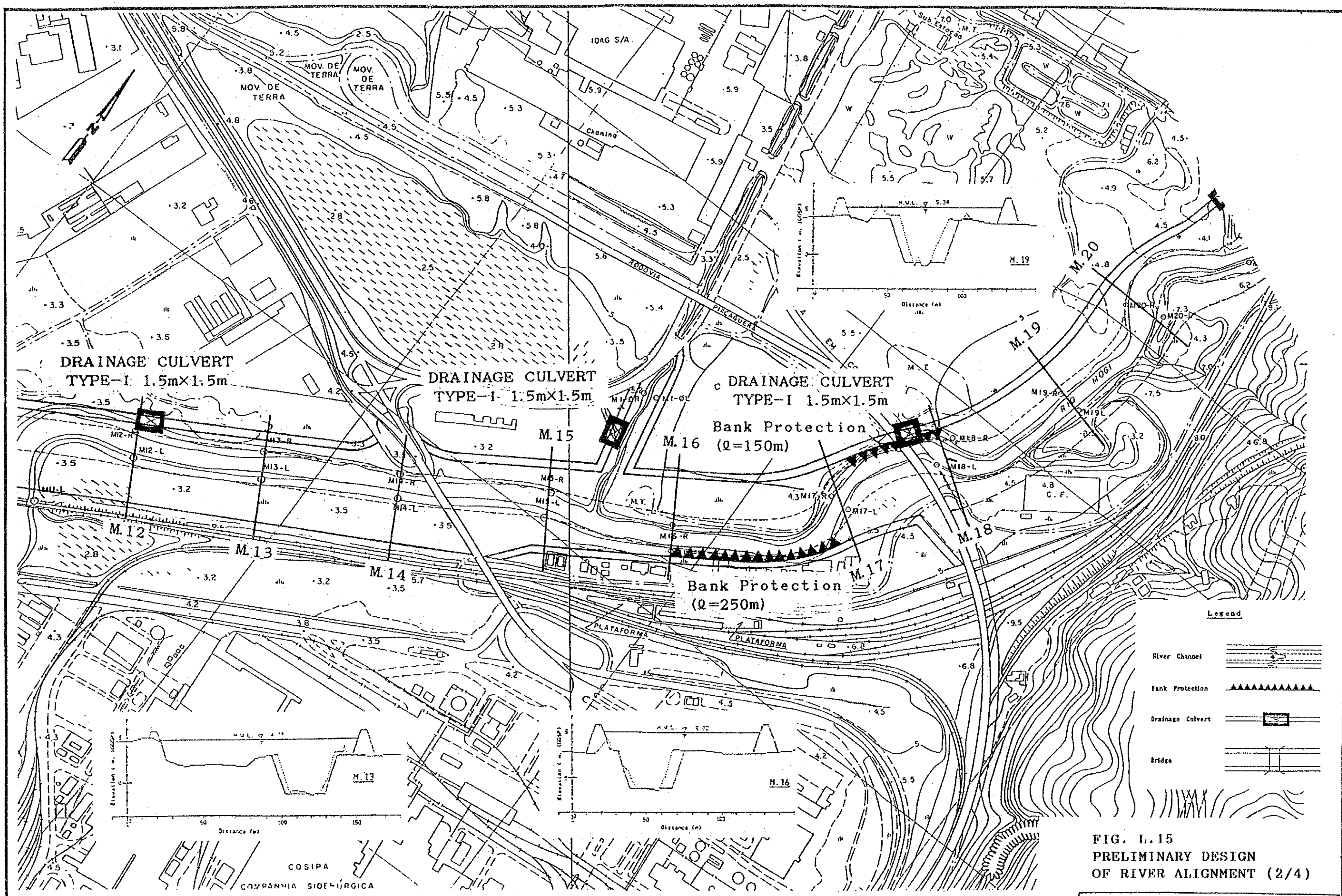


FIG. L.15
PRELIMINARY DESIGN
OF RIVER ALIGNMENT (2/4)

