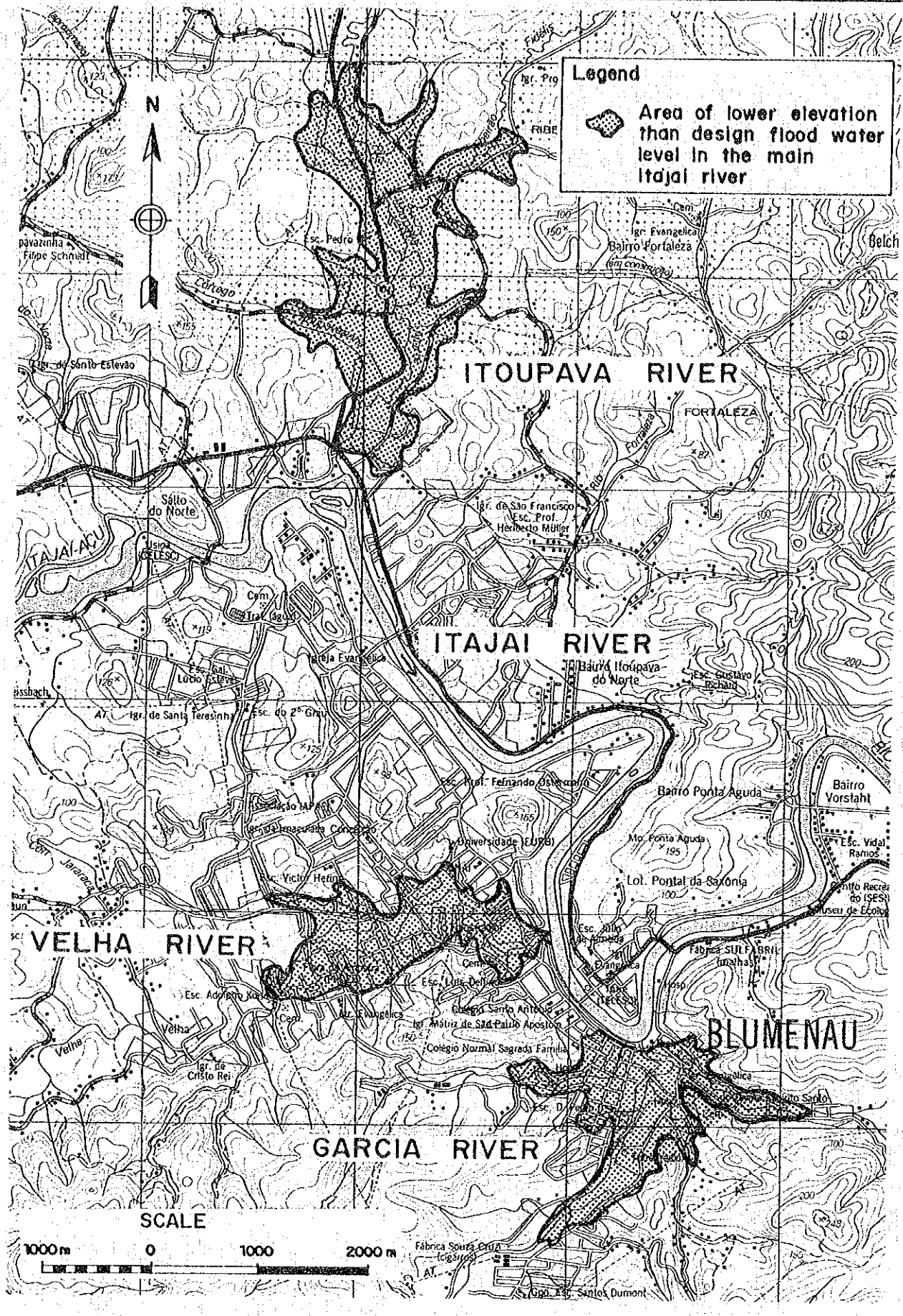
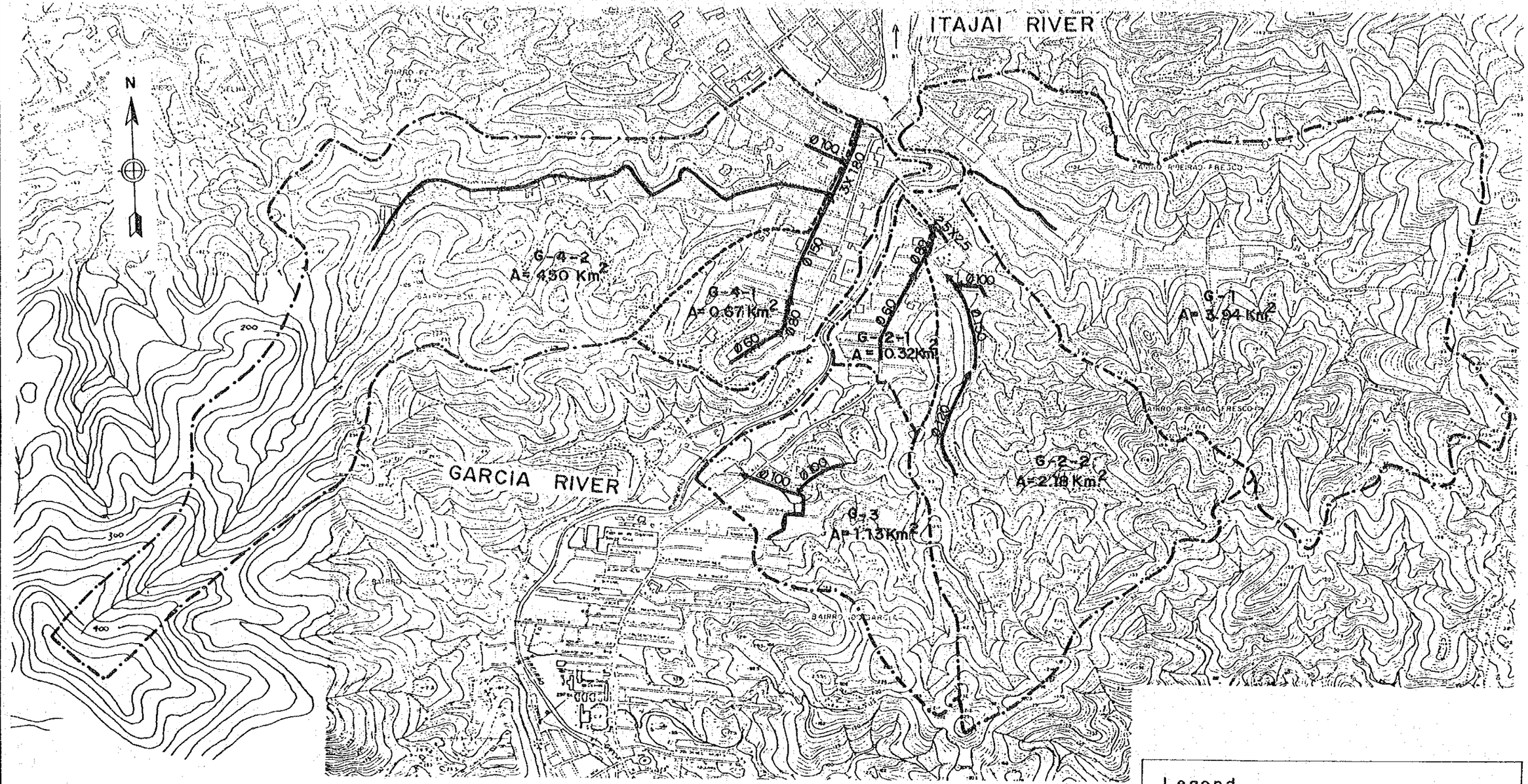


Fig. VII.5.1 DEPRESSION AREAS IN BLUMENAU CITY



Legend

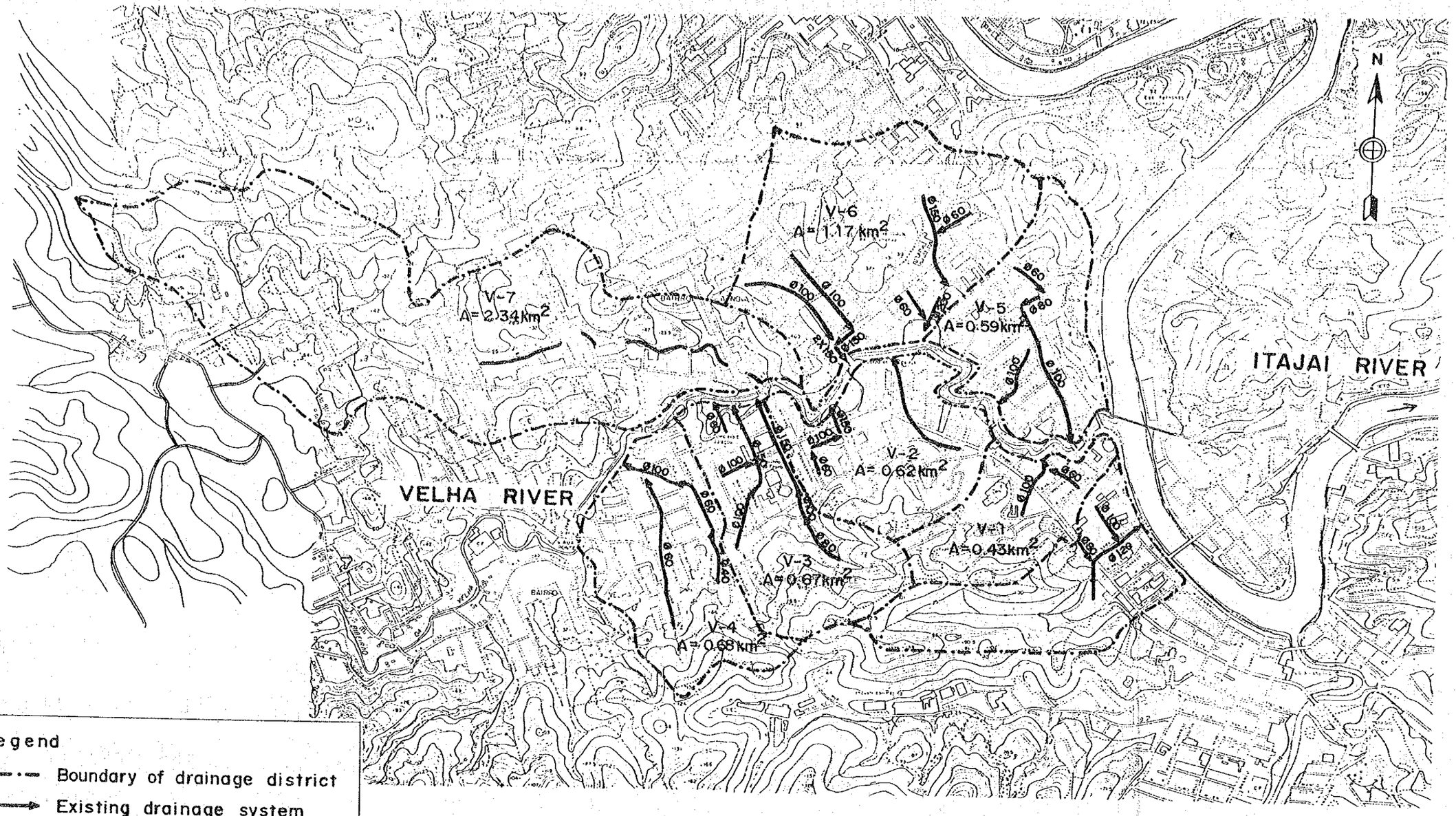
- Boundary of drainage district
- Sub-division in drainage district
- Existing drainage system
- Water course

Note : "Ø" Means diameter of drainage pipe in centimeter.

SCALE

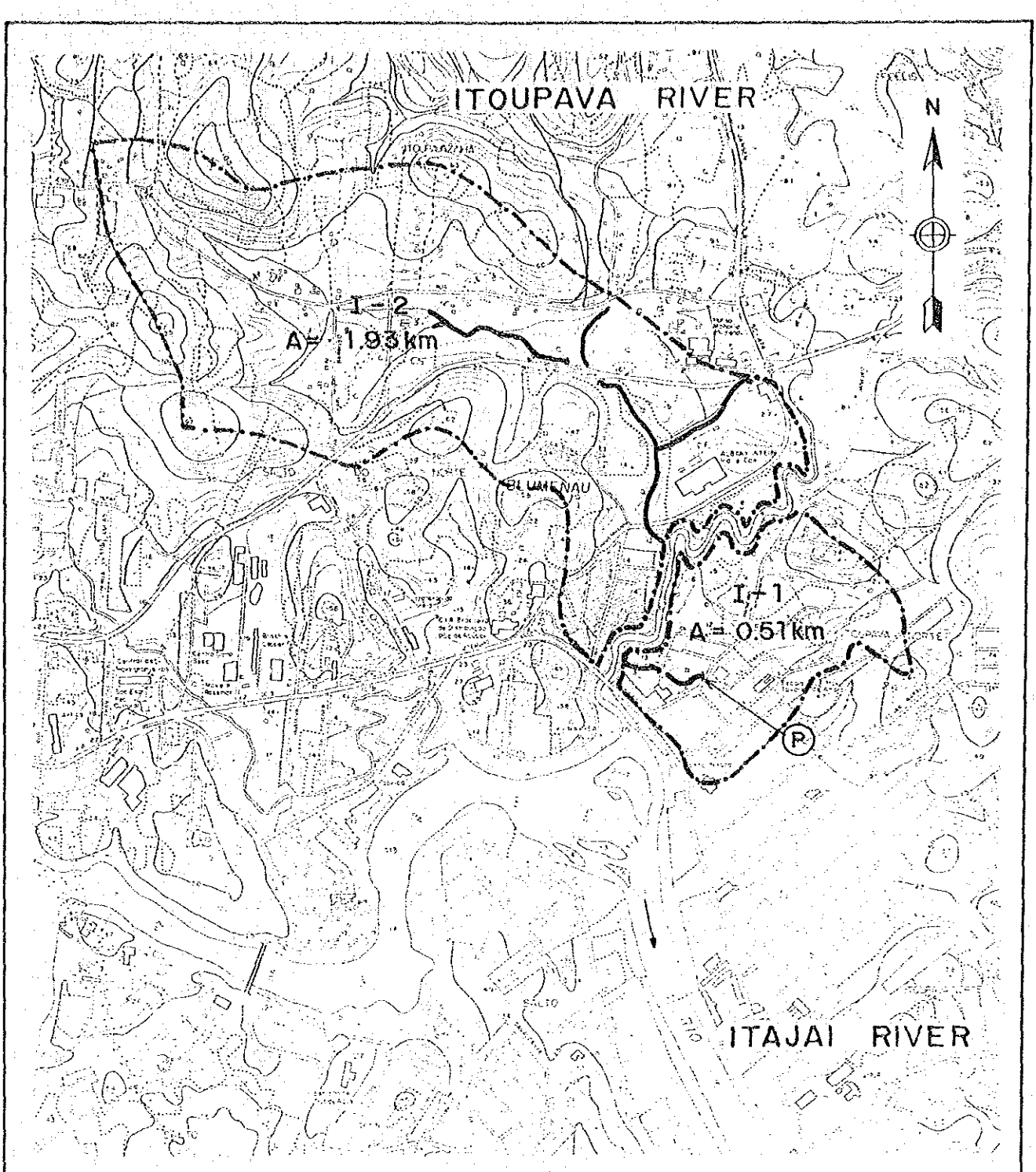
100m 0 100 200 300 400 m

Fig. VII. 5. 2 EXISTING DRAINAGE SYSTEM (1/3)
(GARCIA RIVER BASIN)



Note : "Ø" Means diameter of drainage pipe in centimeter.

Fig. VII.5.2 EXISTING DRAINAGE SYSTEM (2/3)
(VELHA RIVER BASIN)



Legend

- Boundary of drainage district
- Existing drainage pipe
- Water course
- (P) Existing drainage pumping station

SCALE

100m 0 100 200 300 400 m

Fig. VII.5.2 EXISTING DRAINAGE SYSTEM (3/3)
(ITOUPAVA BASIN)

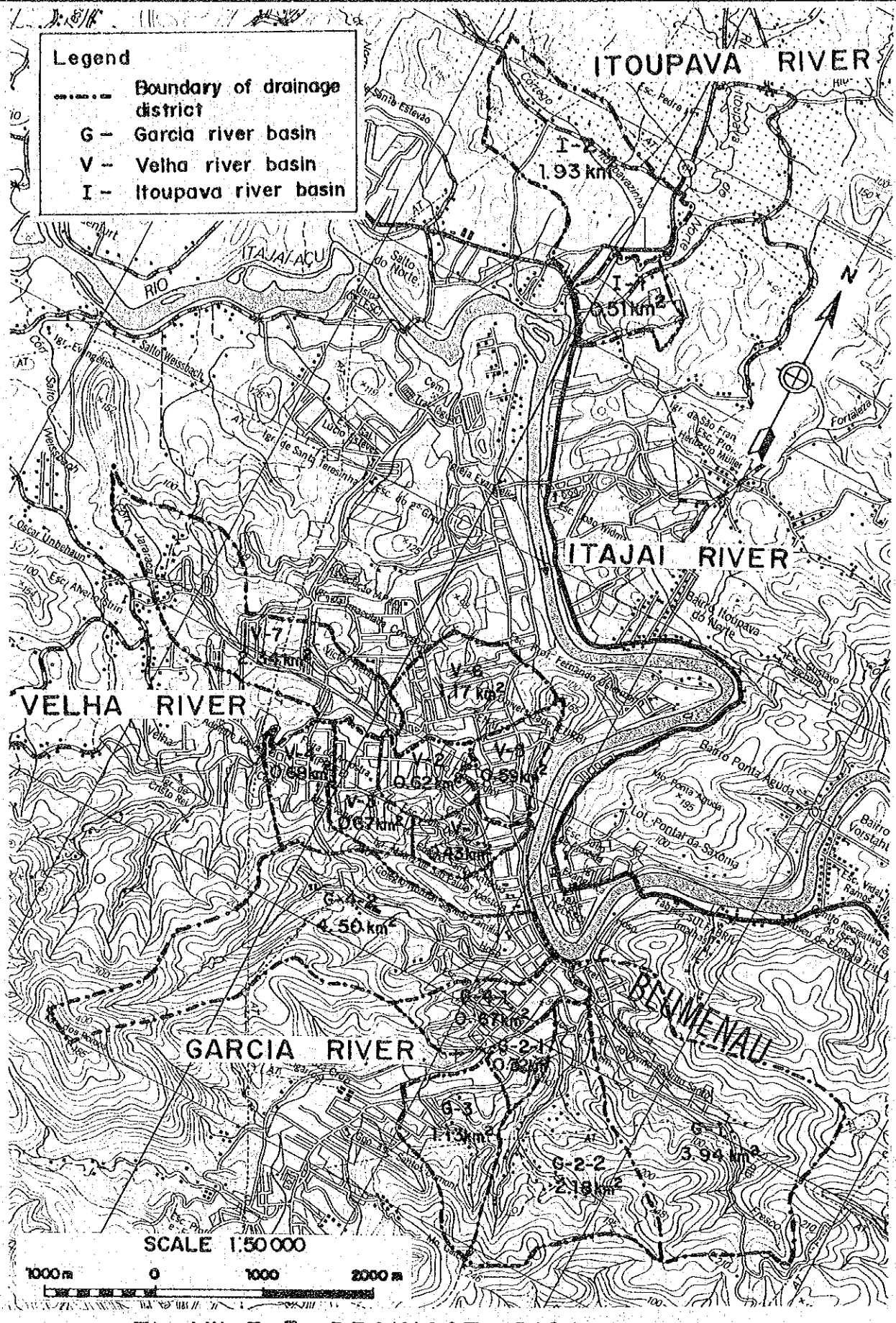
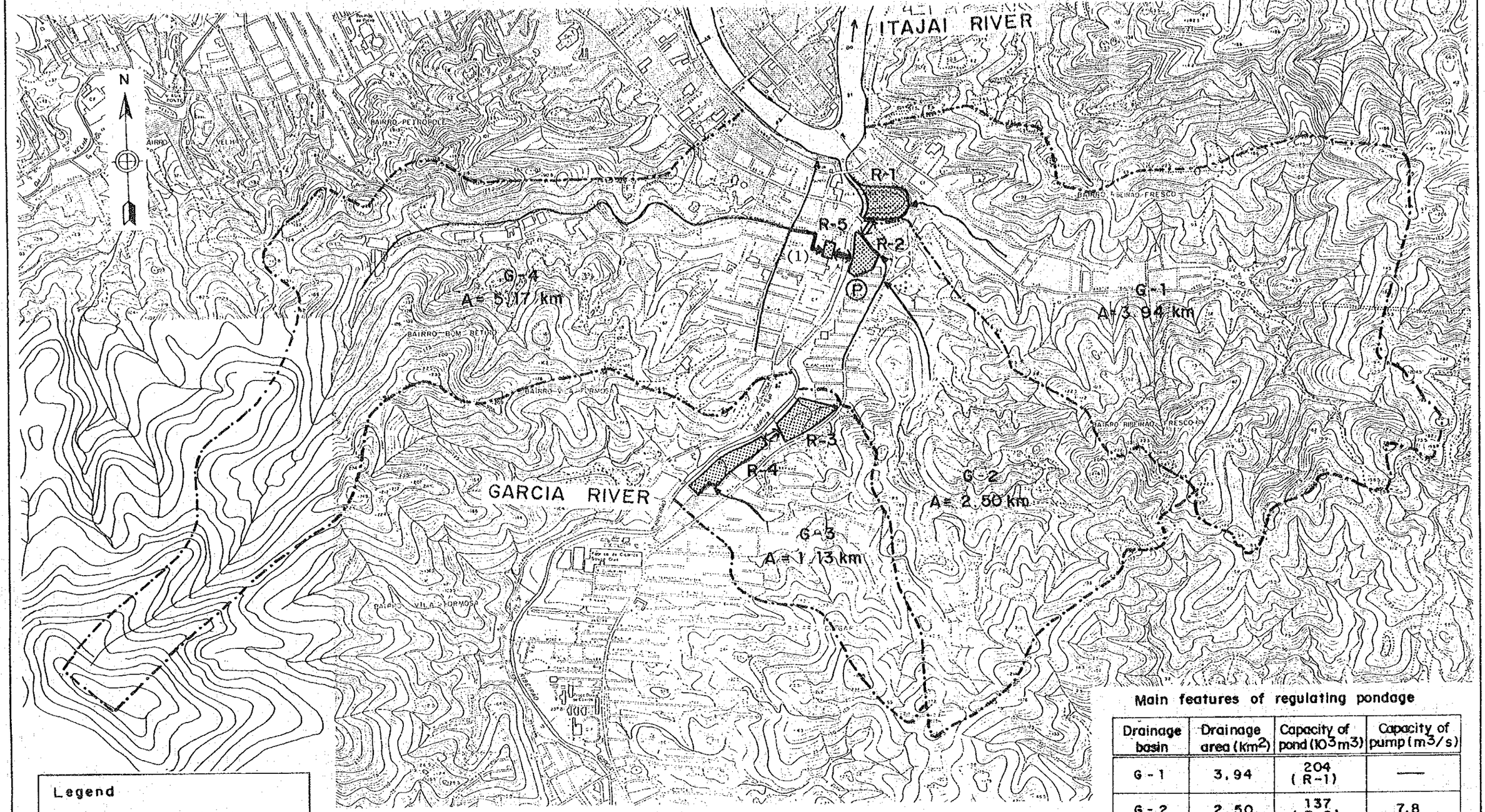


Fig. VII. 5. 3 DRAINAGE DISTRICTS IN THE TRIBUTARY AREAS



Legend

- Boundary of drainage district
- Existing drainage system

Proposed facilities;

- Connecting pipe with existing networks
- Regulating pondage
- (P) Pumping station
- Syphon
- Culvert
- ( ) Connecting pipe number

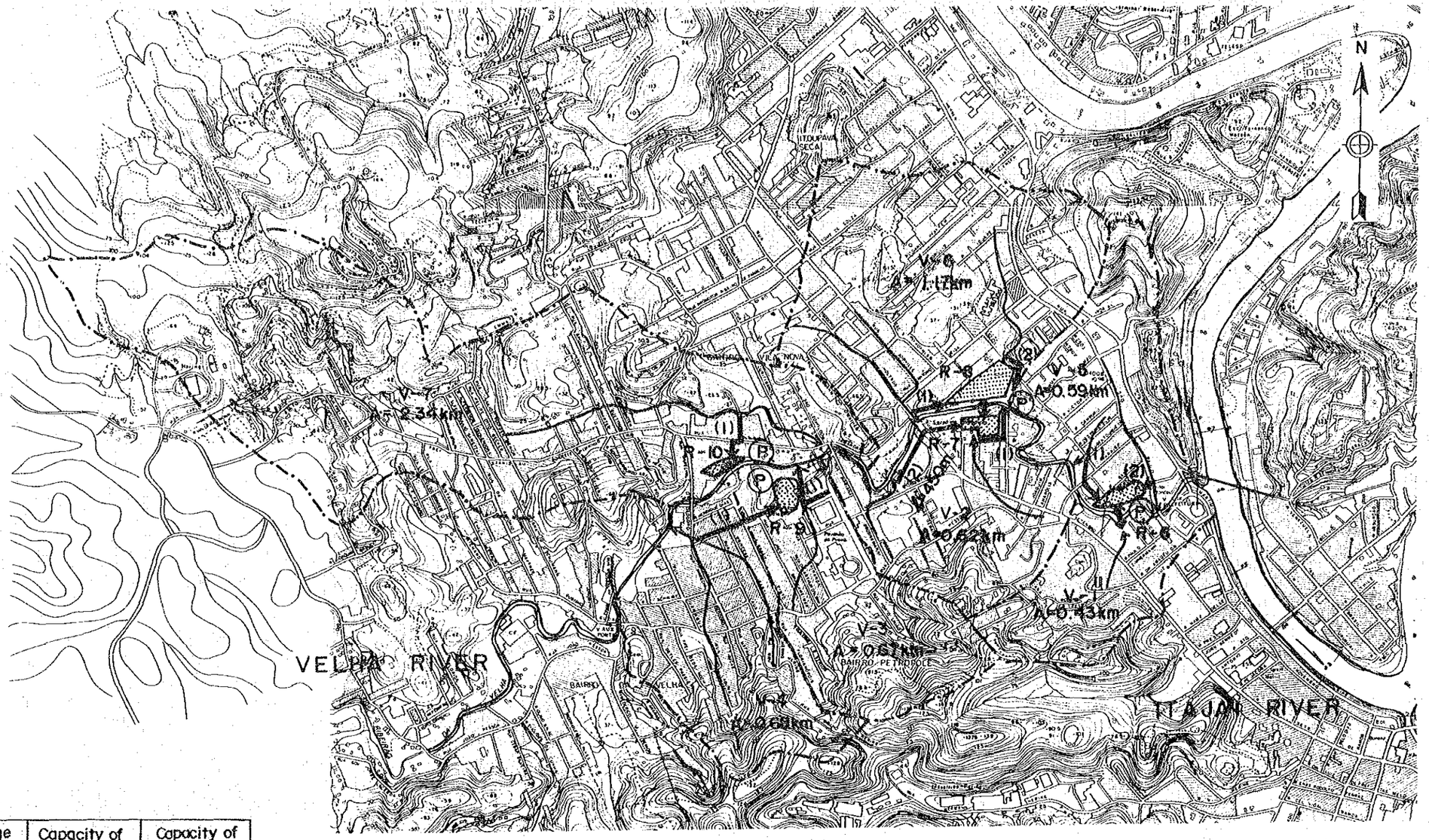
SCALE

100m 0 100 200 300 400 m

Main features of regulating pondage

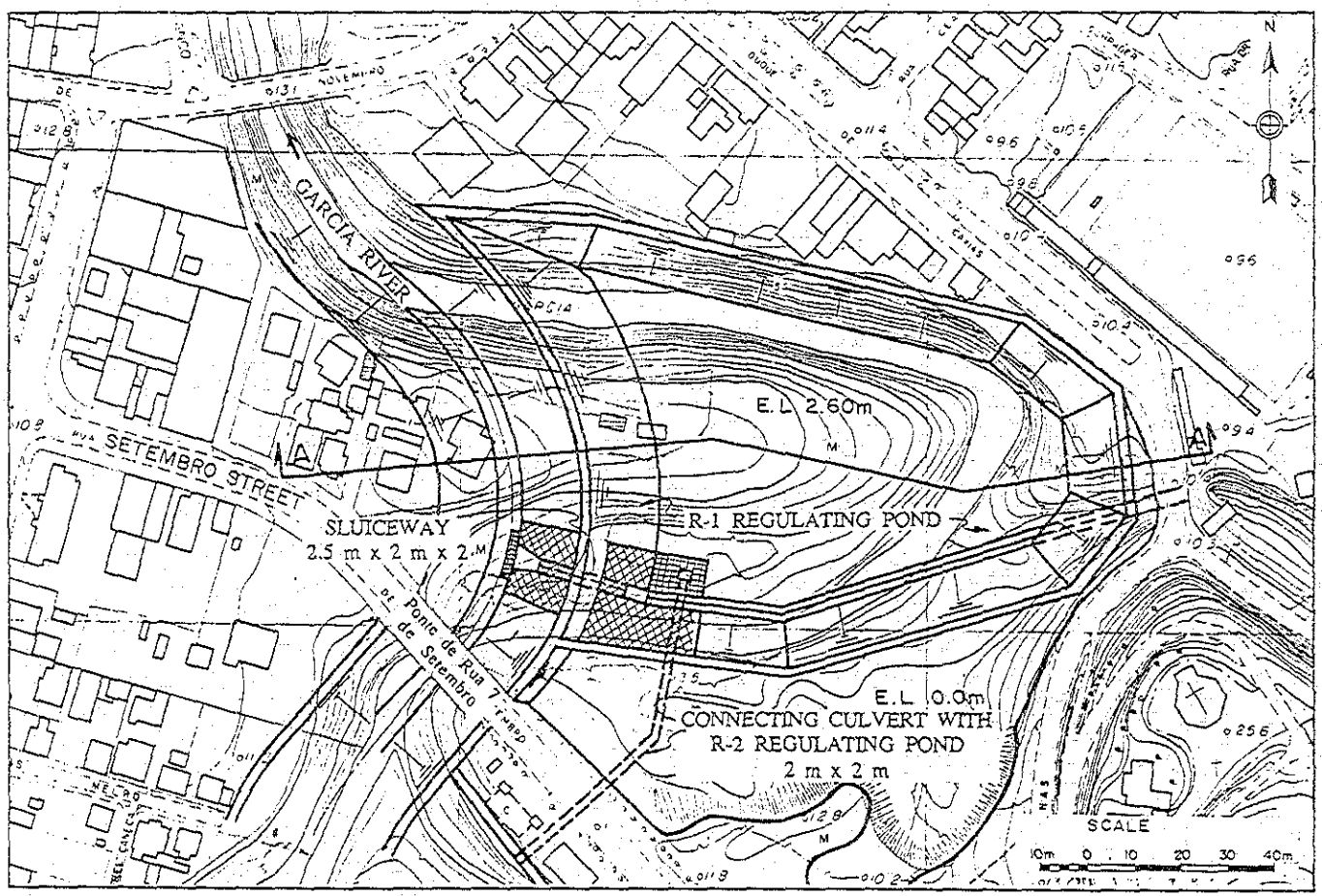
Drainage basin	Drainage area (km^2)	Capacity of pond ($10^3 m^3$)	Capacity of pump (m^3/s)
G-1	3.94	204 (R-1)	—
G-2	2.50	137 (R-2)	7.8
G-3	1.13	240 (R-3)	—
		169 (R-4)	—
G-4	5.17	26 (R-5)	—
TOTAL	12.74	776	7.8

Fig. VII.5.4 GENERAL PLAN OF DRAINAGE FACILITIES (1/2)
(GARCIA RIVER BASIN)



Drainage basin	Drainage area (km^2)	Capacity of pond ($10^3 m^3$)	Capacity of pump (m^3/s)
V-1	0.43	—	—
V-2	0.62	101 (R-7)	—
V-3	0.67	57 (R-9)	1.0
V-4	0.68	—	—
V-5	0.59	50 (R-6)	0.7
V-6	1.17	57 (R-8)	0.7
V-7	2.34	15 (R-10)	4.0
Total	6.50	280	6.4

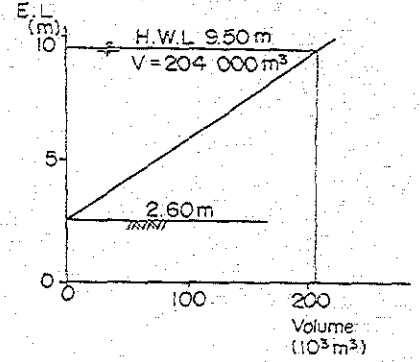
Fig. VII.5.4 GENERAL PLAN OF DRAINAGE FACILITIES (2/2)
(VELHA RIVER BASIN)

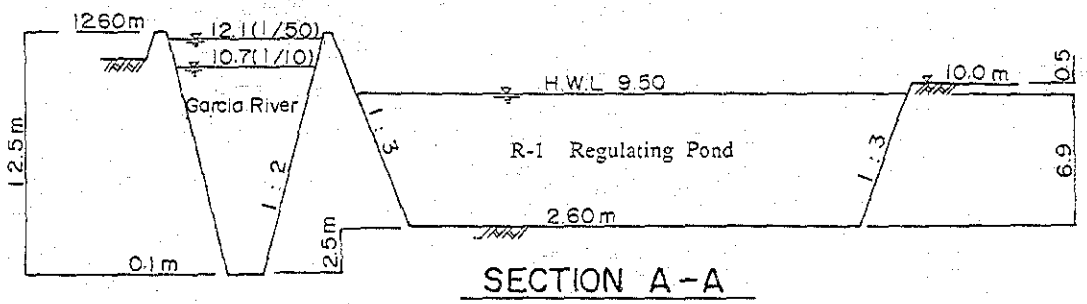


CAPACITY OF REGULATING POND

E.L (m)	Area (m^2)	Volume (m^3)
2.6	20 700	0
9.5		204240
10.0	38 500	219 040
10.0	41 200	

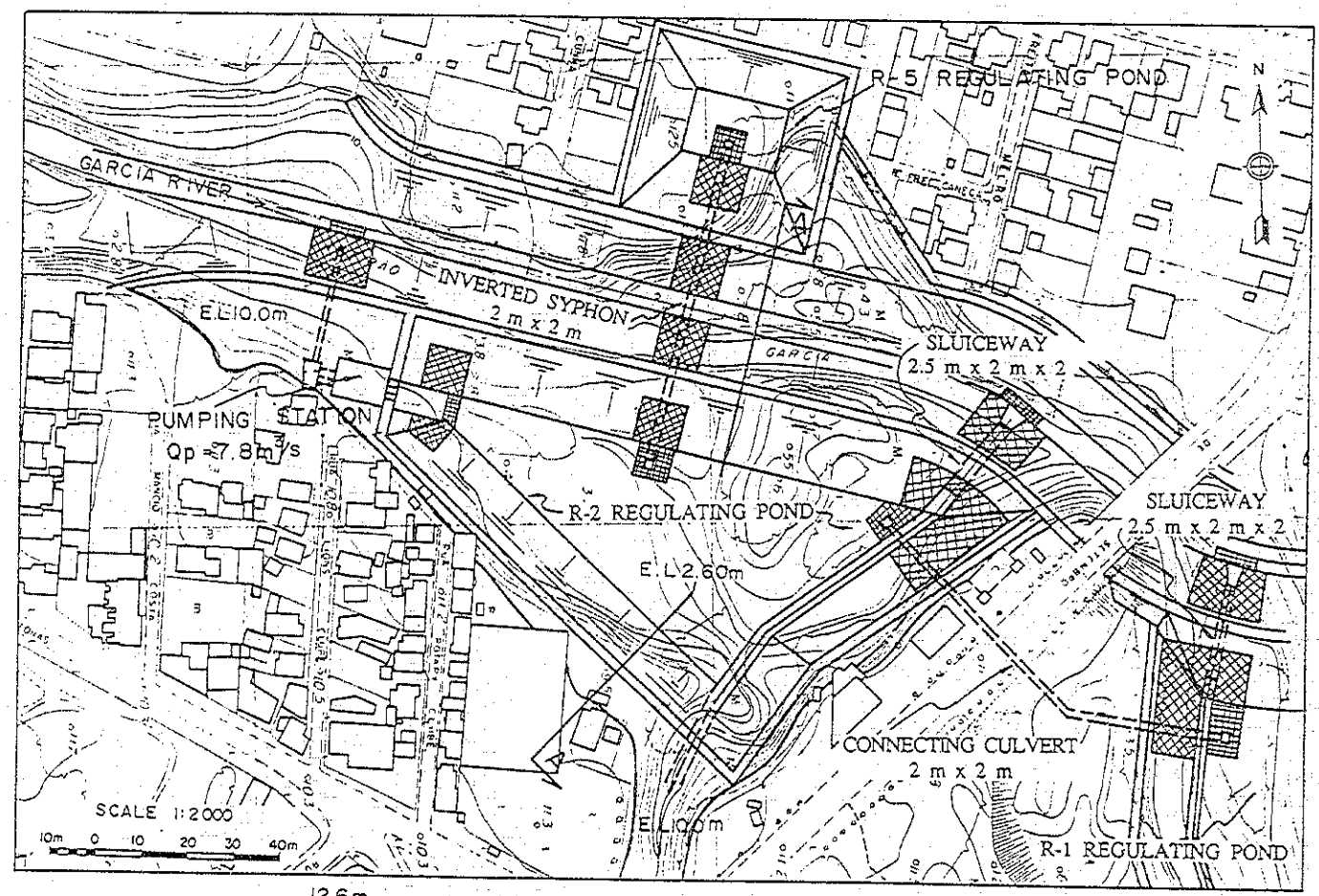
H-V Curve





SECTION A-A

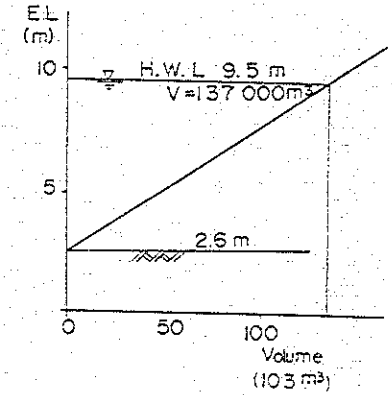
Fig.VII.5.5 GENERAL PLAN AND MAIN FEATURE OF R-1 REGULATING POND

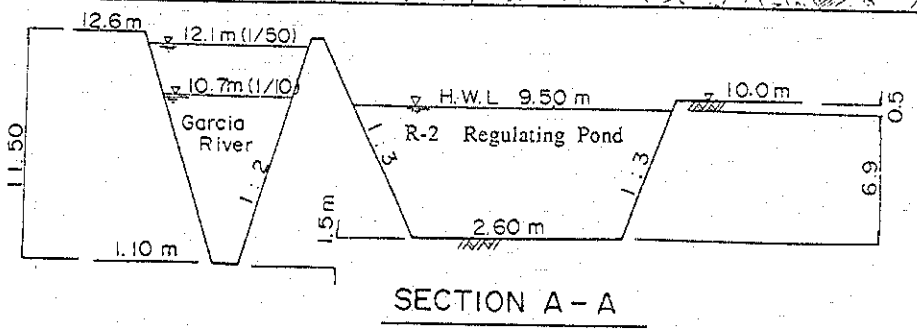


CAPACITY OF REGULATING POND

E.L (m)	Area (m²)	Volume (m³)
2.6	11 800	0
9.5		137310
10.0	28 000	141 290
10.0	29 800	

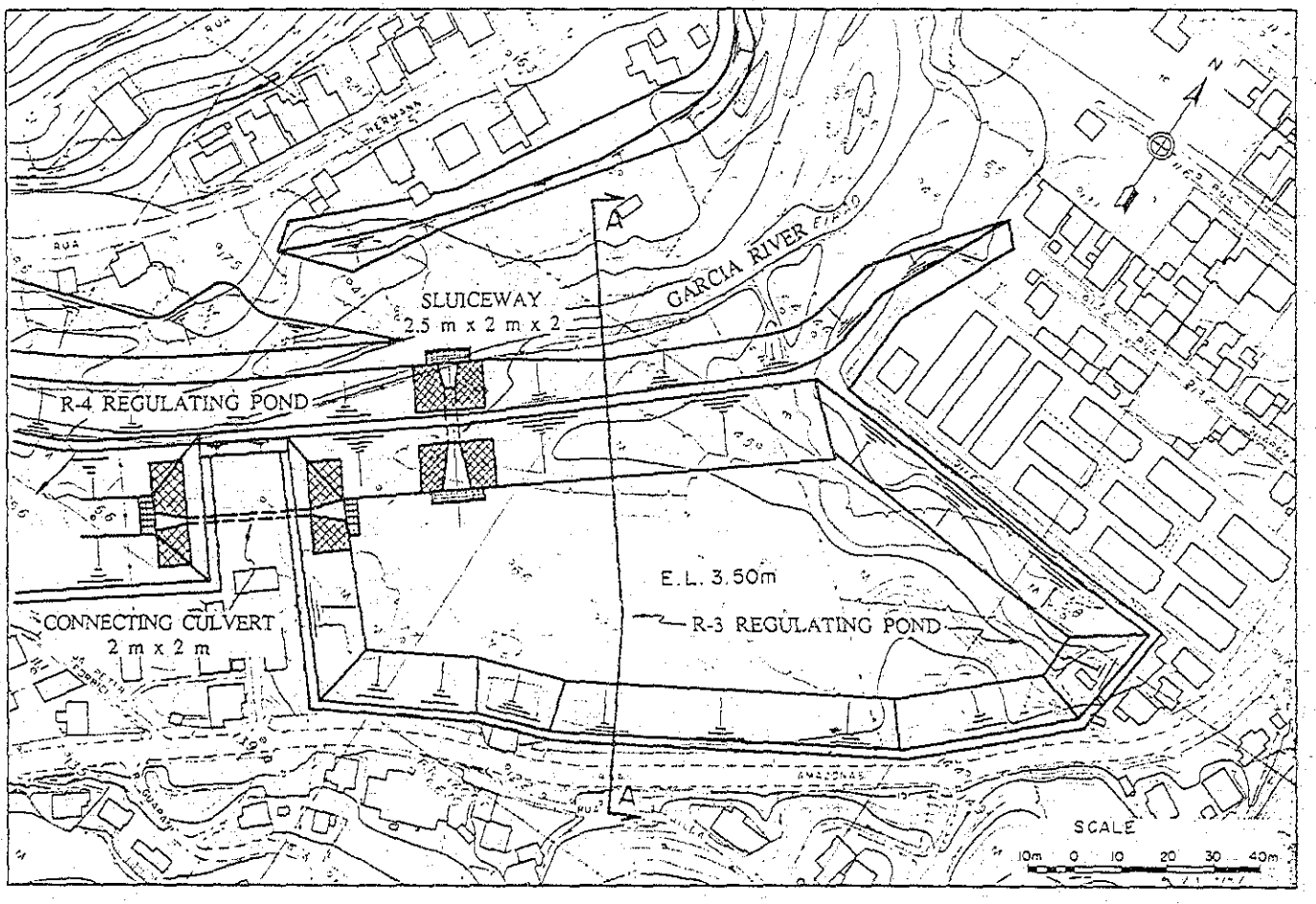
H-V Curve





SECTION A-A

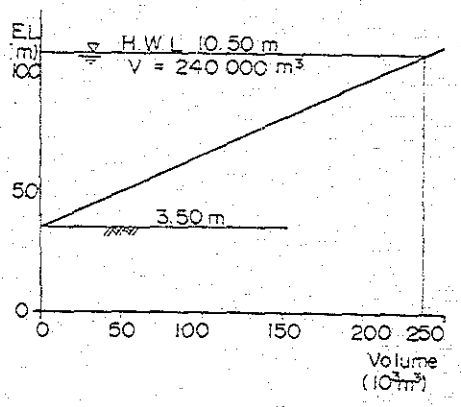
Fig.VII.5.6 GENERAL PLAN AND MAIN FEATURE OF R-2 REGULATING POND

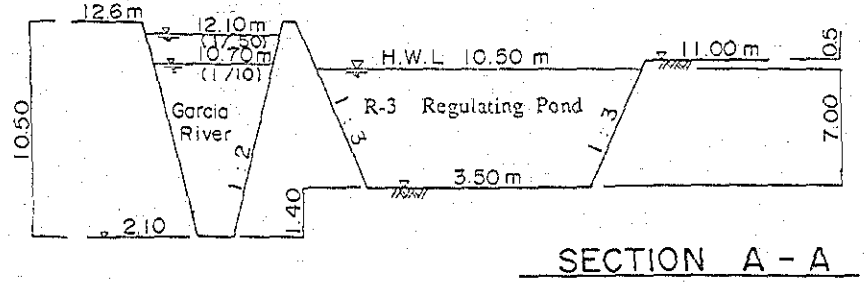


CAPACITY OF REGULATING POND

E.L (m)	Area (m^2)	Volume (m^3)
3.50	23900	0
10.50		240100
11.0	44700	257250
11.0	48200	

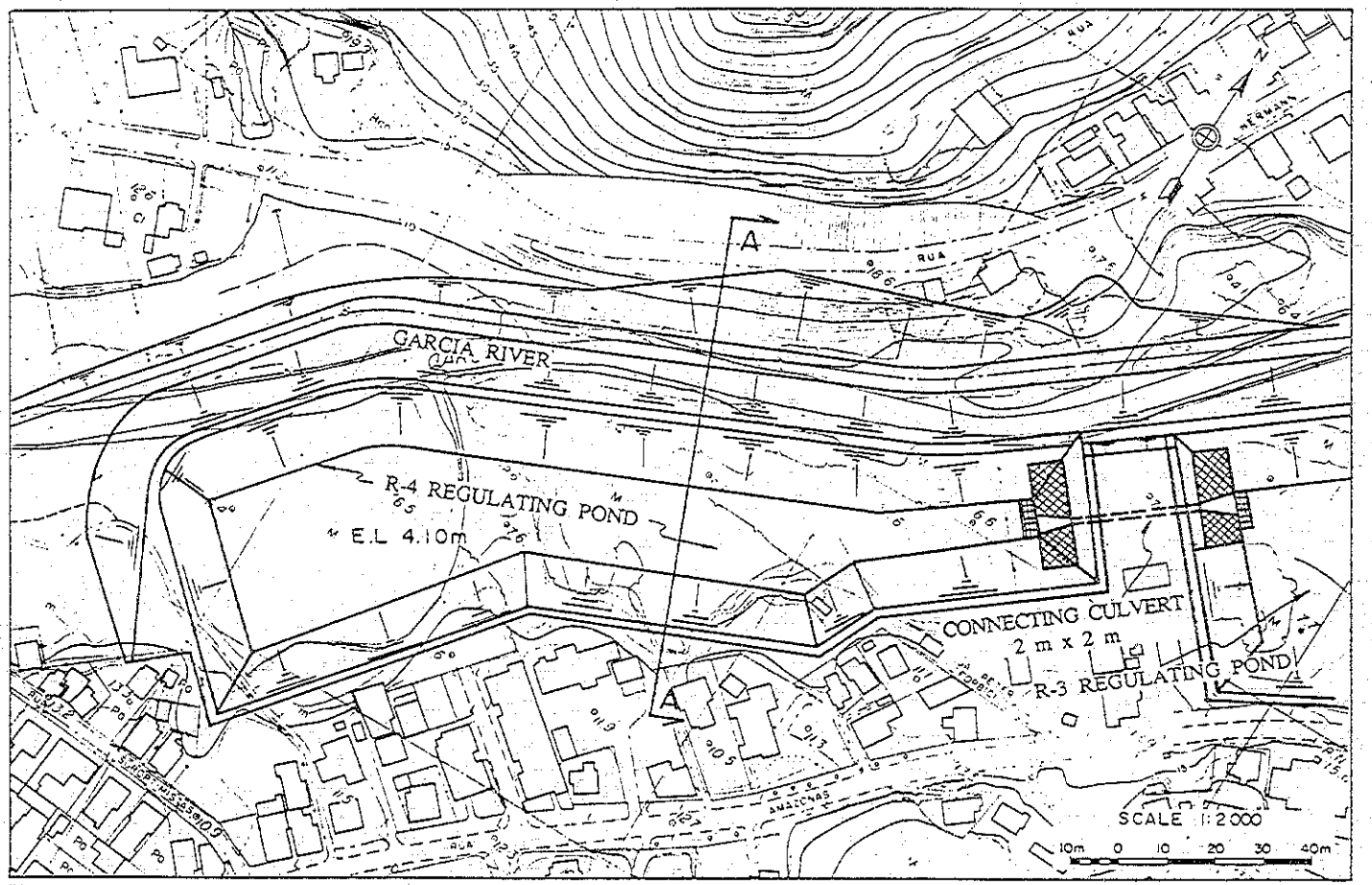
H-V Curve





SECTION A - A

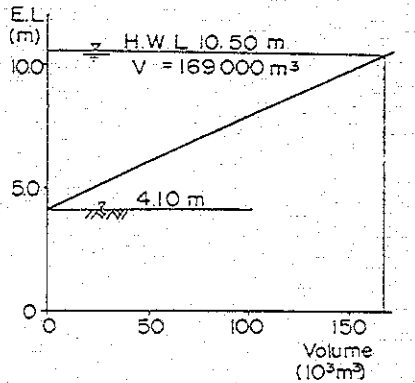
Fig.VII.5.7 GENERAL PLAN AND MAIN FEATURE OF R-3 REGULATING POND

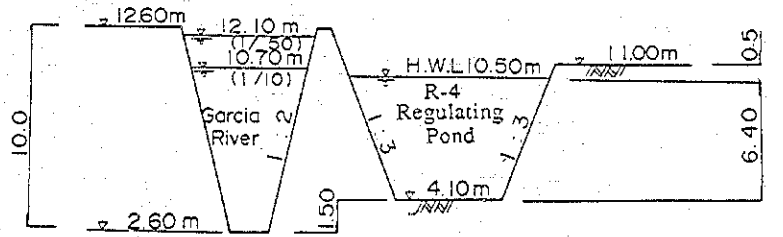


CAPACITY OF REGULATING POND

E.L (m)	Area (m²)	Volume (m³)
4.10	16000	0
10.50		169 280
11.00	36900	182 505
11.00	39100	

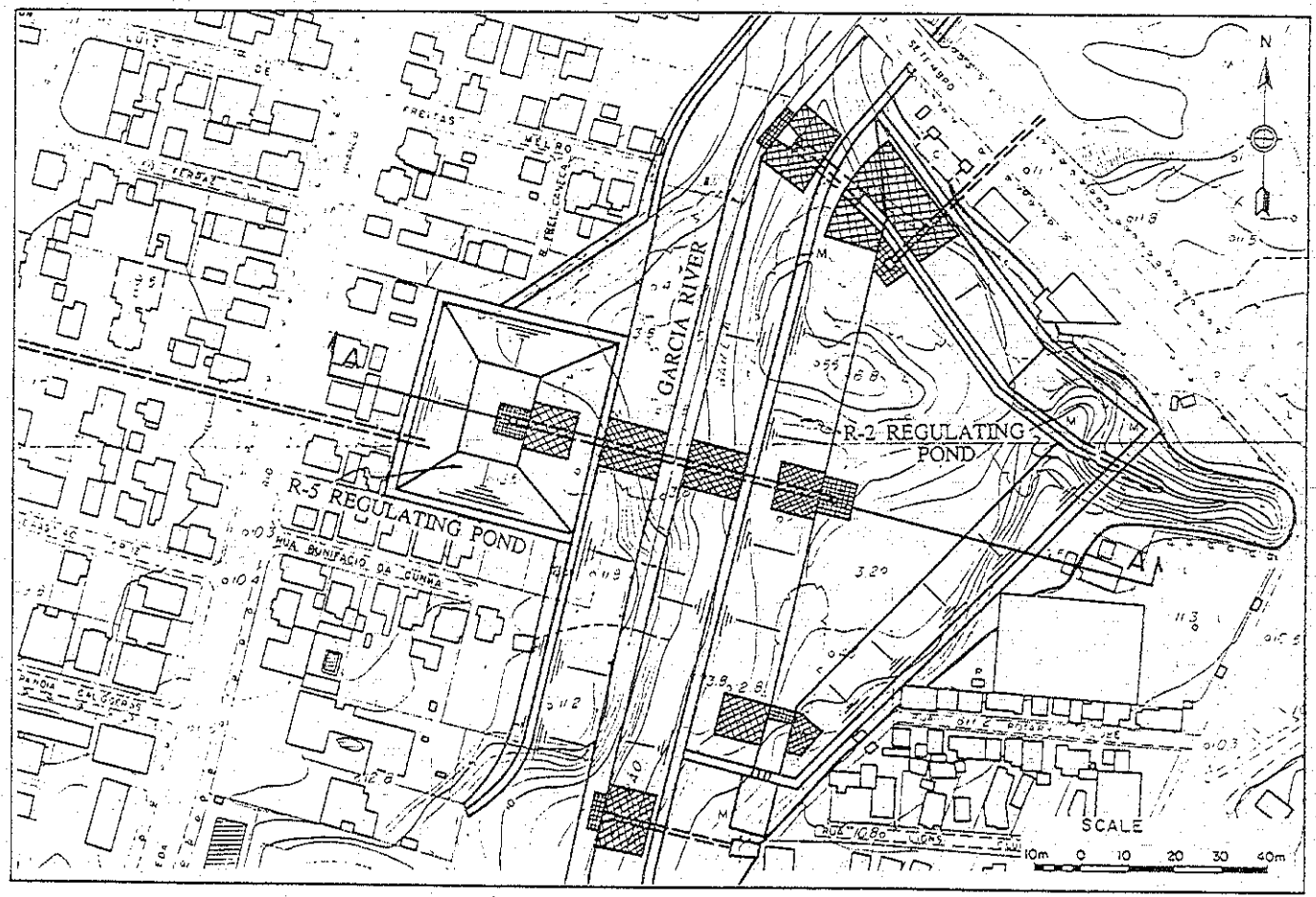
H-V Curve





SECTION A-A

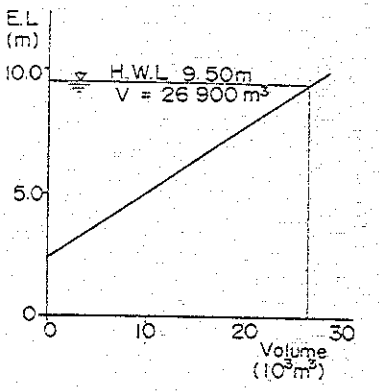
Fig.VII.5.8 GENERAL PLAN AND MAIN FEATURE OF R-4 REGULATING POND



CAPACITY OF REGULATING POND

E.L (m)	Area (m²)	Volume (m³)
2.6	1 080	0
9.5		26 910
10.0	6 720	28 860
10.0	7 720	

H-V Curve



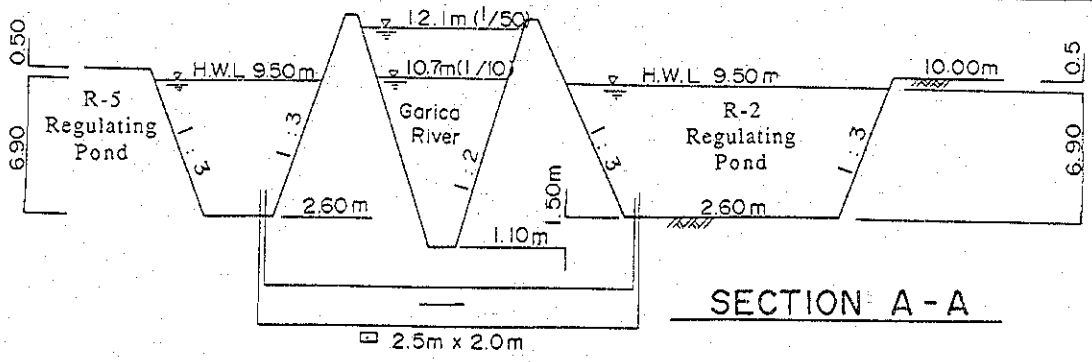
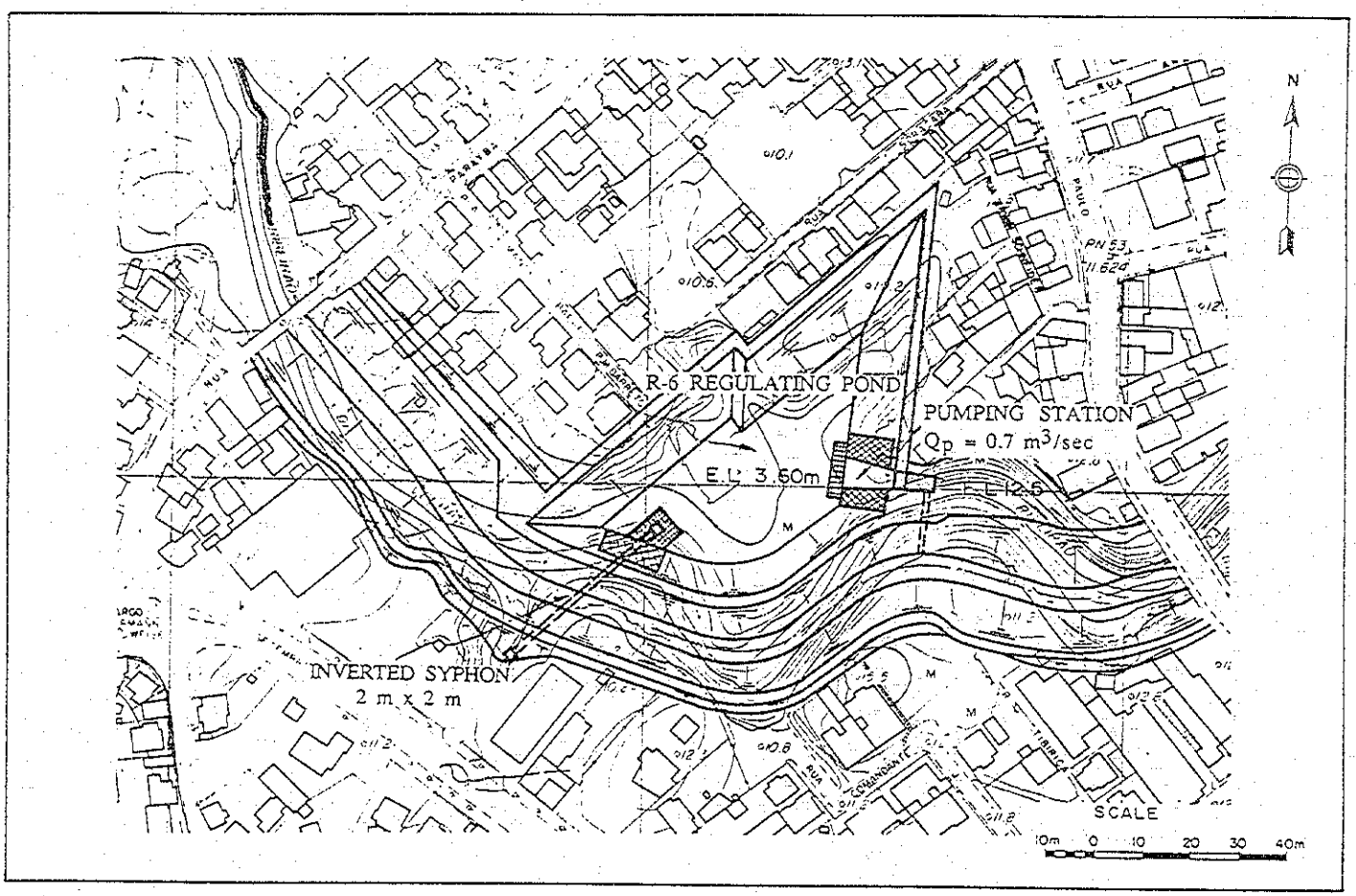


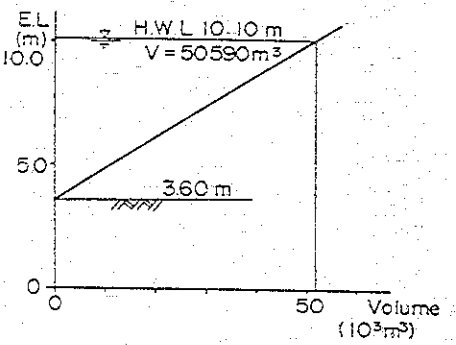
Fig.VII.5.9 GENERAL PLAN AND MAIN FEATURE OF R-5 REGULATING POND

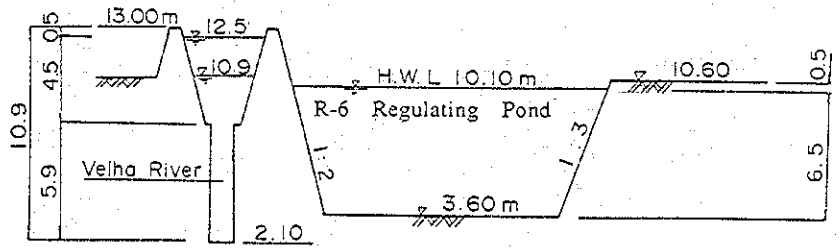


CAPACITY OF REGULATING POND

E.L (m)	Area (m^2)	Volume (m^3)
3.6	4 800	0
8.7	9 000	35 190
10.1		50 590
10.6	13 000	50 590
10.6	14 600	

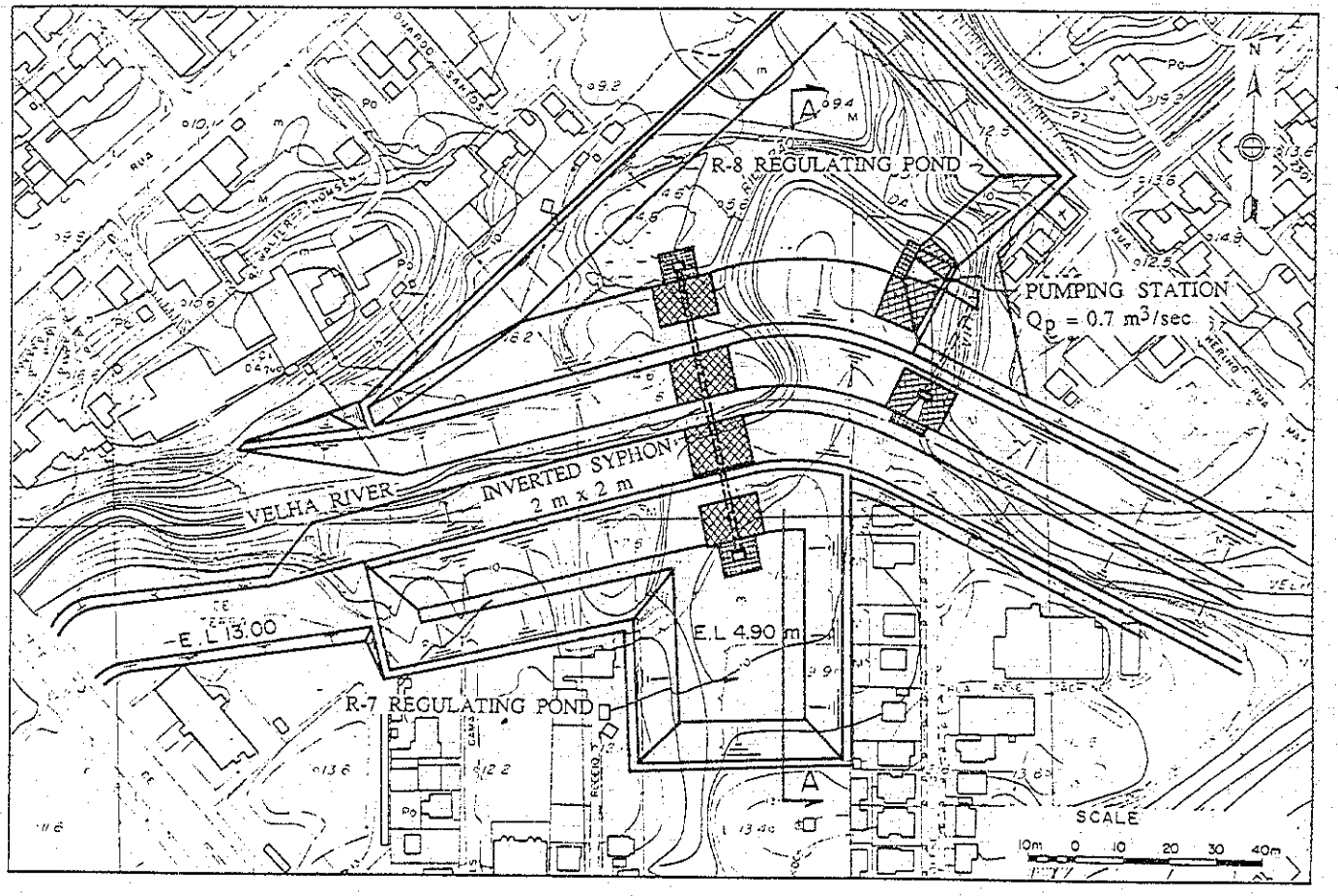
H-V Curve





SECTION A - A

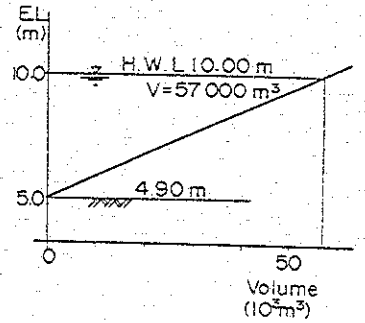
Fig.VII.5.10 GENERAL PLAN AND MAIN FEATURE OF R-6 REGULATING POND

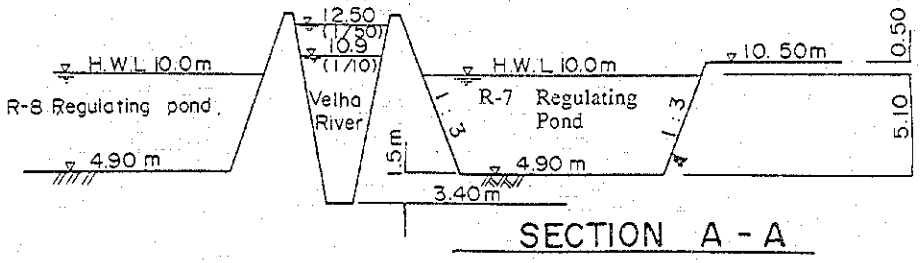


CAPACITY OF REGULATING POND

E.L (m)	Area (m^2)	Volume (m^3)
4.9	5 240	0
10.0		57 222
10.5	17 200	62 832
10.5	18 950	

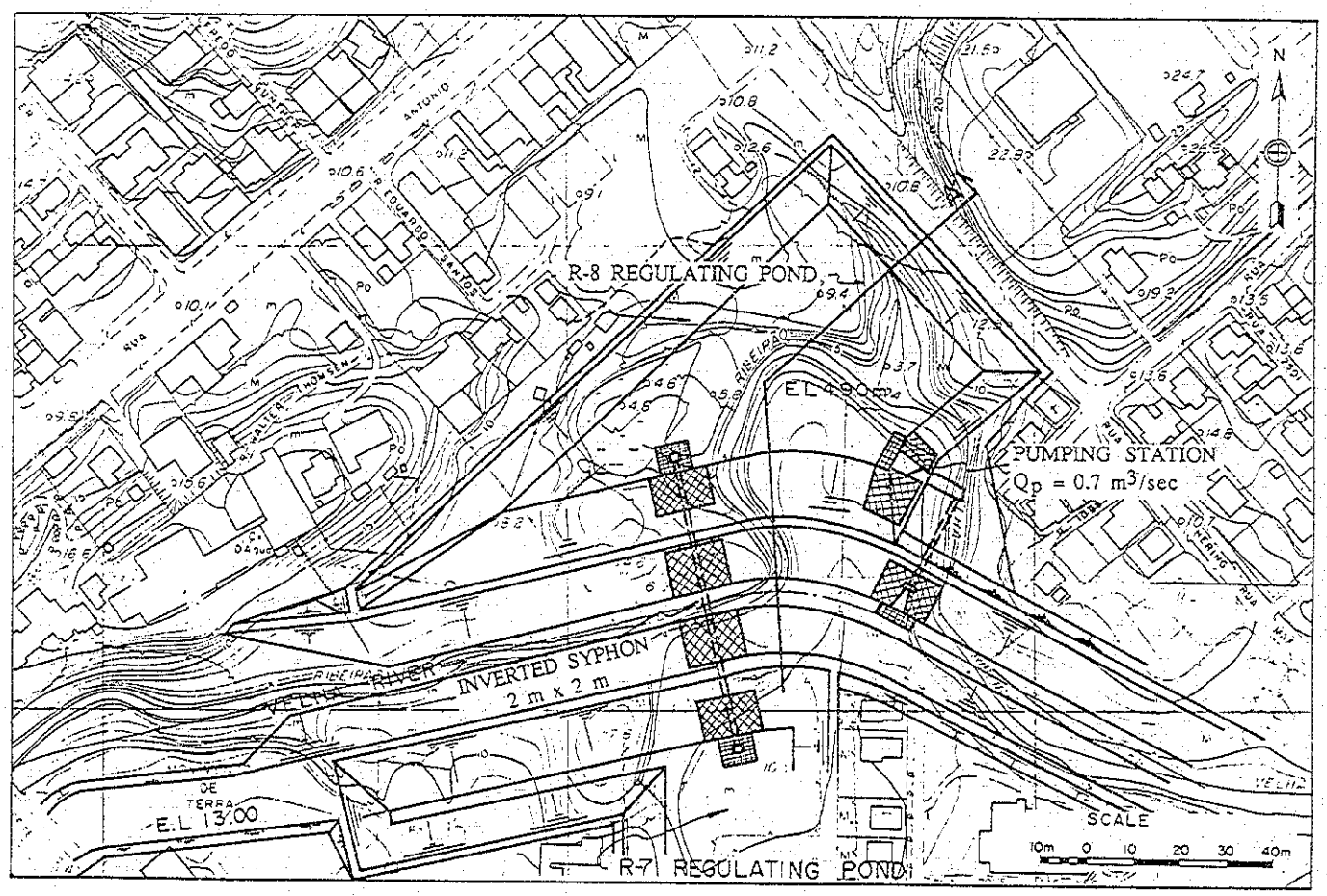
H-V Curve





SECTION A - A

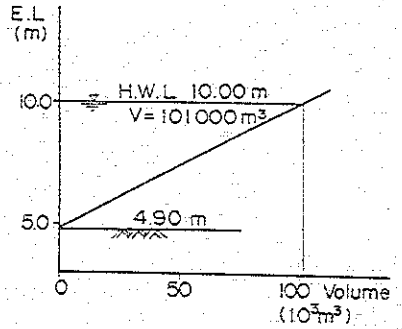
Fig.VII.5.11 GENERAL PLAN AND MAIN FEATURE OF R-7 REGULATING POND

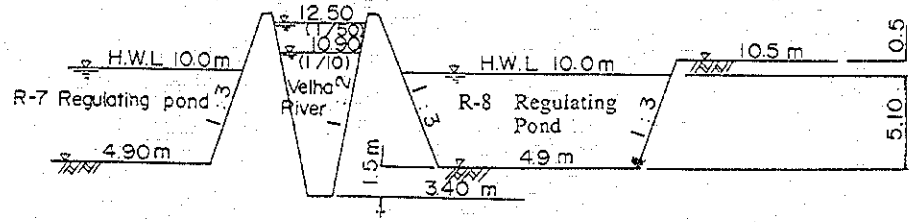


CAPACITY OF REGULATING POND

E.L (m)	Area (m²)	Volume (m³)
4.9	12800	0
10.0		101745
10.5	27100	111720
10.5	30000	

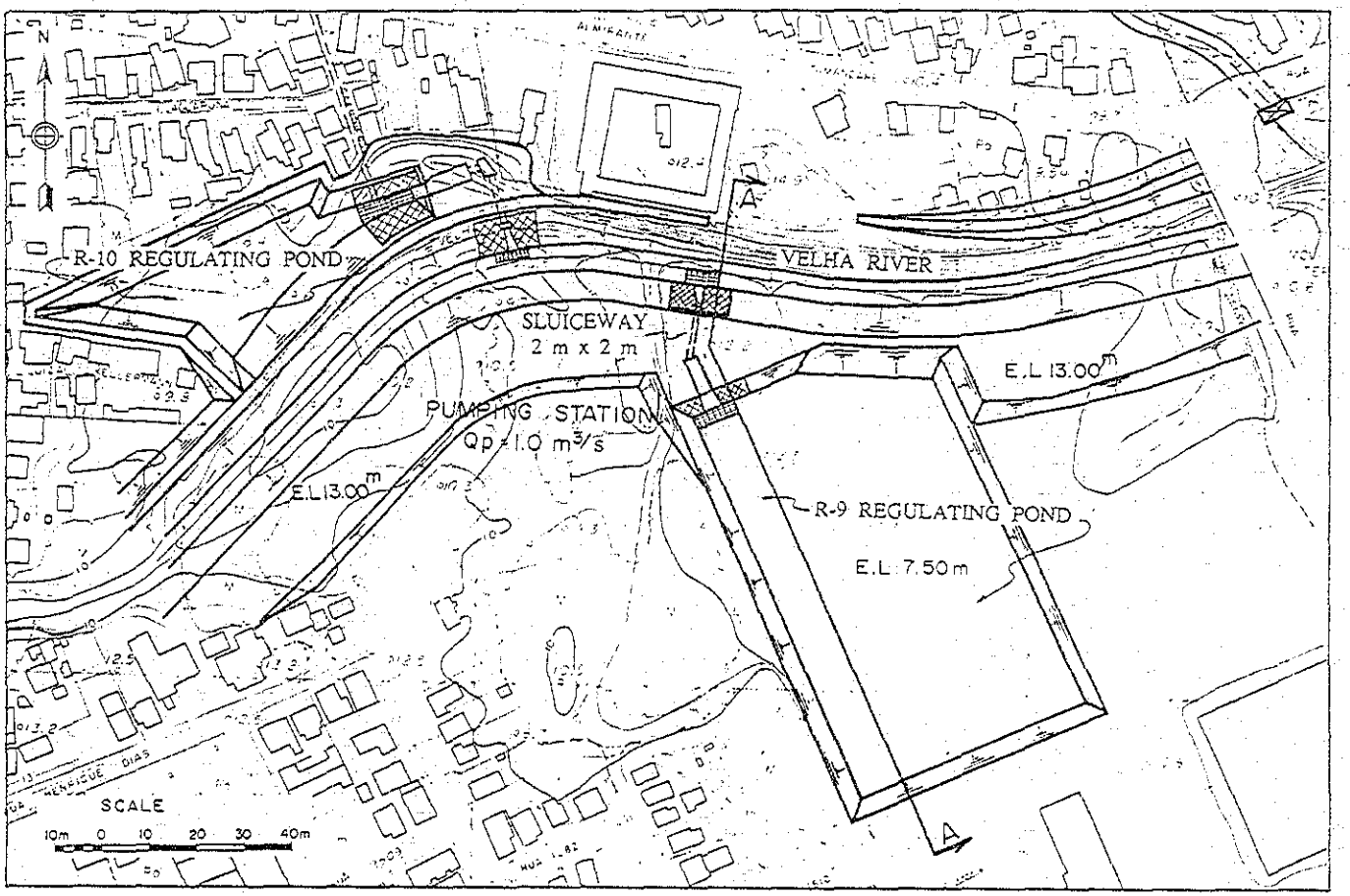
H-V Curve





SECTION A - A

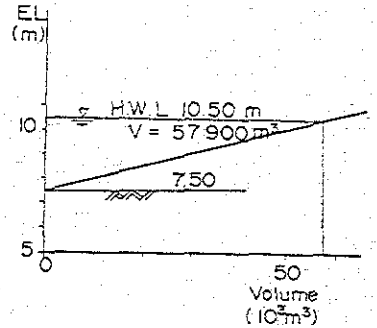
Fig.VII.5.12 GENERAL PLAN AND MAIN FEATURE OF R-8 REGULATING POND



CAPACITY OF REGULATING POND

E.L (m)	Area (m²)	Volume (m³)
7.5	17 000	0
10.5		57 900
11.0	21 600	67 550
11.0	23 200	

H-V Curve



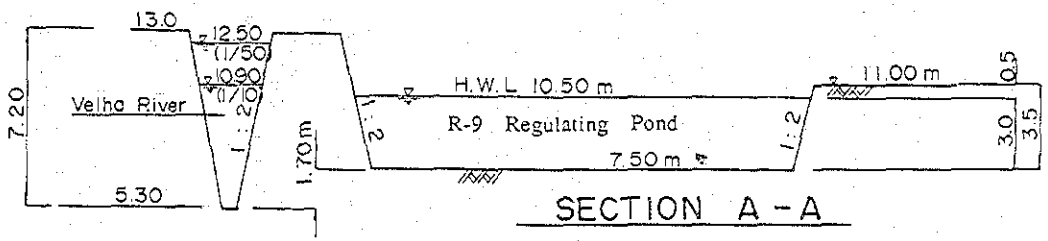


Fig.VII.5.13 GENERAL PLAN AND MAIN FEATURE OF R-9 REGULATING POND

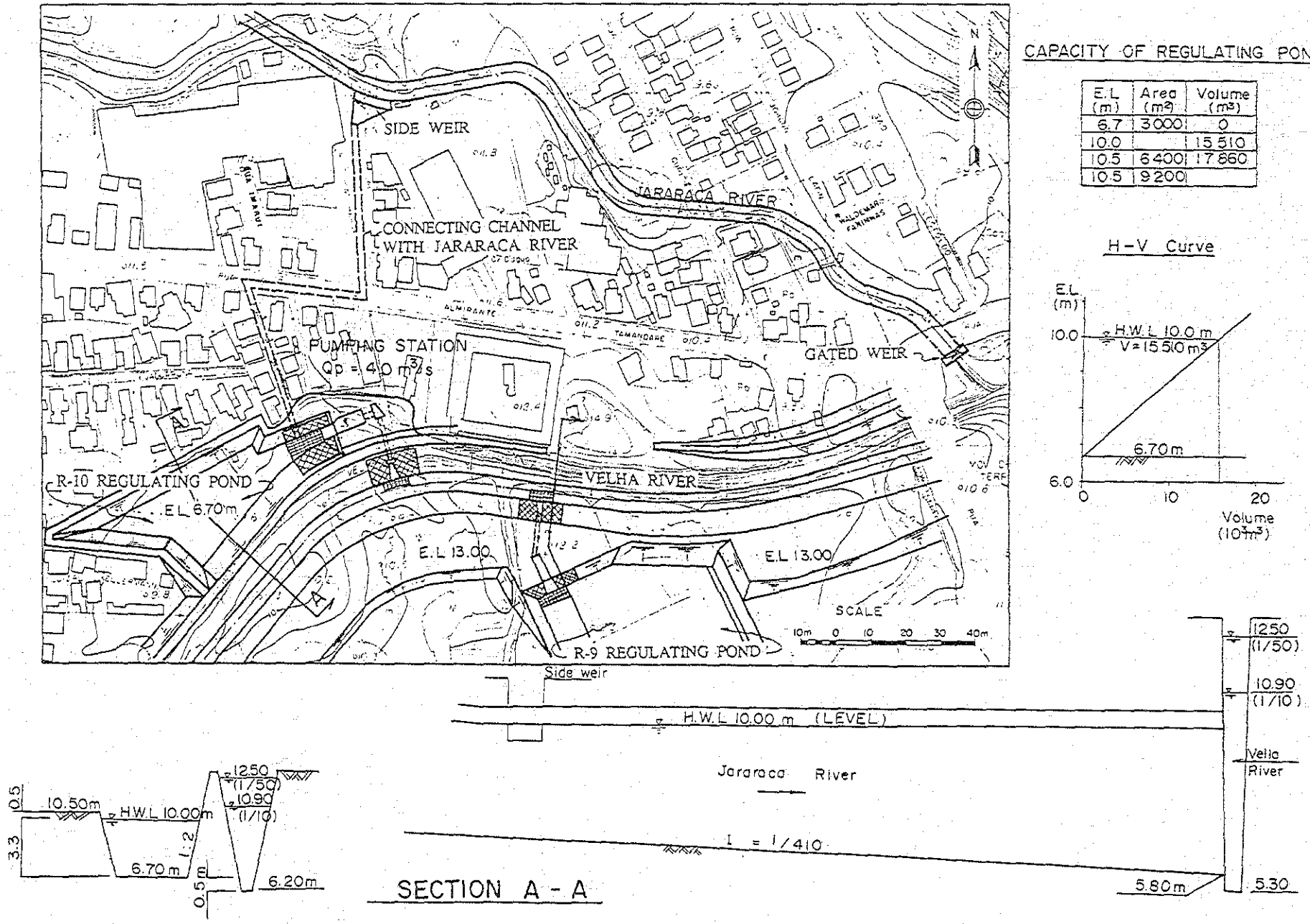
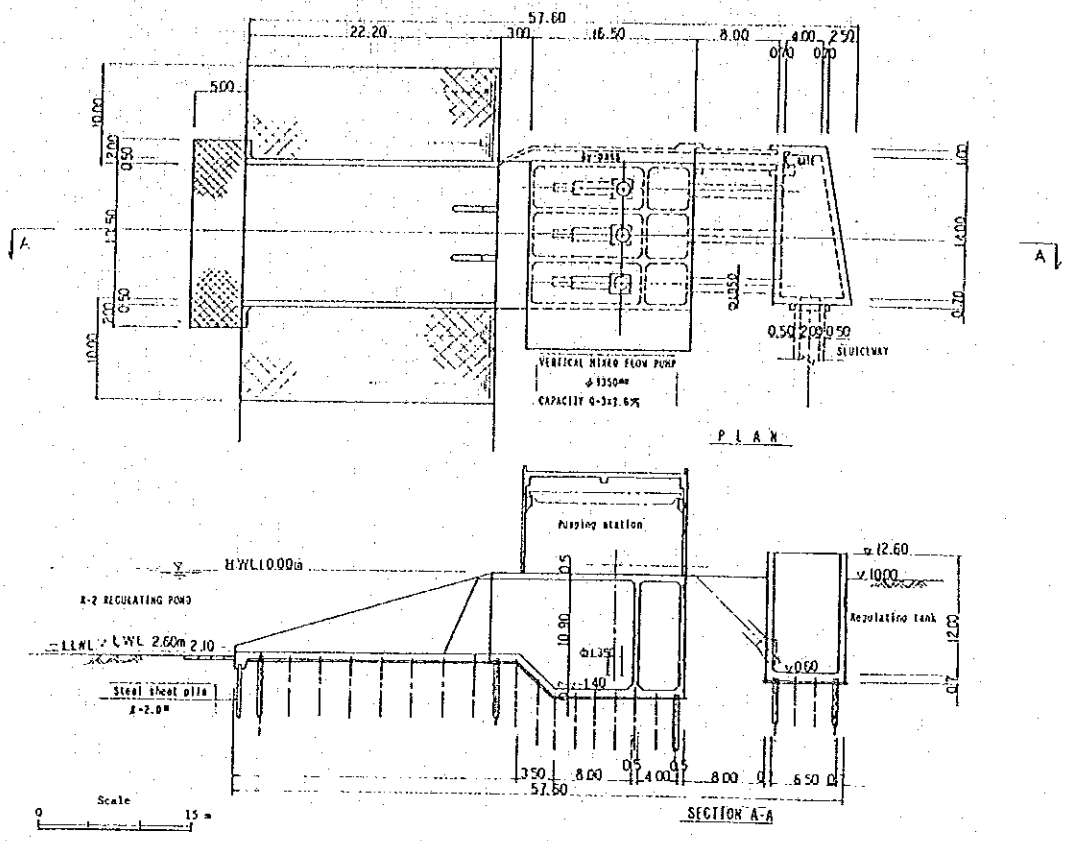
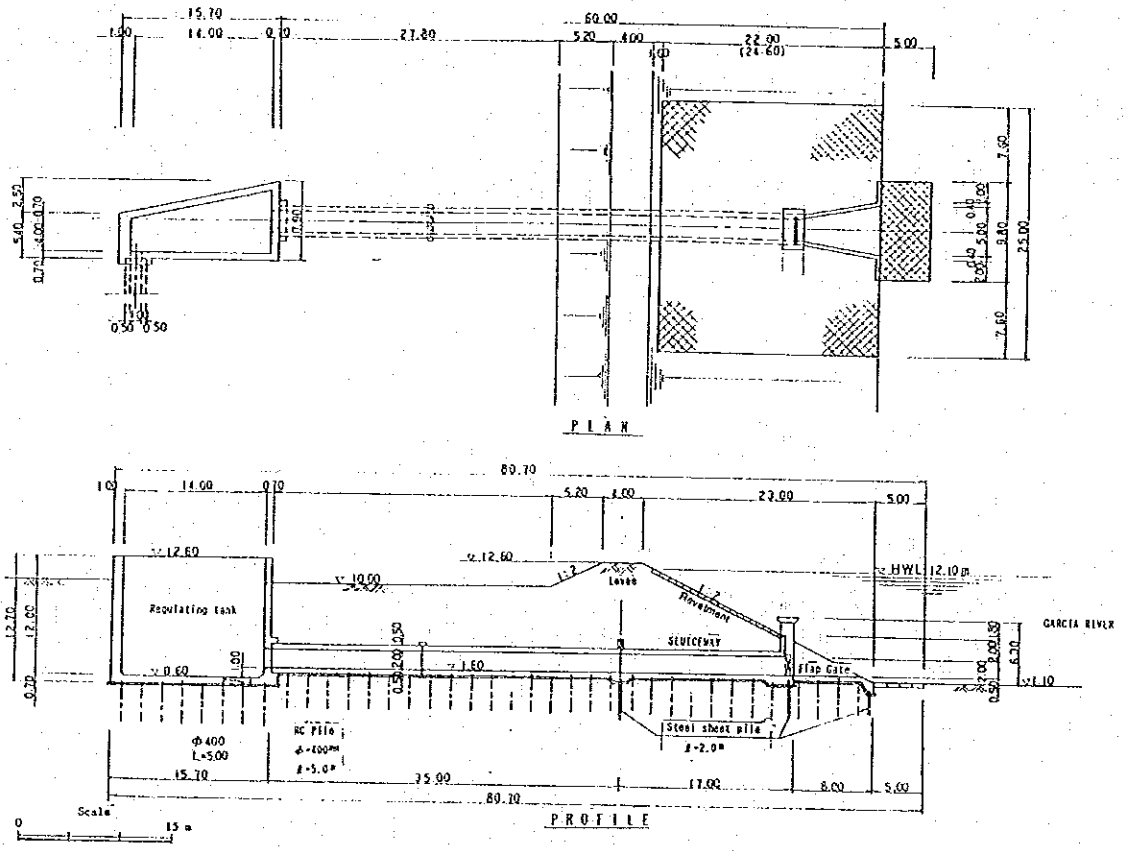


Fig.VII.5.14 GENERAL PLAN AND MAIN FEATURE OF R-10 REGULATING POND

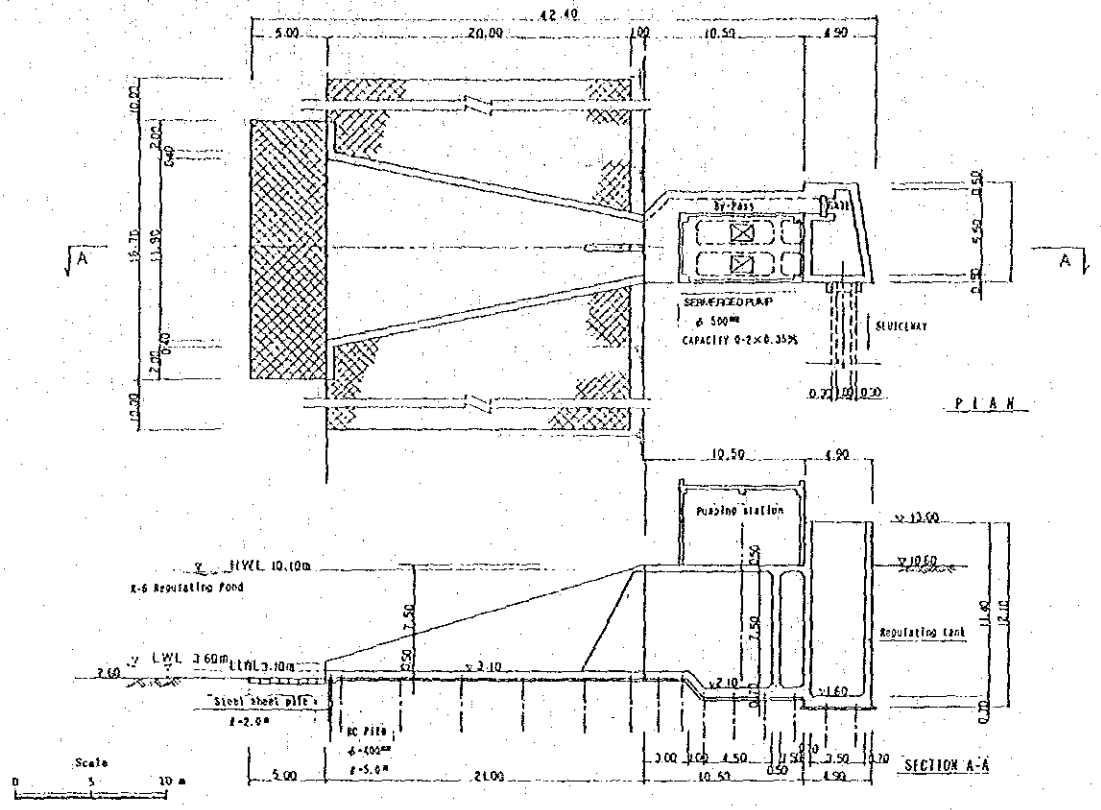


Pumping Station

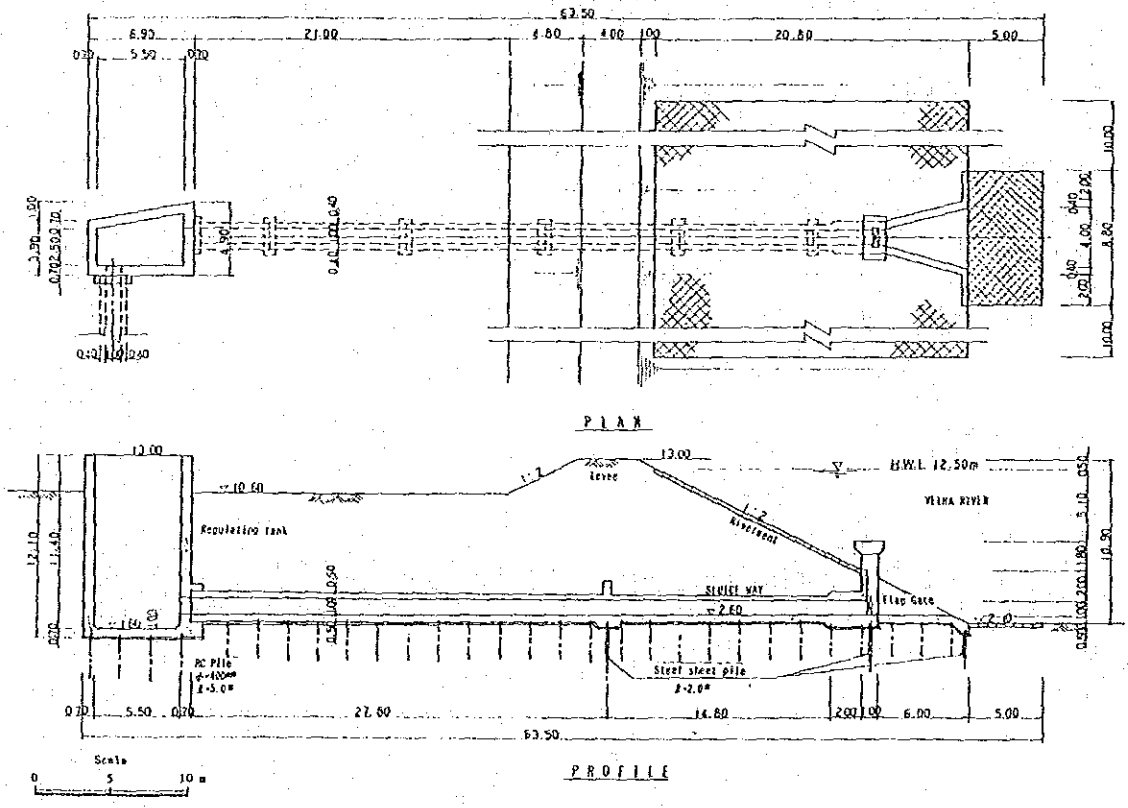


Sluiceway

Fig.VII.5.15 PROPOSED PUMPING STATION AND SLUICEWAY AT R-2 REGULATING POND

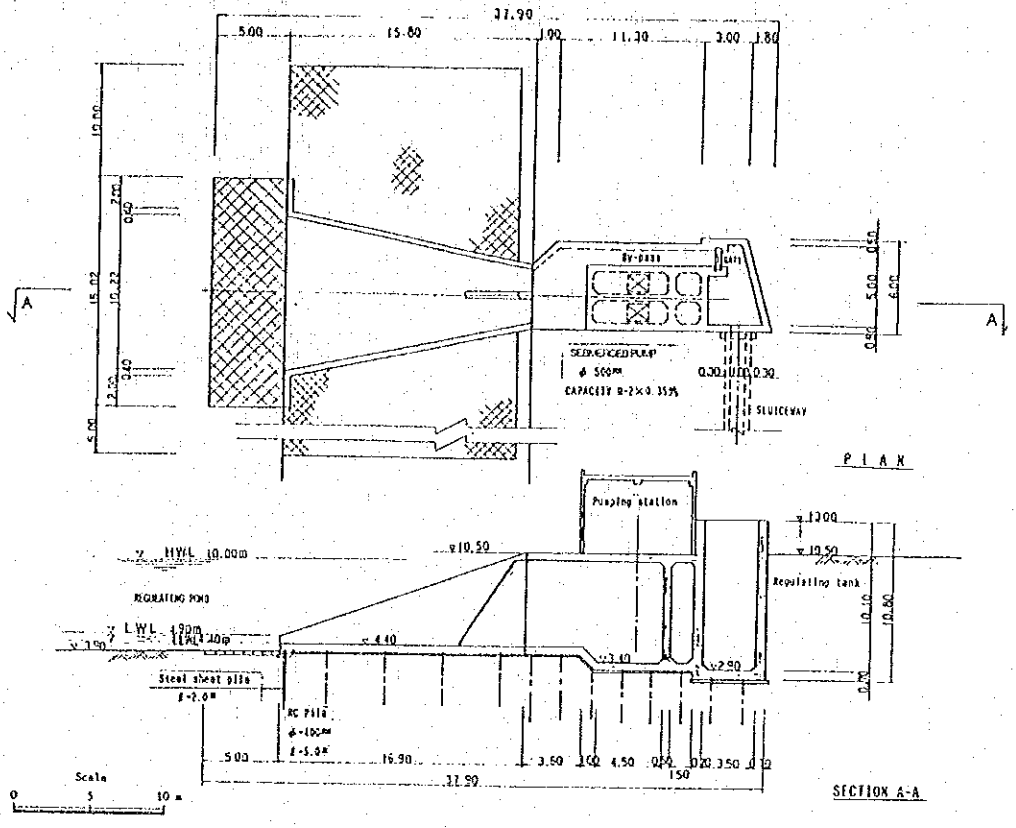


Pumping Station

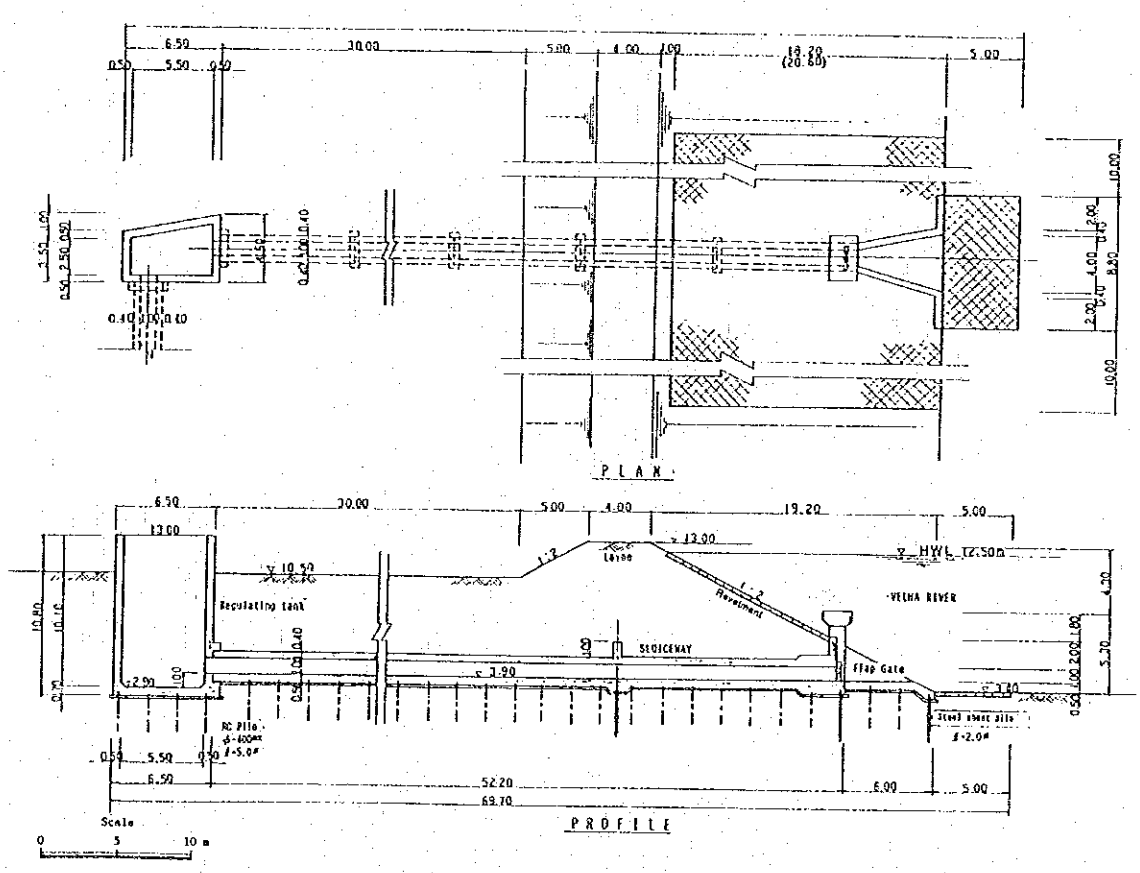


Sluiceway

Fig.VII.5.16 PROPOSED PUMPING STATION AND SLUICEWAY AT R-6 REGULATING POND

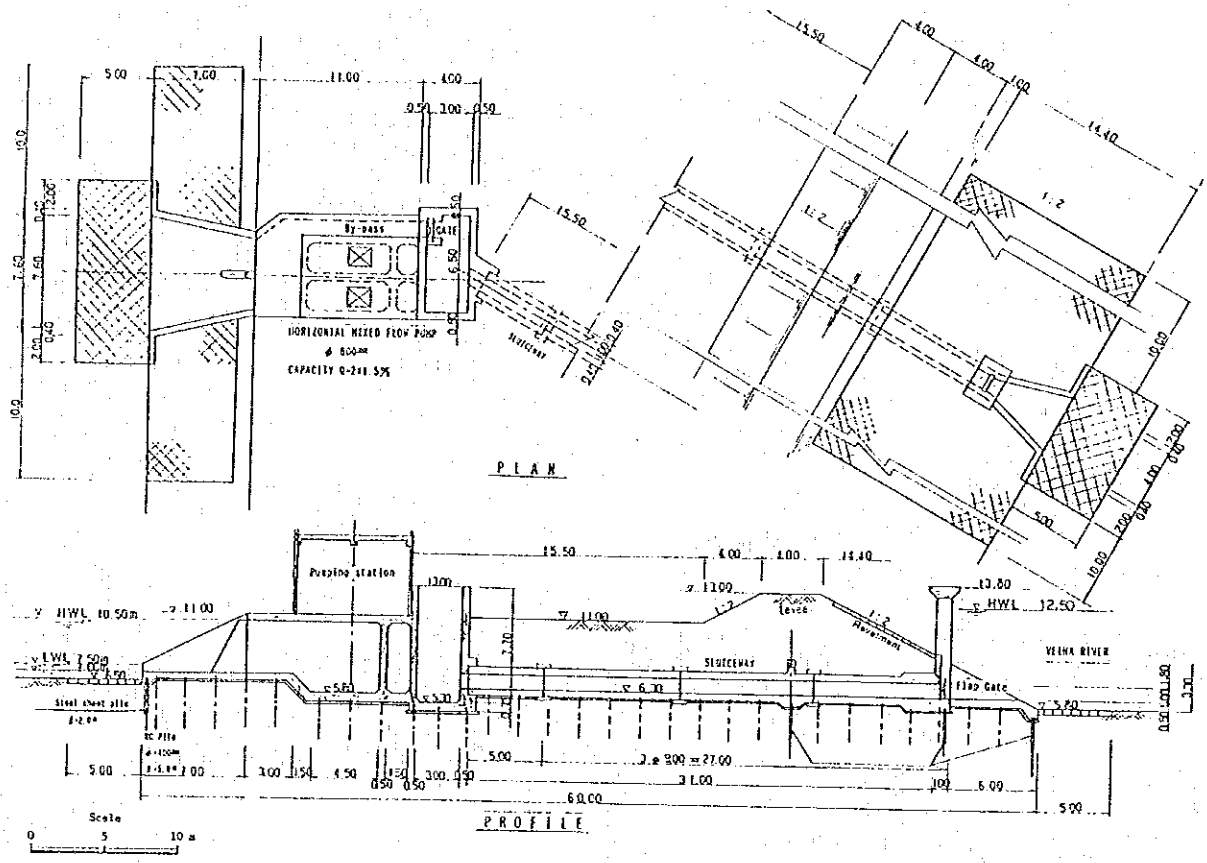


Pumping Station



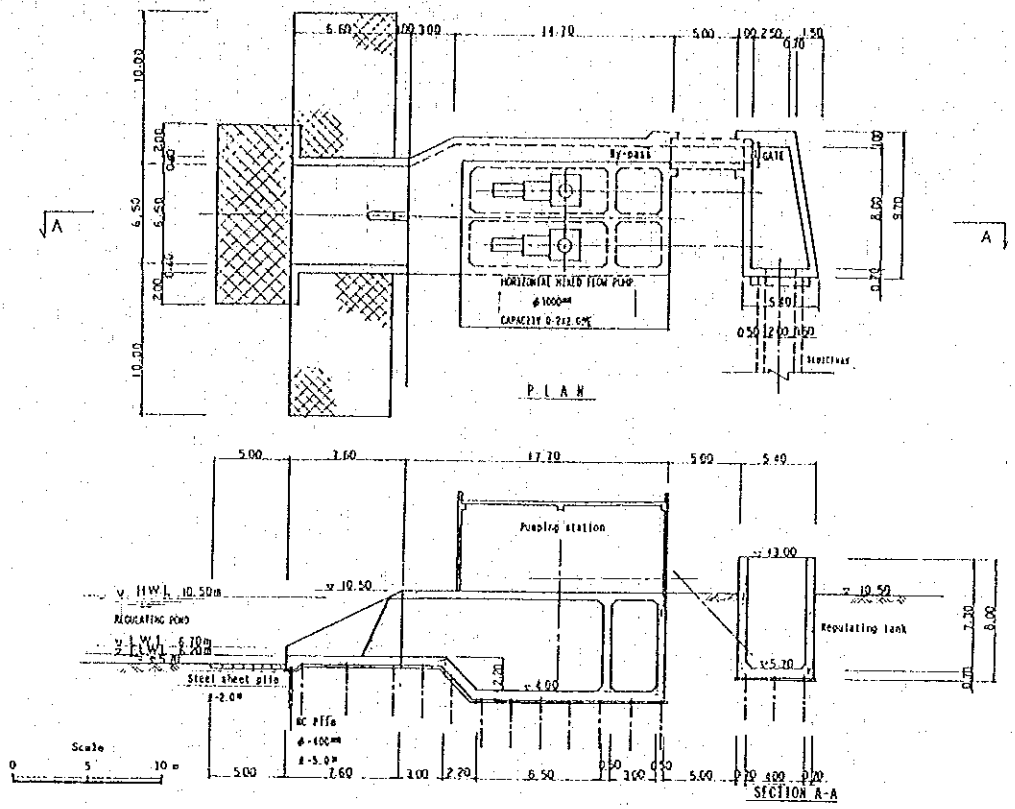
Sluiceway

Fig.VII.5.17 PROPOSED PUMPING STATION AND SLUICEWAY AT R-8 REGULATING POND

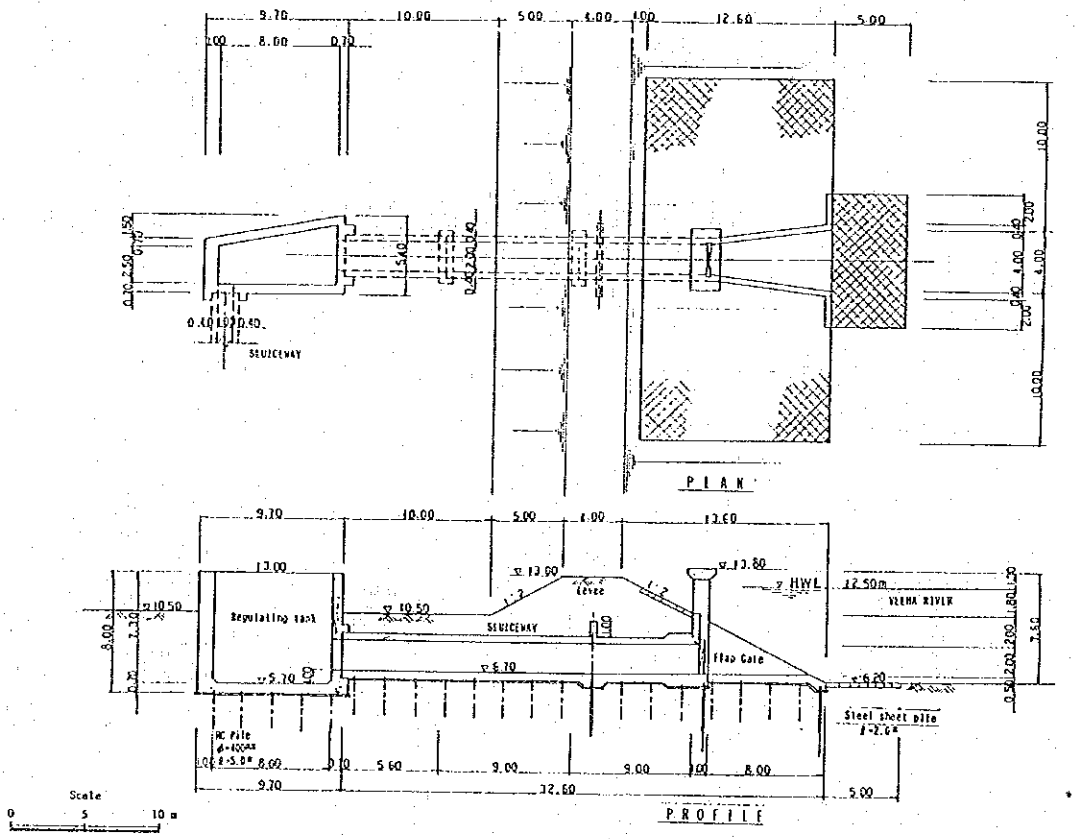


Pumping Station and Sluiceway

Fig.VII.5.18 PROPOSED PUMPING STATION AND SLUICEWAY AT R-9 REGULATING POND



Pumping Station



Sluiceway

Fig.VII.5.19 PROPOSED PUMPING STATION AND SLUICEWAY AT R-10 REGULATING POND

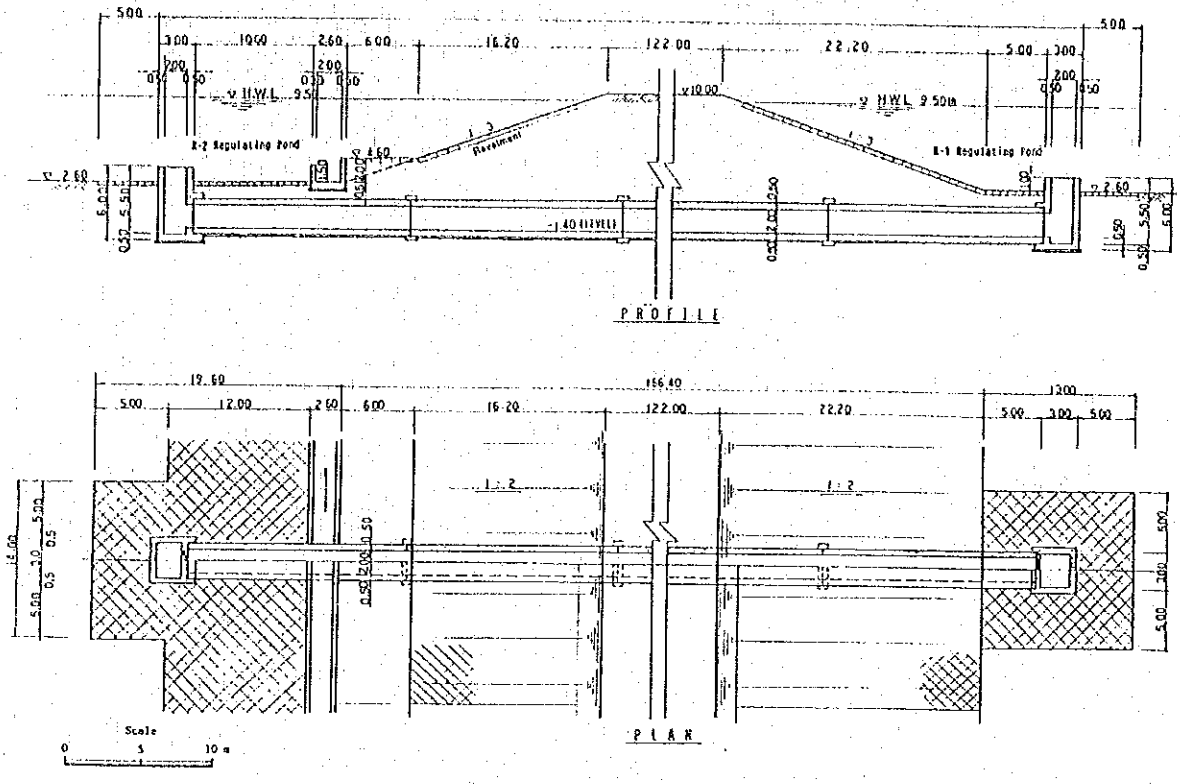


Fig.VII.5.20 PROPOSED CONNECTING CULVERT BETWEEN R-1 AND R-2 REGULATING PONDS

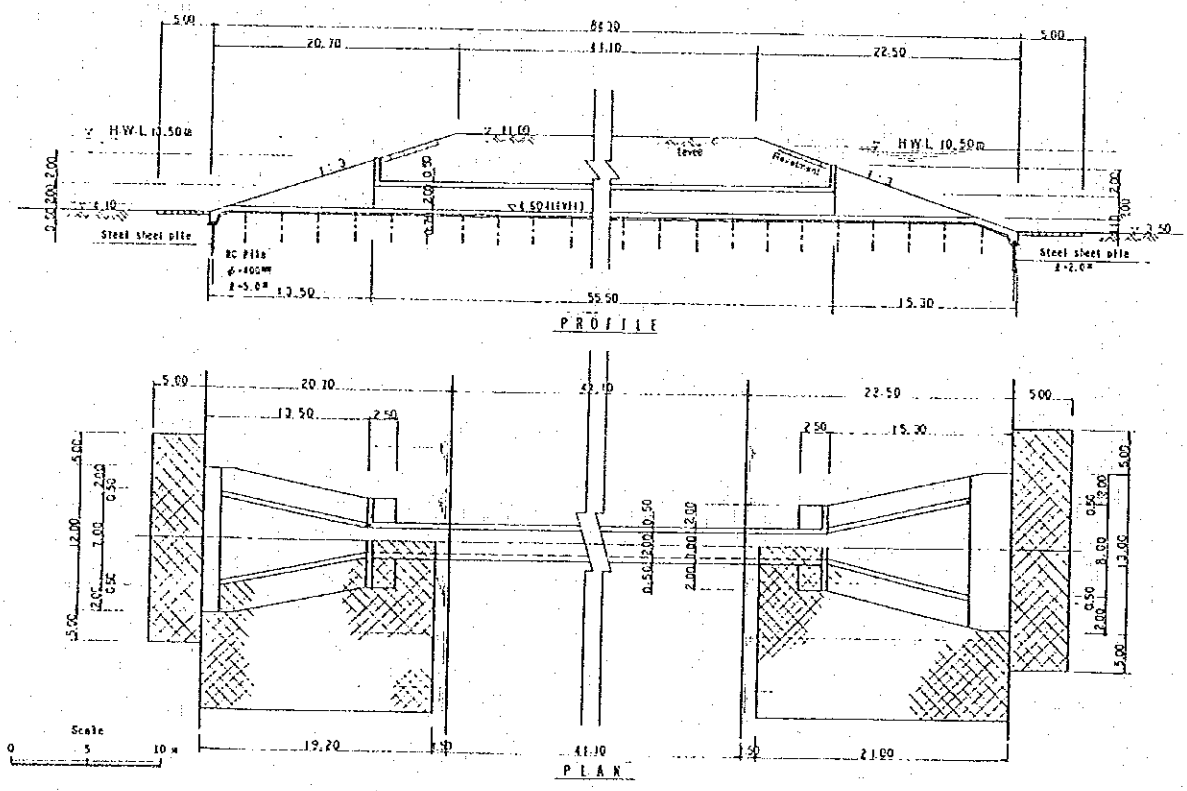


Fig.VII.5.21 PROPOSED CONNECTING CULVERT BETWEEN R-3 AND R-4 REGULATING PONDS

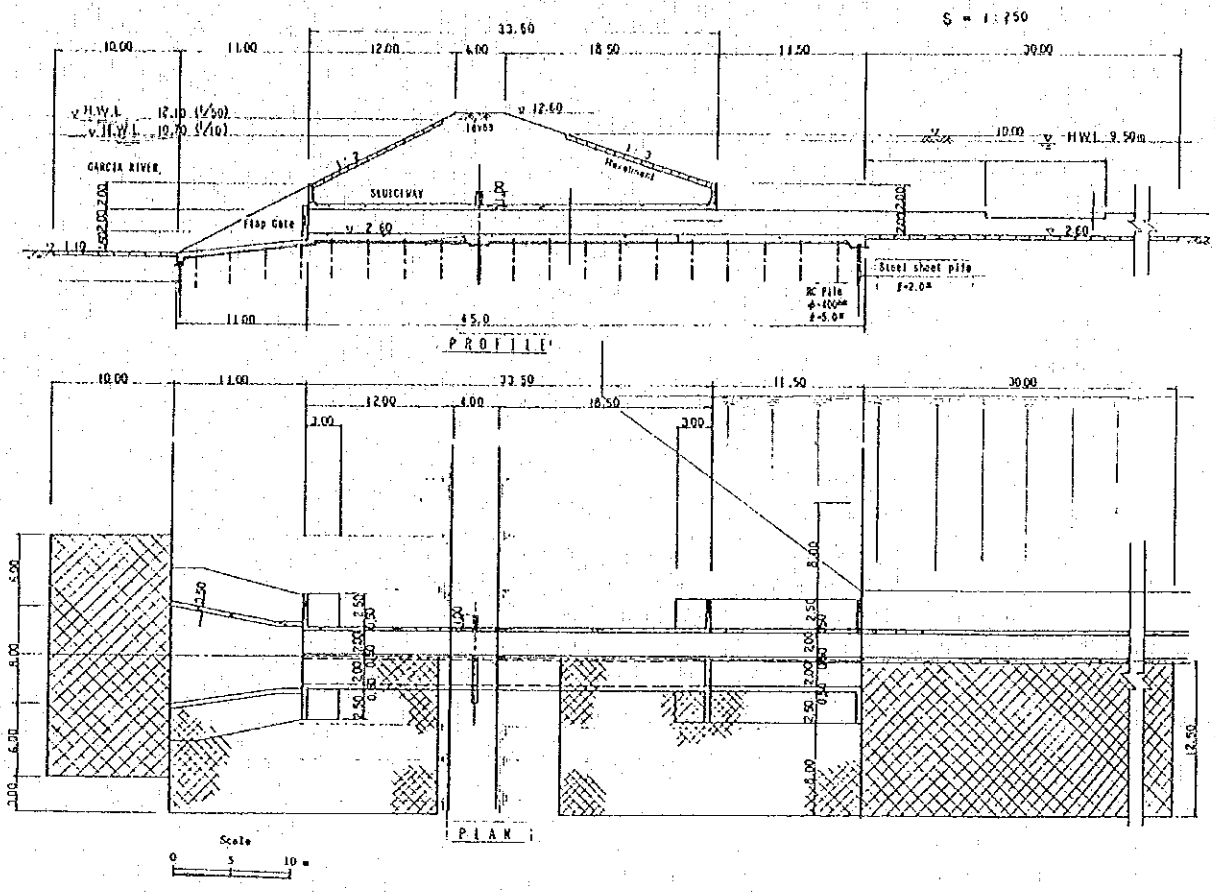


Fig. VII.5.22 PROPOSED SLUICEWAY FOR R-1, R-2 AND R-3 REGULATING PONDS

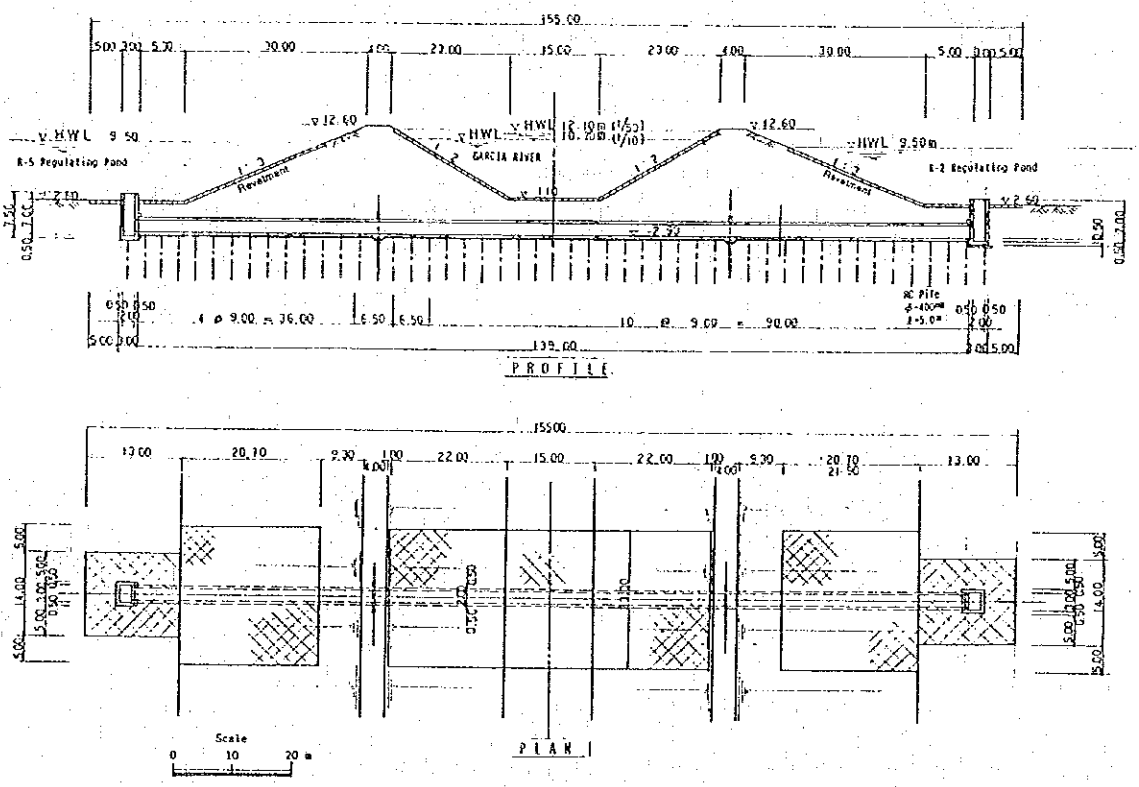


Fig. VII.5.23 PROPOSED INVERTED SYPHON BETWEEN R-2 AND R-5 REGULATING PONDS

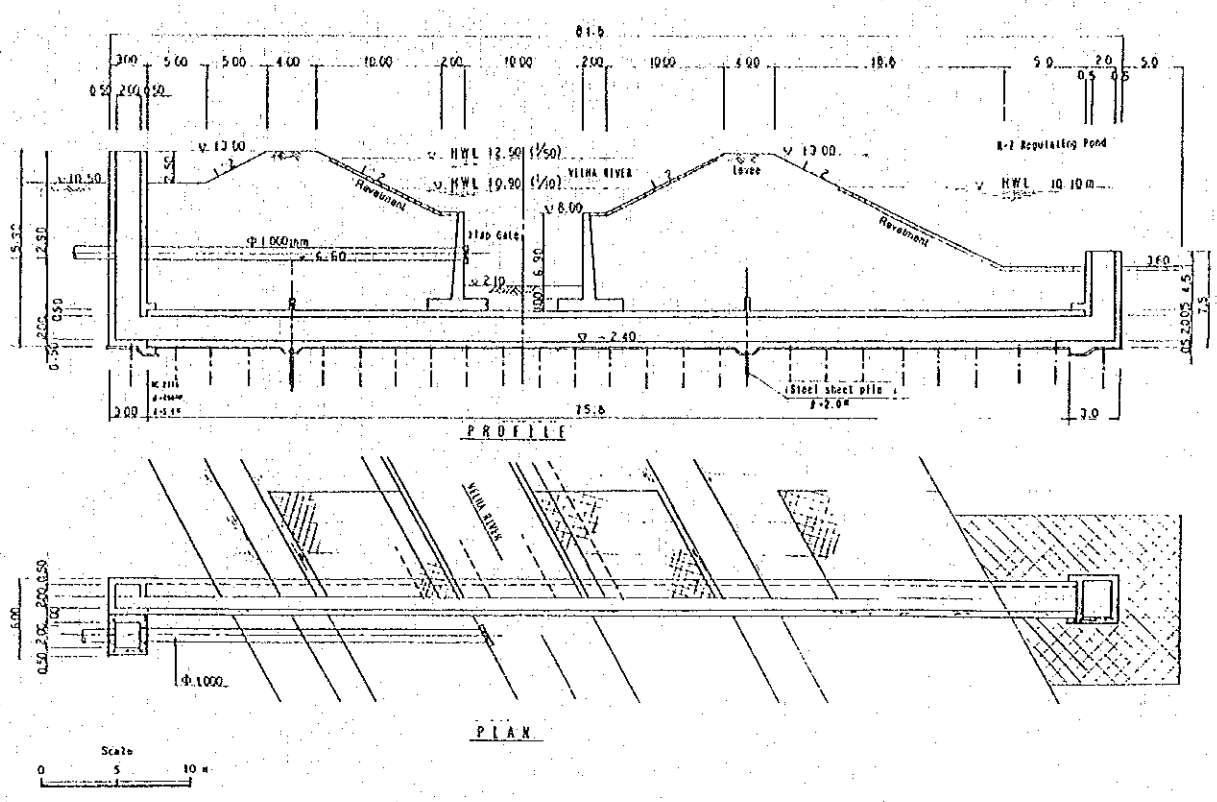


Fig.VII.524 PROPOSED INVERTED SYPHON FOR R-7 REGULATING POND

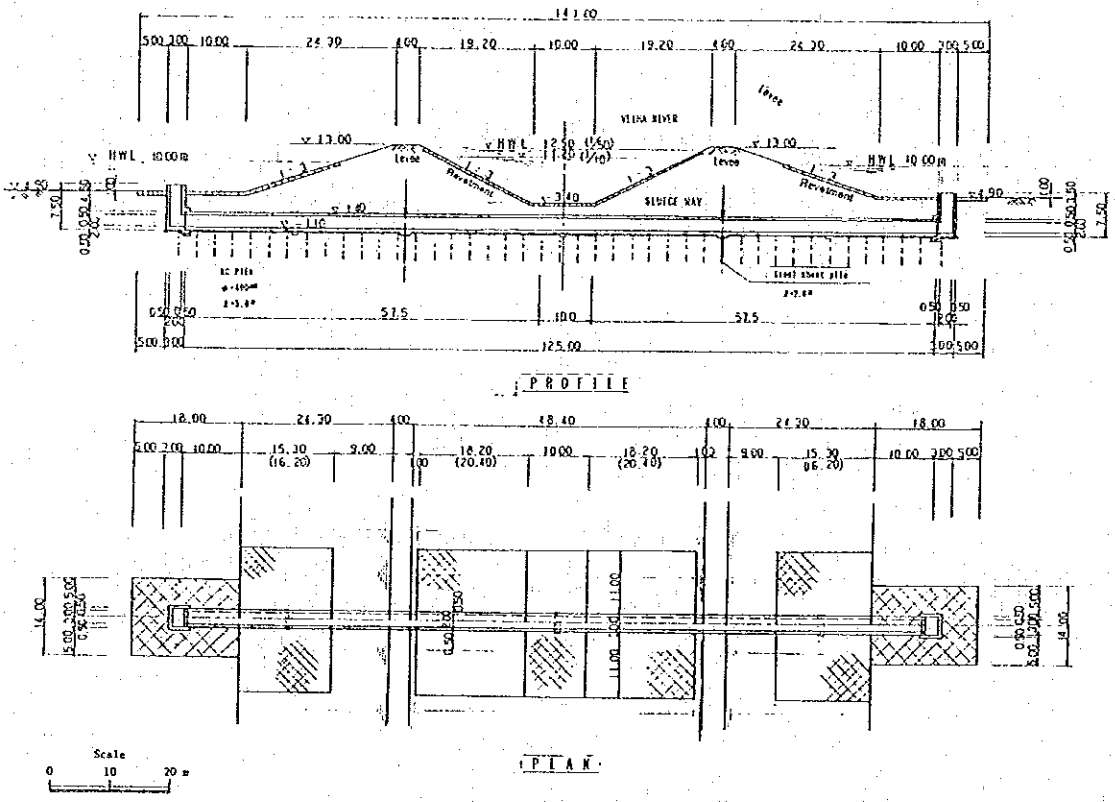


Fig.VII.525 PROPOSED INVERTED SYPHON BETWEEN R-8 AND R-9 REGULATING PONDS

ANNEX VIII. CONSTRUCTION PLAN AND COST ESTIMATE

VIII. CONSTRUCTION PLAN AND COST ESTIMATE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This chapter deals with a construction plan and cost estimate on the proposed provisional plan which protect the Blumenau-Gaspar regions against 10-year probable flood. The project works in this flood control project comprise the river improvement work in the Blumenau-Gaspar stretch in the Itajai river by means of widening of the existing river channel, river improvement by means of levelling-up the low land along the Itajai river and endmost stretch of tributaries, Garcia, Velha and Itoupava rivers flowing into the Itajai river through the Blumenau city, and urban drainage works in the Blumenau city. Since majority of the construction cost of this project work is occupied by the cost for earthmoving work for the excavated materials from the river channel, study on the construction plan was made with emphasis on the minimization of the hauling distance and effective utilization of these material for land reclamation.

The construction plan was worked out in due consideration of the topographic and meteo-hydrological conditions in the project area, result of geotechnical investigation performed in this stage for the project river stretch and other factors affecting the implementation of the project.

2. CONSTRUCTION PLAN

2.1 Conditions for Construction

2.1.1 Site conditions

Site conditions affecting the execution of construction works in the project area are studied as follows;

(1) Topography

The project area in this study is situated in the municipality of Blumenau and Gaspar between 26°45 to 27°10 of south latitude and 48°55 to 49°15 west longitude of the center of Santa Catarina State in the southern part of Brazil.

The project area locates in a flat plain surrounded by mountainous areas and its ground elevation varies from 7.0 m to 22.0 m.

(2) Meteo-hydrology

The project area belongs to subtropical zone, and it is not divided clearly in dry and wet seasons.

The annual mean rainfall in the area is estimated at 1,542 mm at the Blumenau gauge for the period from 1,945 to 1,986. Mean annual temperature is 21°C.

Other characteristics on the meteo-hydrological data on the objective stretch in this study are shown in Table VIII.2.1 and summarized as follows;

Item	Blumenau	Gaspar
Annual mean discharge, m^3/sec	307	312
Mean flowing velocity, m/sec	0.73	0.65

(3) Geology

With regard to general geological conditions along the main river stretch, the base rock lies between 12 to 31 m in depth in the project area. Soft alluvial deposits mainly consisting of clayey soils and fine sand are developed widely above the base rock.

The ultra-soft deposits of which the cone penetration resistance is less than 2 kg/cm^2 were confirmed to exist localy at several places in the project area. Shear strength of those deposits are estimated as follows;

Item	Clayey soil		Sandy soil		
	Ultra soft	Soft	Very loose	Loose	Medium
qc (kg/cm^2)	0 - 2	2 - 4	-	-	-
N (blows/30cm)	-	-	0 - 4	4 - 10	10 - 30

(4) Access to the site

The state road, BR470, running along the project river stretch and connecting with such major cities as Itajai, Ilhota, Gaspar and Blumenau, and municipal and rural roads branching off from the state road are available as access or construction road for the project works. The state road is paved by asphalt and consists of 2 lines with about 8 m in effective width.

Itajai port is main seaport situated in the estuary of Itajai river which has the about 1,500 m of bay length and 8.0 m of draft depth.

The major equipment equipped in this port are gantry cranes with capacity of 1.5 to 20.0 tons, forklift of 1.8 to 37.0 tons and carts of 3.0 to 25.0 tons.

The handling goods of more than 20.0 tons per piece will be loaded or unloaded by the crane equipped in the respective ship. This port is being controlled and administrated by the PORTOBRAS. Distance between this port and the project site is 40 km approximately.

(5) Electricity

Electricity in the project area is supplied by CELESC after transforming to low-voltage from the primary high-voltage lines which is controlled by ELETROSUL (Centrais Electricas do Sul do Brasil S.A.). The distribution line is served in and around the area and it will be utilized for the construction purpose. The total length of distribution line by CELESC is about 760 km in the Blumenau city.

(6) Communication

Dial-in telephone system is developed well in the study area by TELESC (Telecomunicacoes de Santa Catarina S.A.). Telephone communication will be applied mainly between the main office in Florianopolis and the site office during the construction.

Handy type walky-talky will also be used for the communication within the project area.

(7) Construction plant and equipment

Construction plant and equipment required for the implementation of project are available mostly at the local market with national made in Brazil.

For concrete works, 2 ready mixed concrete factories having 50 and 30 m^3/hr in production capacity respectively are available at the Blumenau city.

(8) Construction materials

Required construction materials such as cement, steel material, wooden material, fuel and lubricants and reinforced concrete pile for the foundation works of related structures are available at Santa Catarina State. Hydro-mechanical equipment such as pumps, gates are being manufactured in the Blumenau city of the project area.

(9) Labour source

Skilled and semi-skilled labour could be recruited in the Florianopolis, Blumenau and Itajai cities, but the relative number of those technicians seems to be insufficient. Common labour with sufficient number can be recruited in the Blumenau and Gaspar without seasonal variation.

2.1.2 Mode of construction

It is essential to realize the river improvement plan as earlier as possible to protect the Blumenau-Gasper regions from probable flood.

In order to implement the project work within the limited construction period, it is herein proposed to execute the project works by an international contract system. In consideration of the scale of the works and expected contract amount in case of the international contract basis, the construction section will be divided into the following 2 packages. They are package-A which covers the river improvement works for the Itajai river stretch of about 32 km long between 46 km and 78 km including construction of flood diversion channel at Gaspar, and package-B which covers the river improvement for the 3 tributaries, Garcia, Velha and Itoupava rivers, and urban drainage works in the Blumenau city.

The bill of quantities contract system will be applied upon international open competitive bid accompanied with the prequalification of bidders.

The construction works will be administrated and supervised by DNOS, head and 14 a branch office, in association with an international egnineering consulting firm.

2.1.3 Work items and quantities

The construction works required for the project comprise the following three categories.

- River improvement work in the Blumenau-Gaspar stretch in the Itajai river.
- River improvement work in the endmost stretch of the tributaries, the Garcia, Velha and Itoupava rivers.
- Urban drainage works in the Blumenau city.

Major work items and its quantities of the project are tabulated as follows.

Work items	Unit	Work quantities
I. River improvement works		
Itajai river		
1. Preparatory works	-	L.S.
2. Channel excavation, dredging	m^3	2,100,000 approx.
3. Channel excavation, excavation	m^3	2,200,000 "
4. Filling-up, locally low river bank	m^3	3,500,000 "
5. Levee embankment	m^3	130,000 "
6. Concrete parapet, L=620m	m^3	1,580
7. Revetment	m^2	5,000
8. Excavation of flood diversion channel	m^3	1,500,000 approx.
9. Bridge at flood diversion channel	Set	1 nos., 100 m length
10. Relocation road	m	1,500 m
Tributaries		
11. Channel excavation	m^3	55,000 approx.
12. Levee embankment	m^3	150,000 "
13. Earth filling, locally low river bank	m^3	290,000 "
14. Bridge, heightening	Site	11
15. Sluice	Site	2
II. Drainage works in Blumenau city		
1. Regulating pond	Site	10
2. Connecting pipe the ponds	"	2
3. Drainage pipe	"	3
4. Inverted syphon	"	3
5. T-wall, reversed	"	1
6. Pumping station	"	5
7. Metal works	-	L.S.

2.1.4 Preparatory works

Since the project lies in urban area, there are many public utilities. Those are existing roads, electricity, water and so on. Consequently, preparatory works to be required for project implementation will be the construction of access and construction roads partly connecting to the existing ones, temporary buildings, and communication system. A plan of those works are explained as follows;

(1) Access and construction roads

It will be required to construct newly at the following 2 sites for approaching the job site and as the construction use connecting to the existing rural roads. Macadam road is planned to be constructed for those roads.

	Location	Length	Width
(1)	Along flood diversion channel at Gaspar (Right and left side)	2,000 m approx.	3 m
(2)	Along the proposed levee in the right bank between 48 km to 53 km	5,000 m approx	3 m

(2) Temporary buildings

Temporary buildings are planned to be constructed in the project site for the construction works. Those are site offices for the client and contractor, quarters, material warehouse, repair shop of equipment, laboratory and others. Required area for those buildings is estimated at about 4,000 m^2 approximately.

2.2 Major Construction Works

2.2.1 Basic considerations for planning

In studying the construction plan and schedule, the following basic conditions and assumptions were applied with consideration of topography, meteo-hydrology, geology and other site conditions as stipulated in preceding paragraph.

(1) Based on the daily rainfall record at Blumenau gauge, annual working day for construction was set at 229 days in which rainfall intensity is less tan 10 mm per day. The daily working hour is set at 8 hour.

(2) Conventional method and type of equipment will be principally applied, giving consideration to the local conditions.

(3) For the excavation in water of Itajai river, the dredging method is selected from the economical viewpoint, soil and hydrological conditions. While, the workable day for dredger is set at 280 days based on the hydrological record at Blumenau and rating curve at major river stretch, and assuming that the minimum draft of the dredger is 1.3 m.

(4) Hourly production rate of construction equipment is estimated as tabulated in Table VIII.2.2 to meet with the site condition using the following swelling factor of the earth material.

Material	Loose/Bank	Embank/Bank
Common	1.25	0.88
Coarse/sand and gravel	1.15	1.02
Rock	1.60	1.15

2.2.2 River improvement works

(1) General

The construction plan for river improvement works in the Blumenau-Gaspar stretch in the Itajai river and river improvement works for tributaries flowing into the Itajai river through the Blumenau city was worked out. The river improvement in the Blumenau-Gaspar stretch consists of excavation work for widening of the existing river channel, levee construction and construction of river structures and related structures. The river improvement for the tributaries comprises mainly the construction of levee and heightening work of the existing bridges. The combination of the construction equipment required for each construction works are given in Table VIII.2.3. The construction plan of these works is presented hereinafter.

(2) Channel excavation

It is planned to widen the existing river channel from about 180 m to 220 m to discharge the design flood for the provisional plan. Total volume to be excavated for about 32 km long project river stretch is estimated at around 4.3 million m^3. To minimize the construction cost, the construction plan for this work was worked out under the following principles;

(i) The hauling distance between the excavation site and spoil bank should be reduced as far as possible and,

(ii) The excavated material from the river channel should be effectively utilized for new land reclamation by elevating low land in the pasture and/or unused area along the river stretch.

In line with the above principles, and also considering new land use plan contemplated by Blumenau and Gaspar municipalities, 13 spoil banks were selected as shown in Fig.VIII.2.1. These spoil banks will be utilized as land reclamation area mainly for residential and industrial uses.

The river bank to be widened is composed of alluvial deposit mainly consisting of clayey soils and fine sand. It is judged that the excavation of the river bank can be made using common construction equipment and also dredger. The excavation work for widening of the river channel is planned based on the following criteria;

(i) The dredging method is applied to the excavation under the normal water level.

(ii) The excavation method by use of common equipment is applied for the excavation above the normal water level.

The dredging volume estimated under the foregoing criteria is around 2.1 million m^3. The dredging work is planned to be carried out by pump dredger having the following type considering soil characteristics to be excavated;

Type : Cutter suction pump dredger, diesel engine driven

Capacity : 70 m^3/hr (in net production)

Power : 650 PS. class

Quantity : 2 units

Yearly operation hour is planned at 4,000 hours with 2 to 3 shifts of crew for the daily operation.

It is planned that majority of the dredged material is discharged directly to the disposal site within an average transporting distance less than 1,000 m.

However, in case that the hauling distance is over 1,000 m, 2-step treatment will be applied as follows.

Step-1: The dredged material are discharged to the temporary stockyard which will be provided in the river bank within 1,000 m in discharge distance from the dredger through discharge pipeline.

Step-2: The stocked material temporarily are transported to the proposed discharge site by dump truck after 2 to 3 weeks with dried condition of those material.

The excavation volume above the high water channel is estimated at about 2.2 million m^3. The excavation works will be conducted using the following construction equipment;

Excavation : Swamp bulldozer, 18t class

Loading : Crawler loader 1.5 m^3

Hauling : Dump truck, 10t class

Leveling at land reclamation site : Swamp bulldozer, 13t class

Dragline and backhoe will be used as the supporting equipment. It is planned that the excavated material is transported to the proposed spoil bank by dump truck. The earth moving volume by hauling distance is as follows;

Hauling distance	Volume (m^3)	Method
(Dredged material)		
< 1,000 m	1,707,700	Dredger
2,000 - 5,000 m	378,300	Dredger and dump truck
Sub-total	2,086,000	
(Excavated material)		
< 1,000 m	773,130	Dump truck
2,000 - 5,000 m	1,082,800	"
5,000 - 10,000 m	272,800	"
Sub-total	2,128,730	
Total	4,214,730	

Earth moving plan for those excavated material is proposed as shown in Tables VIII.2.4 and VIII.2.5 dividing the hauling distance from the respective site of excavation.

A part of the following existing roads in Blumenau city will not be utilized as the transportation route of excavated material due to the environmental aspect.

- Setembro road in central zone
- Novembro road in central zone
- Paul Werner road

(3) Levee embankment and/or filling of the excavated material from river channel

It is planned that the levee and/or filling of the excavated material from the river channel is provided only at the river bank with locally low elevation. The levee is planned to be constructed at the Itajai and 3 tributaries. The total levee embankment volume in the Itajai river stretch for the following 3 sites is around 127,000 m^3 as follows;

River	Location	Length (m)	Volume (m^3)
Itajai	Right bank Section No. 5 -14 (45.49 - 47.95 km)	2,560	53,820
Itajai	Right bank Section No. 17 - 23 (49.26 - 50.84 km)	1,910	44,773
Itajai	Left bank Section No. 88 - 91 (70.03 - 70.89 km)	1,280	28,014
	Total	5,750	126,607

Since the excavation material from the river channel is not suitable for levee embankment use, the borrow pit sites as shown in Fig VIII.2.2 were selected. The proposed borrow pit sites are located at the hilly areas in both river banks along the project river stretch.

A series of the levee embankment works including excavation at the borrow pit, loading, hauling, spreading and compacting will be performed using the following equipment;

Excavation at borrow pit	:	Swamp bulldozer, 13t class
Loading at borrow pit	:	Crawler loader, 1.5 m^3 class
Hauling	:	Dump truck, 10t class
Spreading and compaction	:	Bulldozer, 11t class, Vibration roller 5t class

Embankment criteria will be as follows.

Thickness of one layer	:	40 cm approx.
Passing number of compaction equipment	:	5 - 7 times/layer

The excavation slope of borrow pits is planned to avoid the steepen slope and to be covered with grass after extracting the embankment materials.

The filling of the excavated material from the channel is planned to the locally low elevation area other than the levee embankment area.

(4) Construction of flood diversion channel

A flood diversion channel at the Gaspar stretch having the following profile for 600 m^3/sec in maximum diverting capacity is planned to be constructed;

Type	:	Trapezoids cross section with verm and sodding
Length and width	:	2,550 m x 70.8 m top and 10.0 m bottom 1:2.0 in slope. Length of standard cross section is 1,700 m
Depth from existing ground surface to the bottom	:	14.2 m

Major work item of the flood diversion channel at Gaspar is the excavation of around 1.5 million m^3. Swamp type of equipment is planned to be utilized for the excavation work considering the soil condition that ultra-soft deposit exists in the area. Three years construction period will be required for this diversion channel works.

A bridge having the following profile is proposed to be constructed newly crossing over the flood diversion channel.

Type	:	P.C., T-beam
Length and span	:	100.00 m and 5 span
Width	:	9.0 m including 0.75 m x 2 side walk
Foundation	:	R.C. pile, 400 x 400 mm

Foundation piles will be driven using 3.5 tons class diesel pile hammer. Ready mixed concrete will be used for required concrete of bridge construction. Two years construction period will be required for this bridge construction. No temporary bridge is provided.

(5) Concrete parapet

It is planned to construct the concrete parapet wall along the right river bank in the Blumenau city for about 420 m long stretch in the upstream from the confluence with Garcia river which is locally low elevation. The height of concrete parapet will be 1.0 m. Required concrete volume is estimated at 500 m^3. Placing the concrete will

be carried out by 30 m^3/hr class concrete pump car using ready mixed concrete.

(6) Revetment

Revetment works consisting of concrete block and gabion mattress are estimated at about 15,600 m^2 in the Itajai river and tributaries. They will be conducted following to the river channel widening work.

(7) Relocation of existing road

A part of the existing road located along the project river stretch is obliged to be shifted due to the widening of the existing river-channel. The existing road to be shifted is estimated at about 1.5 km. Prior to the widening work of the existing river channel, a series of the reconstruction work of the road including clearing of the site, levelling, compaction, construction of base course and pavement work will be carried out based on the standard for local road.

(8) Heightening work of bridges in tributaries

In order to cope with the design flood water level in the Itajai river, 11 sets of existing road bridges crossing over the endmost stretch of the Garcia, Velha, Gaspar Grande and Gasparinho rivers will be obliged to be heightened. Those road bridges to be heightened are 11 sites as tabulated below.

Name of bridge	Dimension of existing bridge (m) Length	Span	Width /1	Required heightening (m)
Garcia river				
Ponte Da Rua 7 De Setembro (G-1)	52.0	3	19.00	3.67
Velha river				
Ponte Da Rua San Paulo (V-1)	45.1	5	14.70	2.68
Ponte Da Rua Paraiba (V-2)	42.0	3	5.30	4.10
Ponte Da Rua 7 De Setembro (V-3)	30.2	3	18.00	3.79
Ponte Da Rua Mariana Bronneman (V-4)	20.0	3	7.30	3.22
Ponte da Rua Alberto Stein (V-5)	14.4	1	19.60	4.29
Rua Da Marechal Deodoro (V-6)	20.0	3	10.20	1.50
Gaspar Grande river				
Ponte da Rua Gel.Aristiliano Ramos (BR 470) (GG-1)	39.0	5	7.50	1.56
Ponte Da Avenida Das Comunidades (GG-2)	45.0	4	10.85	0.94
Gasparinho river				
Ponte Da Rodovia Jorge Lacerda (BR-470) (GP-1)	47.6	3	5.80	1.00
Ponte da Rodovia Gaspar-Brusque (SC-411) (GP-2)	34.7	3	7.10	1.67

Note /1: Effective width including sidewalk.
/2: All of existing bridges mentioned above are R.C type.

The heightening works will be conducted at 2 to 3 sites concurrently as illustrated below considering minimizatin of traffic jam as far as possible.

Name of tributary	Work order ① → ② → ③	Note
Garcia	G-1	Providing temporary bridge
Velha	V-1, V-3 → V-2, V-4 → V-5, V-6	Without temporary bridge " "
Gaspar Grande	GG-1 → GG-2	Without temporary bridge
Gasparinho	GP-1 → GP-2	Without temporary bridge

The heightening work of G-1 bridge will be conducted in such a way that after temporary bridge and access road are constructed nearby the existing bridge, superstructure will be removed, pier and abutment foundation are heightened using hydraulic jacks and supporting materials, then superstructure is reconstructed. Other bridges of 10 sets are planned to be constructed without providing a temporary bridge.

Concrete breaker, crawler crane, concrete pump and road pavement equipment will be the major equipment for the heightening works of existing bridges.

The heightening works are scheduled to be completed in 2 years work period for all 11 bridges.

2.2.3 Urban drainage works

(1) General

The urban drainage works in the Blumenau city along the Garcia, Velha and Itoupava rivers are planned in this study for relieving the city area from flood in the Itajai river. Major works required for this drainage plan are the construction of regulating ponds at 10 sites, pumping station at 5 sites and related works.

(2) Construction of regulating ponds

The regulating pond is planned to construct at 10 sites with 27.3 ha in total area along the Garcia and Velha rivers. Major works comprise the excavation of about 0.47 million m^3 and embankment of about 0.49 million m^3. It is planned that the excavated material are to be used as the embankment material within the same site principally.

Shortage volume of embankment material of about 20,000 m^3 are planned to be supplied from the borrow pit.

The construction works for regulating ponds will be conducted simultaneously at the several places upon grouping the working crew by the following work order.

(i) Construction of river portion including inverted syphon, connection or drainage pipes, revetment and river bed protection and other related structures

(ii) Diversion of the river flow

(iii) Construction of remaining portion.

Small scale coffering by sand bags will be provided during construction of the ponds. Major work items and quantities for the inverted syphon and T-wall connecting and drainage pipes are tabulated as follows;

Excavation	:	230,000 m^3 approx.
Foundation pile	:	2,070 nos. (R.C, ø350 mm, l = 5 m)
Steel sheetpile	:	20,520 nos. (Type II)
Concrete	:	9,510 m^3
Backfill	:	220,000 m^3
Revetment	:	9,300 m^2
River bed protection	:	1,770 m^2

The following equipment will be used for the construction of the ponds including related structures;

- Swamp bulldozer, 13t class
- Backhoe, 0.6 m^3 class
- Crawler loader, 1.0 m^3 class
- Dump truck, 8t class
- Concrete pump car, 30 m^3/hr class
- Vibration hammer, 22 kw class

Required construction period will be 3 years for 10 sites of regulating ponds without night time works.

(3) Pumping station

It was planned to construct the pumping stations at the several regulating pond sites.

Total number of the pumping station is 5 comprising 1 site for the Garcia river stretch and 4 sites for the Velha river stretch.

Considering the convenience of the operation and maintenance of the pump, the following type of pump are selected.

Drainage district	Name of tributary	Main feature of pump			
		Total capacity (m^3/sec)	Type	Discharge dia. (mm)	Q'ty
G-1, G-2 and G-4	Garcia	7.8	Vertical, mixed flow	1,350	3 units
V-1 and V-5	Velha	0.7	Submersible	500	2 units
V-2 and V-6	Velha	0.7	Submersible	500	2 units
V-3 and V-4	Velha	1.0	Horizontal, mixed flow	600	2 units
V-7	Velha	4.0	Horizontal, mixed flow	1,000	2 units

The civil works including foundation treatment of the pumping station will be carried out concurrently with the construction of the regulating ponds by several crews using the construction equipment such as 30 tons class crawler crane, 22 kw class vibration hammer, 13 tons class swamp type bulldozer, 0.6 m^3 class backhoe, 8 tons class dump truck and concrete pump car of 30 m^3/hr class. The installation of the pumps with related facilities and building works will be conducted using truck crane of 20 tons class in maximum lifting capacity. Those pumping station at 5 sites will be executed during 2 years consisting of 12 months of civil works, 6 months for installation of pumps and 6 months for building works.

(4) Installation of gate facility

In order to drain the inner water stored in the pond by gravity flow when the water level in the pond is higher than the flood water level in the tributaries and also to avoid a complicate operation, flap type gate made of steel or wood is planned to be installed. Besides, it is planned to install the flap type gate at the outlet of the existing drainage network. The number of site to be installed this flap gate is 20 places. The construction work of those gate will be executed in parallel with the work for the regulating pond.

Major construction equipment to be required for foregoing construction plan are summarized in Table VIII.2.6.

2.3 Construction Time Schedule

Implementation period of this project is planned at 7 years including one year for respective tendering, detailed design and tender and contract, and 4 years for construction works.

The construction works by contract system of packages A and B are scheduled to commence at the same time. The river improvement works, for Itajai river and tributaries, and urban drainage works in Blumenau city will be conducted simultaneously. It is expected to complete within 2 years from the starting time for the regulating ponds and

pumping stations considering the site conditions especially the traffic in the area.

Hydro-mechanical equipment is to be arranged in an early stage for purchasing, thus the installation work is conducted without delay. The construction works for 4 years are shown in Fig.VIII.2.3.

3 CONSTRUCTION FUND TO BE REQUIRED

3.1 Conditions for Cost Estimate

The construction cost of the project works is estimated by the following conditions;

(1) Price level : August, 1987

(2) Exchange rate : 1 US$ = Cz$50.00 = ¥150.00

(3) The construction cost consists of 3 main items, namely, direct cost, indirect cost and contingency. The direct cost is estimated based on the required work items and quantities derived from the feasibility design. The indirect cost includes the cost of land acquisition and house evacuation, government administration cost and engineering services cost for detailed design and supervision. The physical contingency is counted into direct and indirect costs accordingly. The price contingency is estimated for escalation on the financial cost estimate.

(4) The direct cost for civil works is estimated by multiplying the unit cost and corresponding work quantity. The preparatory works and minor work items are estimated by lump sum basis with a certain percentage of main works. The unit cost for each work item consists of the cost of construction materials, labour and equipment. The contractor's indirect cost is incorporated in the unit cost for each work item.

(5) Labourer's daily charge are estimated including the social charge (Leis sociais) of 98% as tabulated in Table VIII.3.1.

(6) Prices of construction material available in local market were surveyed at Florianopolis, Blumenau and Itajai in the Santa Catarina State. They are principally counted into the local currency component but their certain proportions are considered into foreign currency component according to their usage of imported raw material and production facilities. Table VIII.3.2 shows the unit price of construction materials divided into the foreign and local currencies.

(7) Equipment cost consists of depreciation and interest, maintenance and repair cost, and management cost. Operator's charge is incorporated to the labour cost. Fuel and lubricant cost are incorporated in the material cost.

The following concept is applied to the estimation of foreign and local currencies of equipment cost upon dividing the imported or local product equipment.

Cost items	Clasification of F.C and L.C	
	For import equipment	For local product equipment
Depreciation and interest cost	100% of F.C	100% of the depreciation cost
Maintenance and repair cost	100% of F.C for spare parts. Material cost is F.C and L.C by certain percentage of each material. 100% of labour cost is L.C.	Spare parts and material cost are F.C and L.C by certain percentage. 100% of labour cost is L.C.
Fuel, lubricant and consumables	Fuel and lubricant cost are F.C and L.C by certain percentage. 100% of consumable cost is F.C.	These cost are F.C and L.C by certain percentage..
Operator's cost	100% of L.C	100% of L.C
Management cost	100% of L.C	100% of L.C

Note : F.C.and L.C. mean the foreign currency and local currency respectively.

Hourly cost per each equipment is tabulated in Table VIII.3.3 by dividing into the foreign and local currency components.

(8) A 30% of direct cost is assumed as the contractor's indirect cost(contractor's overhead and profit), and added to the direct cost in the unit cost of each work item.

(9) Cost estimate for hydro-mechanical works is based on market research and past tendered record of similar works.

(10) Land acquisition and house evacuation costs are estimated on the basis of the prevailing state or DNOS's expropriation cost for land, buildings and other private properties. All of these costs are estimated as the local currency component.

(11) An allowance of 5% of the total estimated direct cost with 100% of local currency component is estimated as the administration cost for the implementation of the project.

(12) Engineering services cost is estimated at 9% of total direct cost for detailed design and construction supervision with 80% and 20% for foreign and local components respectively.

(13) Physical contingency is provided to cope with the unpredictable physical conditions amounting 10% of total cost except for land acquisition respectively.

(14) Price contingency is provided for the reflection of inflational effect against the implementation of the project. Price contingency for financial cost is estimated assuming the inflational rate is 5% per annum for the foreign currency and 12% per annum for the local currency.

The direct construction cost divided into foreign and local currency portions was estimated by multiplying the work quantities by the respective unit costs. The bill of quantities with unit cost are tabulated in Table VIII.3.4 based on the foregoing conditions.

The estimated direct and indirect construction costs are summarized in Tables VIII.3.5 and VIII.3.6.

3.2 Financial Cost and Annual Disbursement Schedule

The financial cost on the proposed provisional plan was estimated as presented in Table VIII.3.7 and summarized as follows;

Cost items	F.C (10^3US$)	L.C (10^3Cz$)	Total (Equiv.10^3US$)
- Direct cost (Construction cost including preparatory works)	24,720	821,000	41,140
- Indirect cost (Land acquisition, administration and engineering service cost)	2,962	372,876	10,421
- Contingency (Physical and price contingency)	6,002	387,040	13,743
Total	33,684	1,581,000	65,304

The direct construction cost of each package is estimated at 22.1 and 19.1 million US$ equivalent for package-A and B respectively.

Based on the construction time schedule as shown in Fig.VIII.2.3, the annual disbursement schedule is prepared as given in Table VIII.3.8.

Tables

Table VIII.2.1 HYDROLOGICAL DATA FOR CONSTRUCTION PLANNING

(1) Discharge (m3/sec)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
	Indaial	243	218	245	137	214	179	412	423	274	294	335	347	286
IT 7	Blumenau	261	234	263	147	230	192	442	454	294	316	360	373	307
IT 6	Gaspar	265	238	267	149	233	195	449	461	299	321	365	379	312

(2) Water level (EL. m)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
IT 7	Blumenau	0.92	0.71	0.93	0.20	0.42	0.20	2.78	2.89	1.10	1.20	2.02	2.14	1.06
IT 6	Gaspar	0.20	0.20	0.20	0.20	0.20	0.20	1.32	1.35	0.20	0.30	0.72	0.80	0.22

(3) Flowing velocity (m/sec)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
IT 7	Blumenau	0.71	0.66	0.73	0.47	0.64	0.61	0.86	0.87	0.73	0.74	0.81	0.82	0.73
IT 6	Gaspar	0.56	0.50	0.57	0.32	0.49	0.41	0.74	0.76	0.63	0.64	0.67	0.67	0.65

(4) Monthly mean rainfall at Blumenau

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Blumenau	173	193	163	101	88	89	99	97	124	146	114	150	1,542

Note : Discharge at IT 6 and IT 7 is estimated from the record at Indaial and area ratio to Indaial's records.

Remark : 1) Water level of 0.2 m is equivalent to the annual mean tide water level.
2) Monthly mean rainfall data from 1944 to 1986.

Table VIII.2.2 PRODUCTION RATE OF EQUIPMENT

1. Cutter suction pump dredger 650 PS, Ø 12"

$$Q = q \times d_0 / 1{,}000 \times E \times r \quad (m^3/hr)$$

where, Q ; Hourly dredging capacity (m^3/hr)

q ; Hourly dredging capacity of 1,000 PS dredger with electric power. q = 190 m^3/hr is estimated by the following condition;

- Material to be dredged ; Clayey soils and fine sand
- N-value ; 20
- Discharge distance ; 1,000 m including 150 m of floating pipe

d_0 ; Dredger's horse power with electric power

Diesel type ; Nominal horse power x 0.8

= 650 PS x 0.8 = 520 PS

E ; Work efficiency. Ratio of dredged volume actually compared with the standard dreding volume, E=0.8

r ; Time factor for actual work, r=0.85

$$Q = 190 \times 520 / 1{,}000 \times 0.8 \times 0.85 = 67.2 \ m^3/hr \ (70 \ m^3/hr)$$

2. Bulldozer

- Excavation

$$Q = 60 \times q \times F \times E / C_m \quad (m^3/hr)$$

where, Q ; Hourly production (m^3/hr)

q ; Dozing capacity per cycle (m^3)

F ; Swell factor of material 0.80

E ; Operation efficiency 0.70

C_m ; Cycle time (min.)

$$C_m = (L/V_1) + (L/V_2) + t_g$$

L ; Hauling distance (m)

V_1 ; Forward speed (m/min.)

V_2 ; Reverse speed (m/min.)

t_g ; Gear change and others

(Continuation)

Common

Class	q	F	E	L	V_1	V_2	t_g	C_m	Q
20 t bulldozer	3.19	0.80	0.70	20	42	58	0.33	1.15	94
18 t buldozer	3.00	0.80	0.70	20	42	58	0.33	1.15	88
13 t buldozer	2.50	0.80	0.70	20	42	58	0.33	1.15	73
11 t buldozer	2.00	0.80	0.70	20	42	58	0.33	1.15	58

- Spreading

$$Q = W \times V \times D \times F \times E / N$$

where, Q ; Hourly production (m^3/hr)
W ; Effective spreading width (m)
V ; Operating speed (m/hr)
D ; Spreading depth (m)
F ; Swell factor of material
E ; Operating factor
N ; Number of spreading

Common

Class	W	V	D	F	E	N	Q
20 t bulldozer	3.96	1,700	0.3	0.80	0.60	5	194
18 t buldozer	3.67	1,500	0.3	0.80	0.60	5	158
13 t buldozer	3.50	1,200	0.2	0.80	0.40	3	90
11 t buldozer	3.05	1,700	0.3	0.80	0.60	5	150

- Compacting

$$Q = W \times V \times D \times F \times E / N$$

where, Q ; Hourly production (m^3/hr)
W ; Effective compacting width (m)
V ; Compacting speed (m/hr)
D ; Compacting depth (m)
F ; Swell factor of material
E ; Operating factor
N ; Number of compacting

(Continuation)

Common

Class	W	V	D	F	E	N	Q
20 t bulldozer	0.8	4,000	0.3	0.8	0.6	6	77
18 t buldozer	0.8	4,000	0.3	0.8	0.6	6	77
13 t buldozer	0.8	4,000	0.3	0.8	0.6	6	77
11 t buldozer	0.6	4,000	0.3	0.8	0.6	6	58

3. Loader

$$Q = 3,600 \times q \times k \times F \times E / C_{ms}$$

where, Q ; Hourly production (m^3/hr)
q ; Bucket capacity (m^3)
K ; Bucket coefficiency
F ; Swell factor of material
E ; Operating efficiency
C_{ms} ; Cycle time (sec.)

Common

	q	K	F	E	C_{ms}	Q
1.0 m^3 Crawler loader	0.7	0.85	0.80	0.7	21	57
0.6 m^3 Crawler loader	0.7	0.85	0.80	0.7	21	57

4. Dump truck

$$Q = 60 \times C \times F \times E_t / C_{mt}$$

where, Q ; Hourly production (m^3/hr)
C ; Vessel capacity (m^3)
F ; Swell factor of material
E_t ; Operating efficiency of dump truck
C_{mt} ; Cycle time of dump truck (min.)

$$C_{mt} = (C_{ms} \times n / 60 \times E_s) + (D/V_1) + (D/V_2) + t_1 + t_2$$

C_{ms} ; Cycle time of loader (min.)
n ; Number of loading $n = C / q \times K$
q ; Bucket capacity of loader (m^3)
E_s ; Operating Efficiency of loader
D ; Hauling distance (m)
K ; Bucket coefficient

(Continuation)

V_1 ; Travel speed with load (m/min.)

V_2 ; Travel speed without load (m/min.)

t_1 ; Unloading time (min.)

t_2 ; Waiting, setting and others (min.)

Common

	1,000m		5,000 m		10,000		15,000	
	8 t	10 t	8 t	10 t	8 t	10 t	8 t	10 t
C	3.8	5.4	3.8	5.4	3.8	5.4	3.8	5.4
F	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
E_t	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
C_{mt}	10.9	10.9	38.9	38.9	73.9	73.9	108.9	108.9
C_{ms}	36	36	36	36	36	36	36	36
n	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
q	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
K	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
E_s	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
D	1,000	1,000	5,000	5,000	10,000	10,000	15,000	15,000
V_1	250	250	250	250	250	250	250	250
V_2	333	333	333	333	333	333	333	333
t_1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
t_2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Q	15.0	21.4	4.2	5.9	2.22	3.15	1.51	2.14

5. Cramshell : 0.6 m^3

$$Q = 3,600 \times E \times F \times q / C_m$$

where, Q ; Hourly production (m^3/hr)

E ; Operation efficiency

F ; Swell or skrinkage factor of material

q ; Capacity of outlet (m^3)

C_m ; Cycle time = 45 sec.

Material	E	F	q	C_m	Q
Common	0.85	0.6	0.75	0.45	30
S & G	0.87	0.6	0.70	0.45	29
Rock	0.61	0.6	0.70	0.45	20

(Continuation)

6. Dragline : 0.6 m^3

$$Q = 3,600 \times F \times q \times E \times S \times C / C_m$$

where, Q ; Hourly production (m^3/hr)

F ; Swell or skrinkage factor of material

q ; Dosing capacity per cycle (m^3)

E ; Operation efficiency

S ; Swing factor

C ; Containing factor

C_m ; Cycle time (sec.)

Material	F	q	E	S	C	C_m	Q
Sandy silt	0.78	0.6	0.70	0.94	0.70	40	19
Common	0.85	0.6	0.75	0.97	0.70	45	21
Sand silt	0.88	0.6	0.75	0.98	0.70	50	20

7. Piling

$$Q = 60 / T_c$$

where, Q ; Number of sheetpile to be driven per hour (no/hr)

T_c ; Cycle time of piling (min.) ; $T_c=(T_b+T_s)/f_c$

T_b ; Piling time (min.) ; $T_b=A \times K \times L$

T_s ; Preparation of piling (min.) ; $T_s=0.4 \times L_0+t_1$ ($T_s=0.2 \times L_0+1.5$)

f_c ; Work efficiency

A ; Coefficient of soil

K ; Coefficient of pile and equipment

L ; Piling depth (m)

L_0 ; Length of pile (m)

t_1 ; Coefficient of equipment

	t	L_0	L	K	A	f_c	T_b	T_s	t_1	T_c	Q
(1) Vibro hammer											
Sheet pile	2	12	6	1.15	1.1	0.75	7.6	6.8	-	19.5	3.1
Sheet pile with auger	2	12	6	1.15	1.1	0.75	7.6	6.8	12.6	32.1	1.9
Sheet pile with extract	1.5	12	6	1.00	0.4	0.65	2.4	3.9	-	9.7	6.2
(2) Diesel hammer											
Sheet pile	2	12	6	1.00	1.4	0.75	8.4	6.8	-	20.3	3.0
Sheet pile with auger	2	12	6	1.00	1.4	0.75	8.4	6.8	12.6	32.9	1.8
Sheet pile	2	3.5	3.5	1.00	1.4	0.75	4.9	3.4	-	11.1	5.4
Sheet pile with auger	2	3.5	3.5	1.00	1.4	0.75	4.9	3.4	7.4	18.5	3.2
Sheet pile with auger	2	10.5	4.7	1.00	1.4	0.75	6.6	6.2	-	17.1	3.5
Sheet pile with auger	2	10.5	4.7	1.00	1.4	0.75	6.6	6.2	9.5	26.6	2.3
Pipe pile ø 600	8.8	8	8	1.00	1.5	0.75	12.0	12.0	-	32.0	1.9
Pipe pile ø 600 with auger	8.8	8	8	1.00	1.5	0.75	12.0	12.0	16.8	46.8	1.3
Pipe pile ø 300 with auger	8.8	12	6	1.00	1.5	0.75	12.0	12.0	-	28.0	2.1
Pipe pile ø 300 with auger	8.8	12	6	1.00	1.5	0.75	9.0	12.0	11.3	39.3	1.5

8. Concrete equipment

- Concrete mixer

$$Q = 60 \times q \times E / C_m$$

where, Q ; Hourly production (m^3/hr)

q ; Mixing capacity (m^3)

E ; Operating efficiency

C_m ; Cycle time (min.)

Concrete mixer 0.2 m^3

Work	q	E	Cm	Q
Concrete	0.2	0.6	4.0	1.8

Portable concrete plant 0.5 m^3

Work	q	E	Cm	Q
Concrete	0.5	0.5	1.5	10

- Transportation of concrete

$$Q = 60 \times V \times E / C_m$$

where, Q ; Hourly production (m^3/hr)

V ; Loading capacity (m^3)

E ; Operating efficiency

C_m ; Cycle time (min.)
$C_m = C_{m1} + C_{m2}$

C_{m1} ; Rounding travelling time (min.)
$C_{m1} = 3 \times L + 5$

C_{m2} ; Loading, unloading and waiting (min.)

L ; Hauling distance (km)

(Continuation)

2.0 m^3 truck mixer

Work	V	E	Cm	Cm1	Cm2	L	Q
0.5 km	2.0	0.95	17.5	6.5	11	0.5	7
1.0 km	2.0	0.95	19.0	8.0	11	1.0	6
2.0 km	2.0	0.95	22.0	11.0	11	2.0	5
3.0 km	2.0	0.95	25.0	14.0	11	3.0	5
4.0 km	2.0	0.95	28.0	17.0	11	4.0	4
5.0 km	2.0	0.95	31.0	20.0	11	5.0	4
6.0 km	2.0	0.95	34.0	23.0	11	6.0	3
7.0 km	2.0	0.95	37.0	26.0	11	7.0	3
8.0 km	2.0	0.95	40.0	29.0	11	8.0	3
9.0 km	2.0	0.95	43.0	32.0	11	9.0	3
10.0 km	2.0	0.95	46.0	35.0	11	10.0	2
11.0 km	2.0	0.95	49.0	38.0	11	11.0	2
12.0 km	2.0	0.95	52.0	41.0	11	12.0	2
13.0 km	2.0	0.95	55.0	44.0	11	13.0	2
14.0 km	2.0	0.95	58.0	57.0	11	14.0	2
15.0 km	2.0	0.95	61.0	50.0	11	15.0	2

Concrete placing

Concrete bucket handled by 20 t crane

1 m3 Bucket

Concrete without reinforcement 9 m^3/hr

Concrete with reinforcement 8 m^3/hr

TAble VIII.2.3 EQUIPMENT SCHEDULE FOR EARTHMOVING WORK
(Major equipment only)

Work Items	Total Volume (MCM)	Standard Progress (Cu.m/hr)	Major equipment required	
A. River improvement				
(1) Dredging	2.10	132	Dredger	650ps x 2 units
(2) Excavation and fill-up	2.20	320	Bulldozer Crawler loader Dump truck	18 t x 4 units 1.5 cu.m x 5 units 10 t x 20 units
(3) Levee embankment	0.13	30	Bulldozer Crawler loader Dump truck	13 t x 2 unit 1.5 cu.m x 1 unit 10 t x 2 units
(4) Excavation at flood diversion channel	1.50	220	Bulldozer Crawler loader Dump truck	18 t x 3 units 1.5 cu.m x 3 units 10 t x 10 units
(5) Excavation for tributaries	0.06	10	Common use of item No.A (1)	-
(6) Fill-up for tributaries	0.15	25	Common use of item No.A (1)	-
B. Urban drainage works				
(1) Excavation and fill-up	1.00	150	Bulldozer Crawler loader Dump truck	13 t x 2 units 1.5 cu.m x 2 units 8 t x 8 units
(2) Embankment	0.70	135	Common use of item No.B (1)	-

Table VIII.2.4 EARTH MOVING PLAN

Section No. (km)		Section Length (m)	Dredging by Dredger: Total Volume of the section (cu.m)	Spoil Bank Number for Destination	Hauling Distance (m)	Hauling method	Excavation by Earthmoving Equipment: Left Bank Volume (cu.m)	Left Bank Spoil Bank Number for Destination	Left Bank Hauling Distance (m)	Right Bank Volume (cu.m)	Right Bank Spoil Bank Number for Destination	Right Bank Hauling Distance (m)
S-3 to S-11	44.85 - 47.37	2,520	325,600	(1) & (2)	< 1,000	Direct discharge /1	0	-	-	0	-	-
S-11 to S-20	47.37 - 49.97	2,600	375,600	(2),(3) & (4)	< 1,000	Direct discharge	38,230	(2) & (3)	< 1,000	40,100	(4)	< 1,000
S-20 to S-29	49.97 - 52.83	2,860	348,100	(3)	< 1,000	Direct discharge	0	-	-	0	-	-
S-29 to S-38	52.83 - 55.46	2,630	182,600	(5) & (6)	< 1,000	Direct discharge	74,800	(5) & (6)	< 1,000	86,500	(7)	< 1,000
S-38 to S-50	55.46 - 58.73	3,270	122,700	(7) (8) (7) & (8)	< 1,000 < 1,000 2,000	Direct discharge, 50,000 cu.m Direct discharge, 50,000 cu.m 2-Step treatment /2 using temporary yards No.7-a & 8-a, 22,700 cu.m	14,000	(8)	< 1,000	15,200	(7)	2,000
S-50 to S-61	58.73 - 61.88	3,150	327,800	(9) & (10)	< 1,000	Direct discharge	519,500	(9) & (10)	< 1,000	92,200	(7)	4,000
S-61 to S-76	61.88 - 66.36	4,480	358,300	(11) (10)	< 1,000 3,000	Direct discharge, 28,000 cu.m 2-Step treatment using temporary yards No.10-a,10-b &10-c 330,300 cu.m	231,300	(10)	3,000	671,200	(10)	4,000
S-76 to S-85	66.36 - 69.00	2,640	31,400	(12) (12)	< 1,000 2,000	Direct discharge 20,000 cu.m 2-Step treatment using temporary yards No. 12-a, 11,400 cu.m	145,800	(10)	6,000	64,800	(10)	8,000
S-85 to S-107	69.00 - 75.59	6,590	13,900	(13)	5,000	2-Step treatment using temporary yards No. 13-a, 13,900 cu.m	72,900	(13)	5,000	62,200	(13)	10,000
Total	44.85 - 75.59	30,740	2,086,000	-	-	-	1,096,530	-	-	1,032,200	-	-

Note : /1 Direct discharge means the dredged material are discharged directly from the dredger to the designated spoil banks (the low land area to be filling-up or level up by dredged material) through discharge pipes.

/2 2-step treatment means the dredged material are treated by the following steps ;
1-step : Discharge from dredger to the temporary stock yard with discharge distance of less than 1,000 m.
2-step : To transport to the designated spoil banks by dump truck.

Table VIII.2.5 SUMMARY OF EARTH MOVING PLAN

(A) Dredged material below normal water level

Hauling distance	Volume (m^3)	Method
< 1,000 m	1,707,700	Direct discharge to spoil bank by dredger
2,000 m	34,100	2-step treatment /1
3,000 m	330,300	2-step treatment
5,000 m	13,900	2-step treatment
Total	2,086,000	

Note : /1 Dredged material are treated by the 2 steps.

Step-1 : Discharge from dredger to the temporary yards with discharge distance of less than 1,000 m.

Step-2 : To transport to the spoil banks by dump truck.

(B) Excavated material above normal water level

Hauling distance	Volume (m^3)	Method
< 1,000 m	773,130	Dump truck
2,000 m	15,200	Dump truck
3,000 m	231,300	Dump truck
4,000 m	763,400	Dump truck
5,000 m	72,900	Dump truck
6,000 m	145,800	Dump truck
8,000 m	64,800	Dump truck
10,000 m	62,200	Dump truck
Total	2,128,730	

Table VIII.2.6 MAJOR CONSTRUCTION EQUIPMENT

No.	Description	Capacity	Q'ty
1.	Cutter suction pump dredger	650ps	2
2.	Anchor barge	40ps	2
3.	Swamp bulldozer (Super low contact pressure type)	18 t	2
4.	Swamp bulldozer (Low contact pressure type)	18 t	5
5.	- do -	13 t	5
6.	Bulldozer	20 t	1
7.	- do -	11 t	3
8.	Crawler loader	1.5 cu.m	10
9.	Backhoe	0.6 cu.m	6
10.	Dragline	0.6 cu.m	2
11.	Clamshell attachment	0.6 cu.m	2
12.	Dump track	10 t	32
13.	- do -	8 t	8
14.	Diesel pile hammer with base machine	3.0 t	1
15.	Vibration hammer	22 kw	1
16.	Crawler crane	30 t	1
17.	Truck crane	10 t	2
18.	Concrete pump car	30 cu.m/h	2
19.	Tire roller	20 t	1
20.	Vibration roller	5 t	2
21.	Road roller	8 t	2
22.	Water tanker	8 kl	2
23.	Fuel tanker	8 kl	2
24.	Grease car	8 t	1
25.	Motor grader	3.7 m	2
26.	Asphalt sprayer	200 l	2
27.	Asphalt finisher	2.4 m	2
28.	Ordinary truck with crane	6 t	2
29.	Hydraulic jack	100 t	10
30.	Welder	200 A	2
31.	Submersible pump	ø=100mm	10
32.	Port. concrete mixer	0.3 cu.m	3
33.	Pneumatic breaker	20 kg	6
34.	Diesel generator	80 kVA	1
35.	- do -	20 kVA	5
36.	Micro bus	30 persons	2

Table VIII.3.1 LABOUR WAGES (8 hours/day)

	Description	Cz$	US$ Equiv.
1.	Foreman	1,170	23.4
2.	Operator for dredger	450	9.0
3.	Operator for equipment	435	8.7
4.	Assistant operator	225	4.5
5.	Driver	345	6.9
6.	Mechanic	450	9.0
7.	Electrician	350	7.0
8.	Welder	325	6.5
9.	Carpenter	300	6.0
10.	Concrete worker	275	5.5
11.	Mason	275	5.5
12.	Steel worker	295	5.9
13.	Semi-skilled labour	325	6.5
14.	Common labour	180	3.6
15.	Plumber	225	4.5
16.	Rigger	300	6.0
17.	Blaster	385	7.7
18.	Surveyer	300	6.0
19.	Office incharge	1,000	20.0
20.	Blacksmith	300	6.0

Note : 1) Social charge/duties (Encargos Sociais or Leis Sociais) of 98.65 % was included to the daily wage.

2) Monthly minimum base salary is Cz$ 2,219.92 as of Aug.1987.

3) Working hour of one shift is 8 hours per day. (8:00-12:00 and 14:00-18:00)

4) Overtime work is 20 %, 50 % and 100 % up of base wage for night, midnight and holiday respectively.

5) Exchange rate : 1 US$ = Cz$ 50.0.

Table VIII.3.2 UNIT PRICE FOR CONSTRUCTION MATERIALS

Items	Unit	Basic Unit Price (US$)	Adjusted Unit Price F.C %	F.C US$	L.C %	L.C Cz$
1. Portland cement	t	74	60	44	40	1,500
2. Reinforcing steel bar	t	500	60	300	40	10,000
3. Steel material						
1.) H-shaped steel	t	530	70	511	30	950
2.) Steel plate, t=8 mm	t	302	70	266	30	5,700
3.) Angle	t	500	70	245	30	5,250
4.) Steel sheet pile, 60 kg/m	t	666	70	504	30	10,800
4. Cobble & rubble stone	cu.m	12.0	10	1.2	90	540
5. River run (screened)	cu.m	14.0	10	1.4	90	630
6. Sand	cu.m	5.6	10	0.6	90	250
7. Annealed steel wire	kg	0.8	60	0.5	40	15
8. Gas pipe	m	15.4	60	9.0	40	320
9. Galvanized pipe, 2"	m	8.9	70	6.2	30	135
10. Galvanized pipe, 6"	m	14.6	70	10.2	30	219
11. Timber, plank	m	260.0	20	52.0	80	10,400
12. Plywood, resinous, t=12 mm	sq.m	8.0	20	1.6	80	320
13. Plywood, waterproof, t=10 mm	sq.m	5.3	20	1.0	80	215
14. Concrete pipe, 1 m dia.	m	50.0	40	20.0	60	1,500
15. Concrete pipe, 0.5 m dia.	m	9.0	40	3.6	60	270
16. PVC pipe 2"	m	1.17	80	0.9	20	13.5
17. Diesel oil	l	0.23	80	0.2	20	1.5
18. Gasoline	l	0.55	80	0.4	20	7.5
19. Alcohol	l	0.41	50	0.2	50	10.5
20. Engine oil	l	3.74	100	3.7	0	-
21. Grease	kg	3.60	100	3.6	0	-
22. Oxygen gas(6.6 cu.m)	cyl.	23.00	70	16.1	30	345
23. Acetylone gas (5.0 cu.m)	cyl.	23.50	50	11.7	50	590
24. Dynamite	kg	1.1	30	0.3	70	40
25. Detonator	pc.	0.14	30	0.04	70	5
26. Electric power	kwh.	0.08	20	0.016	80	3.2
27. Brick, 1000 pcs.	pcs.	46	0	-	100	2,300
28. Asphalt	kg	0.12	10	0.012	90	5.4
29. R.C pile, pre-mould						
1.) ø=200 mm, 20t	m	11.8	60	7.1	40	235
2.) ø=250 mm, 30t	m	18.4	60	11.0	40	370
3.) ø=300 mm, 50t	m	22.4	60	13.4	40	450
4.) ø=400 mm, 70t	m	26.2	60	15.7	40	525
30. Ready mixed concrete						
1.) 135 kg/sq.cm	cu.m	79.0	60	47.4	40	1,580
2.) 150 kg/sq.cm	cu.m	79.8	60	47.9	40	1,595
3.) 180 kg/sq.cm	cu.m	82.8	60	50.0	40	1,640
4.) 200 kg/sq.cm	cu.m	85.2	60	51.1	40	1,710
31. Steel pipe pile						
1.) ø=500 mm	t	650	70	455	30	9,750
2.) ø=600 mm	t	700	70	490	30	10,500
3.) ø=700 mm	t	765	70	535	30	11,500
32. Nail	kg	0.68	70	0.5	30	9
33. Crusher run	cu.m	8.80	70	6.2	30	130
34. Plywood, waterproof, t=12 mm	sq.m	6.10	20	1.2	80	245
35. Pine slate, 3a, 2.5x7.0 cm	m	0.42	20	0.1	80	16
36. Concrete block, 6.3x19.0x39.0 cm	pc.	0.28	30	0.1	70	9
37. Concrete block, 14.0x19.0x39.0 cm	pc.	0.37	30	0.1	70	13.5
38. Concrete block, 19.0x19.0x39.0 cm	pc.	0.44	30	0.1	70	17
39. Galvanized wire	kg	0.80	70	0.5	30	15
40. P.V.C water stop	m	12.0	100	12.0	0	-
41. Metal form, 300x1,500	pc.	15.0	70	10.5	30	225

Note : Exchange rate ; 1 US$ = Cz$ 50.0.

Table VIII.3.3 HOURLY EQUIPMENT COST

No.	Descriptions		Purchase Cost (US$)	Life Year	Life Hour (hrs./y)	Depreciation Cost (US$)	Management /1 Cost (Cz$/hr.)	Maintenane & Repair Cost /2 Total Ratio (%)	Maintenane & Repair Cost /2 Total Equiv. (US$/hr.)	Maintenane & Repair Cost /2 Cost Component F.C /3 (US$/hr.)	Maintenane & Repair Cost /2 Cost Component L.C /3 (Cz$/hr.)	Total Hourly Cost F.C (US$)	Total Hourly Cost L.C (Cz$)
			(a)	(b)	(c)	(d)= (a)x0.9/(b)x(c)	(e)= (a)x7%/(c)	(f)	(g)= (a)x(f)/(b)x(c)	(h)= (g)x70%	(i)= (g)x30%	(j)= (d)+(h)	(k)= (e)+(i)
1.	Dredger	650 PS	1,500,000	7	4,000	48.21	1,312.50	70	37.50	26.25	562.50	74.46	1,875.00
2.	Anchor barge		100,000	14	1,600	4.02	218.75	100	4.46	3.13	66.96	7.14	285.71
3.	Swamp bulldozer	18 t	120,000	6	900	20.00	466.67	80	17.78	12.44	266.67	32.44	733.33
4.	Swamp bulldozer	20 t	130,000	6	900	21.67	505.56	80	19.26	13.48	288.89	35.15	794.44
5.	- do -	13 t	90,000	6	900	15.00	350.00	70	11.67	8.17	175.00	23.17	525.00
6.	Bulldozer w/ripper	20 t	160,000	6	900	26.67	622.22	70	20.74	14.52	311.11	41.19	933.33
7.	- do -	11 t	79,000	6	900	13.17	307.22	70	10.24	7.17	153.61	20.34	460.83
8.	Crawler loader	1.5 cu.m	100,000	6	750	20.00	466.67	55	12.22	8.56	183.33	28.56	650.00
9.	Backhoe	0.6 cu.m	100,000	5	1,200	15.00	291.67	60	10.00	7.00	150.00	22.00	441.67
10.	Dragline	0.6 cu.m	150,000	7	850	22.69	617.65	60	15.13	10.59	226.89	33.28	844.54
11.	Clamshell attachment	0.6 cu.m	20,000										
12.	Dump truck	10 t	53,000	4	1,550	7.69	119.68	60	5.13	3.59	76.94	11.28	196.61
13.	- do -	8 t	37,000	4	1,400	5.95	92.50	60	3.96	2.78	59.46	8.72	151.96
14.	Diesel pile hammer with base machine	3.5 t	307,000	5	800	69.08	1,343.13	60	46.05	32.24	690.75	101.31	2,033.88
15.	Vibration hammer	22 kw	30,000	4	900	7.50	116.67	60	5.00	3.50	75.00	11.00	191.67
16.	Crawler crane	30 t	226,000	6	900	37.67	878.89	50	20.93	14.65	313.89	52.31	1,192.78
17.	Truck crane	10 t	87,000	7	1,100	10.17	276.82	40	4.52	3.16	67.79	13.33	344.61
18.	Concrete pump car	30 cu.m/h	100,000	4	750	30.00	466.67	70	23.33	16.33	350.00	46.33	816.67
19.	Tire roller	20 t	50,000	7	600	10.71	291.67	50	5.95	4.17	89.29	14.88	380.95
20.	Vibration roller	5 t	31,000	5	750	7.44	144.67	45	3.72	2.60	55.80	10.04	200.47
21.	Road roller	8 t	40,000	7	1,400	3.67	100.00	50	2.04	1.43	30.61	5.10	130.61
22.	Water tanker	8 kl	45,000	7	1,400	4.13	112.50	50	2.30	1.61	34.44	5.74	146.94
23.	Fuel tanker	8 kl	46,000	7	1,400	4.22	115.00	50	2.35	1.64	35.20	5.87	150.20
24.	Grease car	8 t	90,000		1,400		225.00						225.00
25.	Moter grader	3.7 m	89,500	6	850	15.79	368.53	50	8.77	6.14	131.62	21.94	500.15
26.	Asphalt distributer	3,000 l	41,000	6	950	6.47	151.05	50	3.60	2.52	53.95	8.99	205.00
27.	Asphalt finisher	2.4 m	96,000	7	550	22.44	610.91	50	12.47	8.73	187.01	31.17	797.92
28.	Ordianry truck w/crane	6 t	46,000	4	1,250	8.28	128.80	60	5.52	3.86	82.80	12.14	211.60
29.	Diesel generator	80kva	22,000	6	900	3.67	85.56	45	1.83	1.28	27.50	4.95	113.06
30.	Diesel generator	20kva	12,000	6	1,500	1.20	28.00	45	0.60	0.42	9.00	1.62	37.00
31.	Micro bus	30 persons	18,000	5	700	4.63	90.00	55	2.83	1.98	42.43	6.61	132.43

Note :

/1 Yearly management cost of 7% is applied by local currency component.The management cost comprises the insurance,tax,interest and other expenses for equipment management.

/2 The ratio of maintenance and repair cost against the CIF site delivery cost are decided refering to the values stipulated in the data book for const. equipment, ministry of construction, Japan.

/3 F.C. portion of 70% & L.C. portion of 30% are applied.

/4 Salvage value of 10% is applied.

/5 Exchange rate; 1 US$ = Cz$ 50.0

Table VIII.3.4 DETAIL OF CONSTRUCTION COST (1/4)

Item No.	Work		Unit	Quantity	Foreign Currency (US$) Unit Price	Foreign Currency (US$) Amount	Local Currency (Cz$) Unit Price	Local Currency (Cz$) Amount	Equiv.US$
I.	**Preparatory works**								
I.1	Access and construction road		-	L.S	-	300,000	-	10,000,000	
I.2	Temporary building		-	L.S	-	150,000	-	15,000,000	
I.3	Power supply system		-	L.S	-	20,000	-	300,000	
I.4	Water supply system		-	L.S	-	15,000	-	200,000	
I.5	Communication system		-	L.S	-	5,000	-	150,000	
I.6	Fuel supply system		-	L.S	-	15,000	-	200,000	
	Sub-total of I					505,000		25,850,000	1,022,000
II.	**River improvement works**								
	Itajai river								
II.1	Channel excavation								
II.1.1	Dredging & direct discharge	L< 1,000 m	cu.m	1,707,700	1.0	1,707,700	25.0	42,692,500	
II.1.2	Dredging & transportation	L< 5,000 m	cu.m	378,300	3.0	1,134,900	100.0	37,830,000	
II.1.3	Exca. & transport. common	L< 1,000 m	cu.m	773,130	2.1	1,623,573	70.0	54,119,100	
II.1.4	Exca. & transport. common	L< 5,000 m	cu.m	1,082,800	2.7	2,923,560	90.0	97,452,000	
II.1.5	Exca. & transport. common	L<10,000 m	cu.m	272,800	3.6	982,080	120.0	32,736,000	
II.1.6	Exca. & transport. rock	L< 1,000 m	cu.m	13,000	24.0	312,000	800.0	10,400,000	
II.2	Levee embankment		cu.m	127,000	4.5	571,500	150.0	19,050,000	
II.3	Concrete parapet								
II.3.1	Exca. & transport. common	L< 2,000 m	cu.m	710	2.4	1,704	80.0	56,800	
II.3.2	Concrete		cu.m	880	72.0	63,360	2,400.0	2,112,000	
II.3.3	Steel sheetpile Type II		t	174	500.0	87,000	8,300.0	1,444,200	
II.3.4	Backfill		cu.m	40	0.9	36	30.0	1,200	
II.3.5	Revetment, concrete block		sq.m	1,070	10.0	10,700	500.0	535,000	
II.3.6	Revetment, gabion		sq.m	600	2.5	1,500	125.0	75,000	
II.4	Revetment, gabion		sq.m	1,680	2.5	4,200	125.0	210,000	
II.5	Sodding		sq.m	666,000	0.3	199,800	25.0	16,650,000	
II.6	Relocation road		m	1,500	48.0	72,000	1,600.0	2,400,000	
	Flood diversin channel with bridge								
II.7	Exca. & transport. , common	L< 1,000 m	cu.m	1,470,000	2.1	3,087,000	70.0	102,900,000	
II.8	Revetment, gabion		sq.m	1,680	2.5	4,200	125.0	210,000	
II.9	New road along F.D. channel, w = 4.0 m		m	3,850	18.0	69,300	600.0	2,310,000	
II.10	Bridge at F.D.channel with approach								
II.10.1	Excavation, common		cu.m	1,400	1.5	2,100	50.0	70,000	
II.10.2	Concrete		cu.m	885	72.0	63,720	2,400.0	2,124,000	
II.10.3	Re-bar		t	84	350.0	29,400	7,500.0	630,000	
II.10.4	R.C. pile 400x400		lin.m	720	16.0	11,520	500.0	360,000	
II.10.5	Backfill		cu.m	1,120	0.9	1,008	30.0	33,600	
II.10.6	P.C. cable 12-17 ø mm		t	19	3,000.0	57,000	0.0	0	
II.10.7	Pavement		sq.m	750	3.6	2,700	120.0	90,000	
II.10.8	Approach road		-	L.S.	-	12,000	-	400,000	

Note : Exchange rate; 1 US$ = Cz$ 50.0

Table VIII.3.4 DETAIL OF CONSTRUCTION COST (2/4)

Item No.	Work		Unit	Quantity	Foreign Currency (US$) Unit Price	Foreign Currency (US$) Amount	Local Currency (Cz$) Unit Price	Local Currency (Cz$) Amount	Equiv.US$
	Tributaries								
II.11	Exca. & transport. common	L< 5,000 m	cu.m	54,400	2.7	146,880	90.0	4,896,000	
II.12	Levee embankment		cu.m	147,400	5.1	751,740	170.0	25,058,000	
II.13	Filling-up, locally low bank		cu.m	290,000	3.6	1,044,000	120.0	34,800,000	
II.14	Concrete parapet								
II.14.1	Excavation, common		cu.m	420	2.4	1,008	80.0	33,600	
II.14.2	Concrete		cu.m	700	72.0	50,400	2,400.0	1,680,000	
II.14.3	Steel sheetpile Type II		t	120	500.0	60,000	8,300.0	996,000	
II.14.4	Backfill		cu.m	80	0.9	72	30.0	2,400	
II.14.5	R.C. pile ø 300 mm , l=3.5 m		nos.	116	72.0	8,352	2,400.0	278,400	
II.14.6	Revetment, gabion		sq.m	11,530	2.5	28,825	125.0	1,441,250	
								(Including Velha)	
II.15	Sluice, Itoupava								
II.15.1	Excavation, common		cu.m	172	1.5	258	50.0	8,600	
II.15.2	Concrete		cu.m	190	72.0	13,680	2,400.0	456,000	
II.15.3	R.C. pile ø 200 mm , l=3 m		nos.	94	42.0	3,948	1,350.0	126,900	
II.15.4	Revetment, concrete block		sq.m	570	10.0	5,700	500.0	285,000	
II.15.5	Revetment, gabion		sq.m	140	2.5	350	125.0	17,500	
II.16	Sodding		sq.m	94,400	0.3	28,320	25.0	2,360,000	
II.17	Heightening existing bridge								
II.17.1	Ponte da Rua 7 de setembro Heightening : 3.67 m		-	L.S	-	90,000	-	3,000,000	
II.17.2	Ponte da Rua Sau Paulo Heightening : 2.68 m		-	L.S	-	48,000	-	1,600,000	
II.17.3	Ponte da Rua Paraiba Heightening : 4.1 m		-	L.S	-	45,000	-	1,500,000	
II.17.4	Ponte da Rua 7 de setembro Heightening : 3.79 m		-	L.S	-	96,000	-	3,200,000	
II.17.5	Ponte da Rua Mariana Bronnemann Heightening : 3.22 m		-	L.S	-	48,000	-	1,600,000	
II.17.6	Ponte Rua Alberto Stein-Alberto Busnardo Heightening : 4.29 m		-	L.S	-	120,000	-	4,000,000	
II.17.7	Ponte da Rua Gel Aristiliano Ramos Heightening : 1.56 m		-	L.S	-	24,000	-	800,000	
II.17.8	Ponte da Avenida das Comunidades Heightening : 0.94 m		-	L.S	-	24,000	-	800,000	
II.17.9	Ponte da Rodovia Jorge Lacerda Heightening : 1.0 m		-	L.S	-	18,000	-	600,000	
II.17.10	Ponte da Rodovia Gaspar-Brusque Heightening : 1.67 m		-	L.S	-	30,000	-	1,000,000	
II.17.11	Rua Marechal Deodoro Heightening : 1.5 m		-	L.S	-	27,000	-	900,000	
	Sub-total of II					15,749,094		518,331,050	26,115,715

Note : Exchange rate; 1 US$ = Cz$ 50.0

Table VIII.3.4 DETAIL OF CONSTRUCTION COST (3/4)

Item No.	Work	Unit	Quantity	Foreign Currency (US$) Unit Price	Foreign Currency (US$) Amount	Local Currency (Cz$) Unit Price	Local Currency (Cz$) Amount	Equiv.US$
III.	Urban drainage works							
III.1	Regulating ponds							
III.1.1	Excavation, common	cu.m	470,000	1.5	705,000	50.0	23,500,000	
III.1.2	Embankment	cu.m	488,000	4.2	2,049,600	140.0	68,320,000	
III.1.3	Sodding	sq.m	304,000	0.3	91,200	25.0	7,600,000	
III.2	Inverted syphon, 3 places							
III.2.1	Excavation, common	cu.m	75,300	1.5	112,950	50.0	3,765,000	
III.2.2	Concrete	cu.m	1,880	72.0	135,360	2,400.0	4,512,000	
III.2.3	R.C. pile ø 350 mm, l=5 m	nos.	360	72.0	25,920	2,400.0	864,000	
III.2.4	Revetment , concrete block	sq.m	3,330	10.0	33,300	500.0	1,665,000	
III.2.5	River bed protection, gabion	sq.m	920	2.5	2,300	125.0	115,000	
III.2.6	Backfill	cu.m	71,650	0.9	64,485	30.0	2,149,500	
III.3	Connecting pipe the ponds, 2 place							
III.3.1	Excavation, common	cu.m	53,570	1.5	80,355	50.0	2,678,500	
III.3.2	Concrete	cu.m	1,260	72.0	90,720	2,400.0	3,024,000	
III.3.3	R.C. pile ø 350 mm, l=5 m	nos.	246	72.0	17,712	2,400.0	590,400	
III.3.4	Revetment , concrete block	sq.m	1,080	10.0	10,800	500.0	540,000	
III.3.5	River bed protection, gabion	sq.m	260	2.5	650	125.0	32,500	
III.3.6	Backfill	cu.m	51,040	0.9	45,936	30.0	1,531,200	
III.3.7	Flap gate	t	1	2,400.0	2,400	30,000.0	30,000	
III.4	Drainage pipe, 3 places							
III.4.1	Excavation, common	cu.m	24,050	1.5	36,075	50.0	1,202,500	
III.4.2	Concrete	cu.m	1,570	72.0	113,040	2,400.0	3,768,000	
III.4.3	R.C. pile ø 350 mm, l=5 m	nos.	264	72.0	19,008	2,400.0	633,600	
III.4.4	Revetment , concrete block	sq.m	4,880	10.0	48,800	500.0	2,440,000	
III.4.5	River bed protection, gabion	sq.m	600	2.5	1,500	125.0	75,000	
III.4.6	Steel sheetpile, Type II	t	10	500.0	5,000	8,300.0	83,000	
III.4.7	Backfill	cu.m	21,040	0.9	18,936	30.0	631,200	
III.4.8	Flap gate	t	1	2,400.0	2,400	30,000.0	30,000	
III.5	T-wall, reversed, 1 place							
III.5.1	Excavation, common	cu.m	76,800	1.5	115,200	50.0	3,840,000	
III.5.2	Concrete	cu.m	4,800	72.0	345,600	2,400.0	11,520,000	
III.5.3	Steel pipe pile ø 500 mm, l=5 m	nos.	500	400.0	200,000	10,000.0	5,000,000	
III.5.4	Backfill	cu.m	74,370	0.9	66,933	30.0	2,231,100	
III.6	Pumping station							
	(Civil works)							
III.6.1	Excavation, common	cu.m	61,310	1.5	91,965	50.0	3,065,500	
III.6.2	Concrete	cu.m	4,610	72.0	331,920	2,400.0	11,064,000	
III.6.3	R.C. pile ø 400 mm, l=5 m	nos.	285	80.0	22,800	2,500.0	712,500	
III.6.4	R.C. pile ø 350 mm, l=5 m	nos.	335	72.0	24,120	2,400.0	804,000	
III.6.5	Steel sheetpile, Type II	t	35	500.0	17,500	8,300.0	290,500	
III.6.6	Revetment , concrete block	sq.m	3,860	10.0	38,600	500.0	1,930,000	
III.6.7	River bed protection, gabion	sq.m	600	2.5	1,500	125.0	75,000	
III.6.8	Backfill	cu.m	43,710	0.9	39,339	30.0	1,311,300	
	(Electro-mechanical works)							
III.6.9	Pump, vertical mixed flow ø 1,350 mm, H=9.5 m (Q=7.8 cm/s)	set	3	-	360,000	-	9,000,000	
III.6.10	Pump, hoprizontal mixed flow ø 1,000 mm, H=5.8 m (Q=4.0 cm/s)	set	2	-	150,000	-	4,000,000	
III.6.11	Pump, hoprizontal mixed flow ø 600 mm, H=5.0 m (Q=1.0 cm/s)	set	2	-	60,000	-	2,000,000	
III.6.12	Submersible pump ø 500 mm, H=8.9 m (Q=0.7 cm/s)	set	2	-	50,000	-	1,000,000	
III.6.13	Submersible pump ø 500 mm, H=7.6 m (Q=0.7 cm/s)	set	2	-	50,000	-	1,000,000	
III.6.14	Flap gate	t	3	2,400.0	7,200	30,000.0	90,000	
III.6.15	Screen, 200 kg/sq.m	t	46.6	1,500.0	69,900	25,000.0	1,165,000	
III.6.16	Overhead crane, 16 t	set	1	-	70,000	-	2,000,000	
III.6.17	Overhead crane, 10 t	set	1	-	40,000	-	1,500,000	
III.6.18	Electric mottors	lot	1	-	200,000	-	2,105,000	

Note : Exchange rate; 1 US$ = Cz$ 50.0

Table VIII.3.4 DETAIL OF CONSTRUCTION COST (4/4)

Item No.	Work	Unit	Quantity	Foreign Currency (US$) Unit Price	Foreign Currency (US$) Amount	Local Currency (Cz$) Unit Price	Local Currency (Cz$) Amount	Equiv.US$
	(Building work)							
III.6.19	Building for G-1 pump station	sq.m	330	120.0	39,600	9,000.0	2,970,000	
III.6.20	Building for V-1&5 pump station	sq.m	42	120.0	5,040	9,000.0	378,000	
III.6.21	Building for V-2&6 pump station	sq.m	42	120.0	5,040	9,000.0	378,000	
III.6.22	Building for V-3&4 pump station	sq.m	56	120.0	6,720	9,000.0	504,000	
III.6.23	Building for R-11 pump station	sq.m	175	120.0	21,000	9,000.0	1,575,000	
III.7	New water channel							
III.7.1	Excavation, common	cu.m	220,000	1.5	330,000	50.0	11,000,000	
III.7.2	Concrete	cu.m	23,600	72.0	1,699,200	2,400.0	55,200,000	
III.7.3	Backfill	cu.m	175,700	0.9	158,130	30.0	5,271,000	
III.8	Water gate							
III.8.1	Excavation, common	cu.m	4,510	1.5	6,765	50.0	225,500	
III.8.2	R.C pile, ø 350 mm, l=5 m	nos	91	72.0	6,552	2,400.0	218,400	
III.8.3	Steel sheetpile, Type II	t	29	500.0	14,500	8,300.0	240,700	
III.8.4	Concrete	cu.m	1,330	72.0	95,760	2,400.0	3,192,000	
III.8.5	Revetment, concrete block	sq.m	385	10.0	3,850	500.0	192,500	
III.8.6	River bed protection, gabion	sq.m	236	2.5	590	125.0	29,500	
III.8.7	Flap gate	t	1.2	2,400.0	2,880	30,000.0	36,000	
	Sub-total of III				8,461,651		276,894,900	13,999,549
	Total (I + II + III)				24,715,745 (24,720,000)		821,075,950 (821,000,000)	41,137,264 (41,140,000)

Note : Exchange rate; 1 US$ = Cz$ 50.0

Table VIII.3.5 SUMMARY OF DIRECT CONSTRUCTION COST

Item No.	Work	Unit	Quantity	Foreign Currency (US$) Unit Price	Foreign Currency (US$) Amount	Local Currency (Cz$) Unit Price	Local Currency (Cz$) Amount	Equiv. US$
I	Preparatory works			-	505,000	-	25,850,000	1,022,000
II	River improvement							
	- Itajai river improvement			-	9,695,613	-	317,763,800	16,050,889
	- Flood diversion channel with bridge			-	3,339,948	-	109,127,600	5,522,500
	- Tributaries' improvement			-	2,713,533	-	91,439,650	4,542,326
	Sub-total of II			-	15,749,094	-	518,331,050	26,115,715
III	Urban drainage works			-	8,461,651	-	276,894,900	13,999,549
	Total				24,715,745 (24,720,000)		821,075,950 (821,000,000)	41,137,264 (41,140,000)

Note : Exchange rate ; 1 US$ = Cz$ 50.0

Table VIII.3.6 SUMMARY OF INDIRECT COST

Item No.	Work	Unit	Quantity	Foreign Currency (US$) Unit Price	Foreign Currency (US$) Amount	Local Currency (Cz$) Unit Price	Local Currency (Cz$) Amount	Equiv. US$
1.	Land acquisition & house compensation cost							
1.1	Land acquisition, farm land	sq.m	947,800	-	-	30.0	28,434,000	
1.2	Land acquisition, residential area along the Itajai river	sq.m	86,400	-	-	50.0	4,320,000	
1.3	Land acquisition, residential area along the tributaries	sq.m	29,900	-	-	80.0	2,392,000	
1.4	House evacuation along the Itajai river	Nos.	295	-	-	490,000	144,550,000	
1.5	House evacuation along the tributaries	Nos.	84	-	-	630,000	52,920,000	
	Sub-total						232,616,000 (233,000,000)	4,652,320 (4,660,000)
2.	Administration cost (5% of total direct cost)	-	-	-	-	-	102,850,000	2,057,000
3.	Engineering service cost (9% of total direct cost)	-	-	-	2,962,080	-	37,026,000	3,704,000
	Total				2,962,080		372,876,000	10,419,600

Note : Exchange rate ; 1 US$ = Cz$ 50.0

Table VIII.3.7 SUMMARAY OF FINANCIAL COST

Cost Items	Foreign Currency (Thousand US$)	Local Currency (Thousand Cz$)	Total Equivalent (Thousand US$)
1. Direct cost	24,720	821,000	41,140
2. Land acquisition and compensation cost	-	233,000	4,660
3. Administration cost	-	102,850	2,057
4. Engineering service cost	2,962	37,026	3,704
5. Contingency			
Price contingency	2,940	264,500	8,230
Physical contingency	3,062	122,540	5,513
Total	33,684	1,581,000	65,304

Note : Exchange rate ; 1 US$ = Cz$ 50.0

Table VIII.3.8 DISBURSEMENT SCHEDULE

	1st. Year		2nd. Year		3rd. Year		4th. Year		Total	
	F.C (US$)	L.C (Cz$)	F.C (US$)	L.C (Cz$)	F.C (US$)	L.C (Cz$)	F.C (US$)	L.C (Cz$)	F.C (US$)	L.C (Cz$)
A. Direct cost										
A.1 Annual allocation	∠1 9,888,000	∠1 328,400,000	∠2 4,944,000	∠2 164,200,000	∠2 4,944,000	∠2 164,200,000	∠2 4,944,000	∠2 164,200,000	24,720,000	821,000,000
A.2 Price contingency (F.C=5%,L.C=12%)	∠3 247,200	∠3 19,704,000	494,400	41,050,000	791,040	65,680,000	1,087,680	93,594,000	2,620,320	220,028,000
A.3 Physical contingency (F.C=10%,L.C=10%)	1,013,520	34,810,400	543,840	20,525,000	573,504	22,988,000	603,168	25,779,400	2,734,032	104,102,800
Sub-total	11,148,720	382,914,400	5,982,240	225,775,000	6,308,544	252,868,000	6,634,848	283,573,400	30,074,352	1,145,130,800
B. Land acquisition & compensation cost ∠4	-	233,000,000	-	-	-	-	-	-	-	233,000,000
C. Administration cost										
C.1 Annual allocation	-	25,712,500	-	25,712,500	-	25,712,500	-	25,712,500	-	102,850,000
C.2 Price contingency (L.C=12%)	-	3,085,500	-	6,428,125	-	10,285,000	-	14,656,125	-	34,454,750
C.3 Physical contingency (L.C=10%)	-	2,879,800	-	3,214,063	-	3,599,750	-	4,036,863	-	13,730,476
Sub-total	-	31,677,800	-	35,354,688	-	39,597,250	-	44,405,488	-	151,035,226
D. Engineering service cost										
D.1 Annual allocation	∠5 1,406,988	∠5 17,587,350	518,364	6,479,550	518,364	6,479,550	518,364	6,479,550	2,962,080	37,026,000
D.2 Price contingency (F.C=5%,L.C=12%)	70,350	2,110,482	51,836	1,619,888	82,938	2,591,820	114,040	3,693,344	319,164	10,015,534
D.3 Physical contingency (F.C=10%,L.C=10%)	147,734	1,969,783	57,020	809,944	60,130	907,137	63,240	1,017,289	328,124	4,704,153
Sub-total	1,625,072	21,667,615	627,220	8,909,382	661,432	9,978,507	695,644	11,190,183	3,609,368	51,745,687
Total annual disbursement cost	12,773,792	669,259,815	6,609,460	270,039,070	6,969,976	302,443,757	7,330,492	339,169,071	33,683,720 (33,684,000)	1,580,911,713 (1,581,000,000)

Note : ∠1 Advance payment (20%) + Progress payment
∠2 Progress payment
∠3 Excluding advance payment of 20%
∠4 Land acquisition cost is assumed to disburse in 1st. year.
∠5 The cost for detailed design is included (30 % of total).
∠6 Exchange rate ; 1 US$ = Cz$ 50.0

Figures

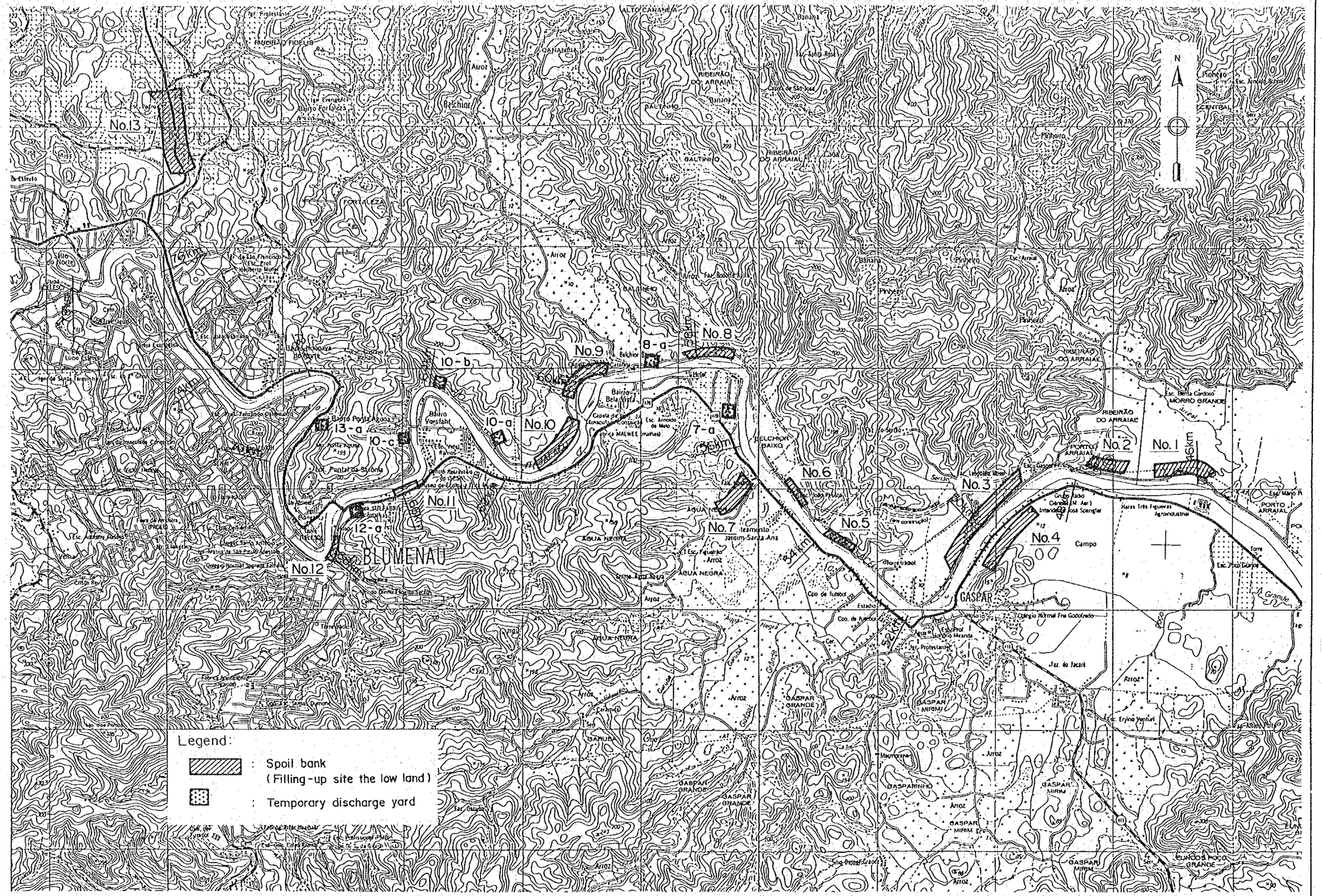


Fig.VIII.2.1 LAYOUT OF SPOIL BANK (FILLING-UP THE LOW LAND BY THE EXCAVATED MATERIAL)

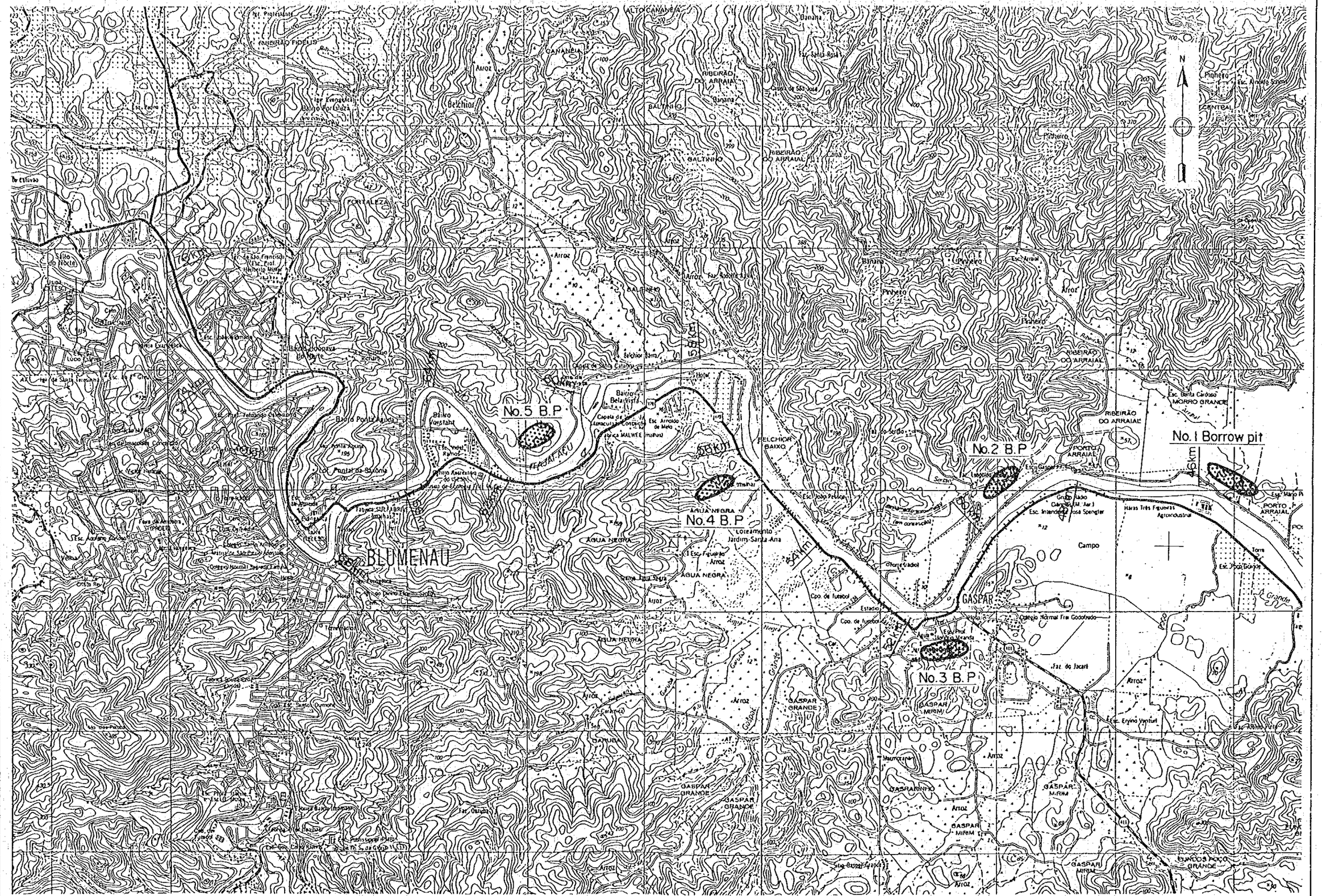


Fig.VIII.2.2 LOCATION OF BORROW AREA

Fig.VIII.2.3 CONSTRUCTION TIME SCHEDULE

CONSTRUCTION ITEMS	UNIT	QUANTITY
I. Prepareatory works		
II. River improvement works		
Itajai river		
1. Dredging, channel	Cu·m	2,100,000
2. Excavation, channel	Cu·m	2,200,000
3. Levee embankment	Cu·m	130,000
4. Concrete parapet, 2 sites	m	620
5. Sodding	Sq·m	666,000
6. Flood diversion channel	m	2,550
7. Bridge, L = 100m, W = 9m	Set	1
8. New road, W = 4m	m	3,850
9. Relocation road, W = 4m	m	1,500
Tributaries		
10. Channel excavation	Cu·m	55,000
11. Levee embankment	Cu·m	150,000
12. Filling-up, low bank	Cu·m	290,000
13. Concrete parapet, 2 sites	m	290
14. Sodding	Sq·m	95,000
15. Sluice	Site	2
16. Revetment	Sq·m	710
17. Heightening of existing bridges	Site	11
III. Urban drainage Works		
1. Regulating pond	Place	10
2. Inverted syphon	Place	3
3. Connecting pipe the ponds	Place	2
4. Drainage pipe	Place	3
5. T-wall, reversed	Place	1
6. Pumping station		
1) Civil work	Lot	1
2) Hydro-mechanical Work	Lot	1
3) Building Work	Lot	1
7. Revetment	Sq·m	13,540