SCALE: 1:5.000

0m 50 100 200 300 400 500m

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

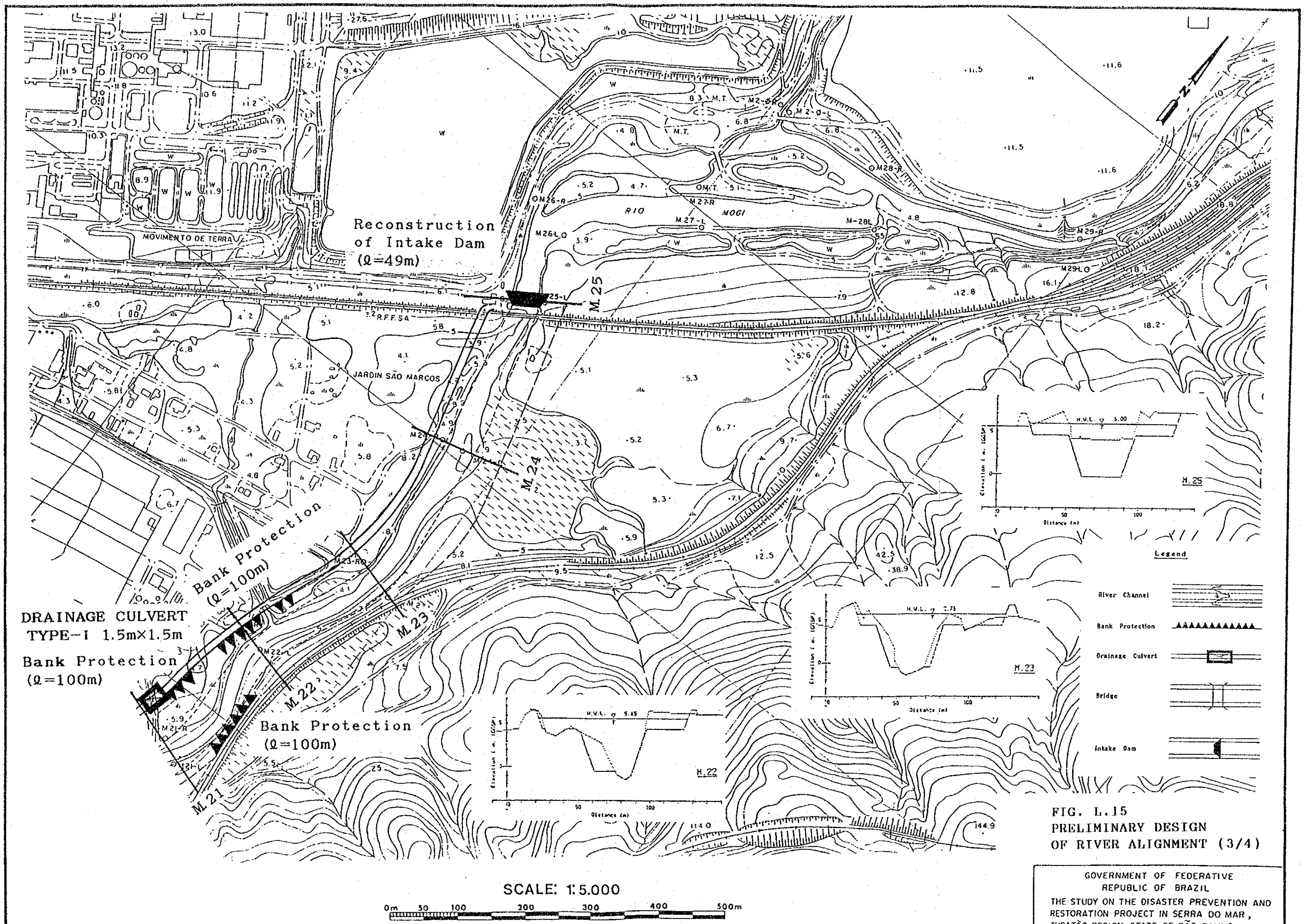


FIG. L.15
PRELIMINARY DESIGN
OF RIVER ALIGNMENT (3/4)

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO
JAPAN INTERNATIONAL COOPERATION AGENCY

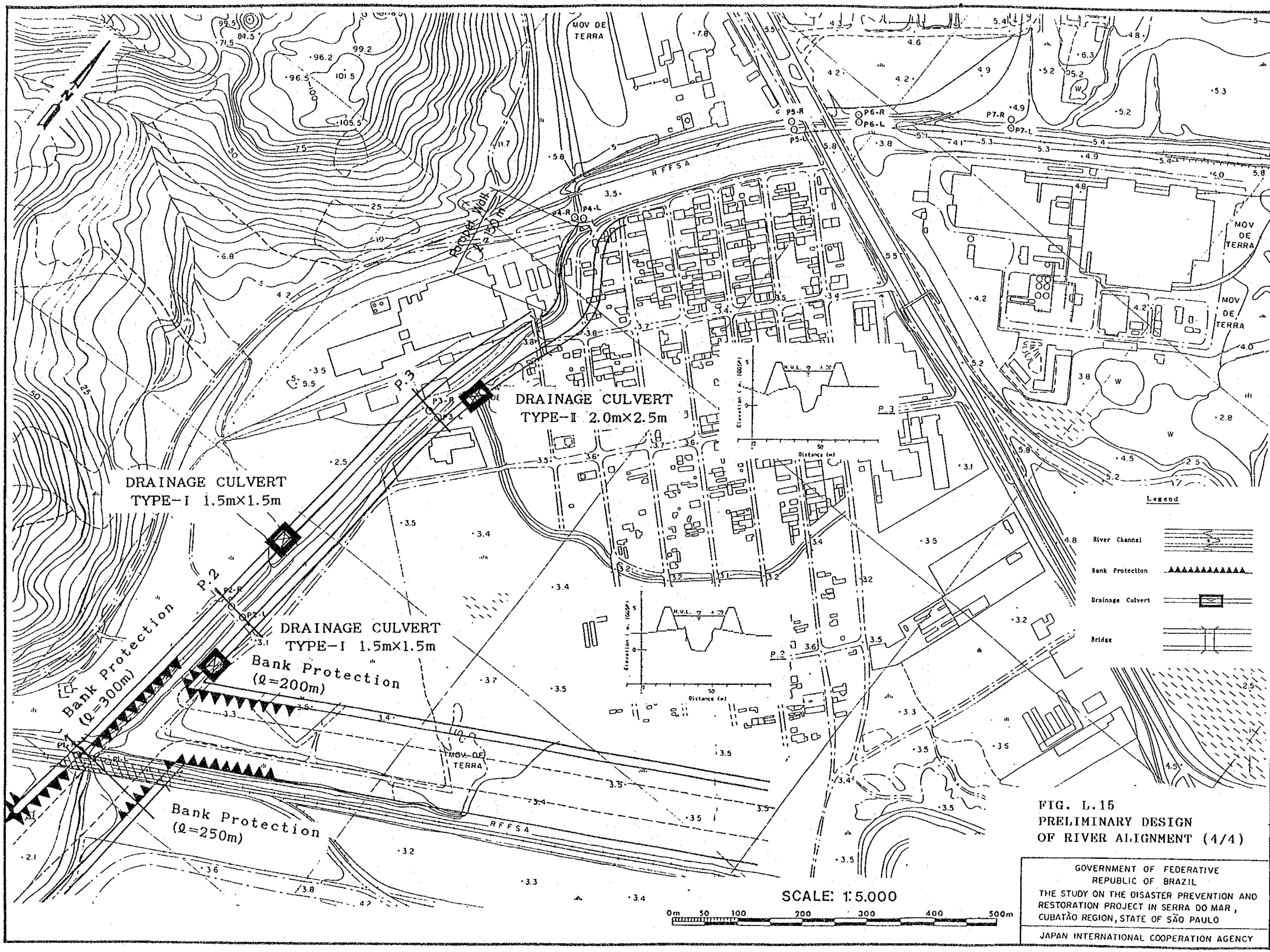


FIG. L.15
PRELIMINARY DESIGN
OF RIVER ALIGNMENT (4/4)

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY