- Syphon (Q = 16.0 m^3/s)

L1 = 62 m	,	hp = 13 m	(B = H = 2.9m, Concrete box culvert)
L2 = 225 m	,	hp = 38 m	(D = 3,200 mm concrete pipe)
L3 = 325 m	,	hp = 47 m	(- do -)
L4 = 55 m	,	hp = 7 m	(B = H = 2.9 m, Concrete box culvert)
L5 = 50 m	,	hp = 10 m	(- do -)
L6 = 189 m	,	hp = 20 m	(- do -)

- Tunnel (Q = 16.0 m^3/s)
  L = 10.7 km (I = 1/1,500)
  D = 3.5 m (Standard horse-shoe (2R) section, free flow type)

(3) Poza Honda-Mancha Grande river water transbasin scheme

- Tunnel (Q = 4.0 m^3/s)
  L = 3.9 km
  D = 2.5 m (Standard horse-shoe (2R) section, free flow type)

Based on the results of field investigation and geological tests, location of Severino pumping station and head tank, and routes of open channel, syphons and three (3) tunnels were revised.

3.1.2 Economic slopes of tunnel and open channel

Economic slopes of tunnel and open channel for the water transbasin scheme "Esperanza (Severino) – Poza Honda dam" were studied. Through the cost comparative study, tunnel slope of 1/1,500 and open channel slope of 1/3,000 were judged most economical (See Fig. I.24). Therefore, tunnel slope of 1/1,500 was adopted for other water transbasin schemes; "Daule Peripa – Esperanza" and "Poza Honda – Mancha Grande river" as a economical slope.

3.2 Hydraulic Design

3.2.1 *Basic factors for hydraulic design*

(1) Design discharge and slope

In the former part of the Phase II Study, more detailed water balance study was made and the design discharges of the both water transbasin schemes below were determined.

a)	Esperanza dam (Severino) - Poza Honda Water transbasin scheme	16.0 m^3/s
b)	Poza Honda - Mancha Grande River Water transbasin scheme	4.0 m^3/s
c)	Daule Peripa - Esperanza Water transbasin scheme	18 m^3/s

Design slopes of the open channel and tunnel were determined in the economic view point mentioned previously.

- Open channel I = 1/3,000
- Tunnel I = 1/1,500

(2) Flow formula

The Manning formula was used for hydraulic calculation of the flow for the water transbasin schemes.

$$Q = A\,V = A\,\frac{1}{n}\,R^{2/3}\,I^{1/2}$$

Where,
- Q = design discharge (m^3/s)
- A = flow area (m^2)
- V = mean flow velocity (m/s)
- h = roughness coefficient
  concrete : 0.015, steel : 0.012
- R = hydraulic radius (m)
- I = hydraulic gradient

(3) Allowable flow velocities

Minimum allowable velocity

Minimum allowable velocity is generally determined not to produce sand deposit and water weeds.

- Open channel .... 0.5 - 0.9 m/s
- Syphon .... more than 1.5 times of the velocity in open channel
- Tunnel .... more than 1.3 times of the velocity in open channel

Maximum allowable velocity

Maximum allowable velocity is experimentally determined depending upon the applicable different types of materials used for the water transbasin scheme.

- Thin concrete (approx. 10 cm)....................... 1.5 m/s
- Thick concrete (approx. 18 cm)....................... 3.0 m/s
- Precast concrete pipe .... 2.5 m/s
- Steel pipe .... 5.0 m/s

3.2.2 Hydraulic cross section

(1) Tunnel

Standard horse-shoe type (2r) is normally adopted for free flow type. Radius of tunnel can be calculated by the following formula, which is transformed from the Manning formula.

$$r = \left(\frac{Qn}{I^{1/2}\ ab^{2/3}}\right)^{3/8}$$

Where, r = radius of tunnel (m)
a = coefficient for calculation of cross sectional flow area
b = coefficient for calculation of hydraulic radius

Design water depth in tunnel is generally determined as follows:

h = 0.8 D

Where, h = design water depth (m)
D = diameter of tunnel (m)

Minimum diameter of tunnel is to be 2.5 m in view of construction and maintenance.

(2) Open channel

Trapezoidal type of open channel with a side slope of 1 to 1.5 was adopted. B/h ratio was determined at 1.0 taking into account the suitable hydraulic characteristic and topographic condition in hilly area. Free board is to be 0.3 m for the design discharge of 16.0 m^3/s.

(3) Transitions

Transitions classified into the following two (2) types are required to minimize head losses due to change in flow section among the head tank, open channel, syphon and tunnel.

Open transition (O.T.)

Required length of open transition between open channel and syphon, and between open channel and tunnel can be calculated by the following equation:

$$L = \frac{B - b}{2} \cot \theta$$

Where, L : required length of open transition (m)
B : water surface width in open channel (m)
b : water surface width in closed transition (m)
θ : angle of contraction (generally less than 10°)

20 m in length of open transition was designed based on the equation above in the basic design stage.

Closed transition (C.T.)

In case of horseshoe section, the length of closed transition is determined as it approximately equals to the diameter of tunnel. 5 m in length of closed transition was considered in the basic design stage.

3.2.3 Hydraulic calculation

Following head losses shall be considered in principle. Other head losses due to transhrack, pier and etc. were considered neglectible in this study.

(1) Head loss due to friction

(2) Head loss due to inflow or outflow

(3) Head loss due to change of canal section

The head loss due to channel curve is generally neglected. The change of the water level is expressed using the Bernoullis' formula as follows:

$$dh = Z_1 - Z_2 = \Sigma h_i + \left(\frac{V^2{}_2}{2g} - \frac{V^2{}_1}{2g}\right)$$

Where,

Σh_i	:	Total head loss (m)
V_1	:	Velocity in the upstream section (m/s)
V_2	:	Velocity in the downstream section (m/s)
Z_1	:	Water level in the upstream section (m)
Z_2	:	Water level the downstream section (m)
dh	:	Difference in water level between the upstream and downstream sections (m)

If the channel sections are nearly uniform or change gradually and continuously in a certain distance, the head loss can be considered to be only friction one. In this case the fall in the water surface due to friction will be equal to the channel bed slope.

(1) Head loss due to friction

The calculation of head loss due to friction is made using the Manning formula as shown below:

$$hf = \frac{Q^2 L}{2} \quad \frac{n_1^2}{R_1^{4/3} A_1^2} + \frac{n_2^2}{R_2^{4/3} A_2^2} = \frac{1}{2} \quad (\frac{n_1^2 V_1^2}{R_1^{4/3}} + \frac{n_2^2 V_2^2}{R_2^{4/3}}) \ L$$

Where,

Q	:	Discharge (m^3/s)
hf	:	Head loss due to friction (m)
R	:	Hydraulic radius (m)
V	:	Mean velocity (m/s)
A	:	Cross section area of flow (m^2)
L	:	Distance calculated (m)
n	:	Coefficient roughness

Numbers attached to R, A, n, V denote the Section 1 and 2 respectively.

(2) Head loss due to inflow or outflow and change of water level

(a) Inflow

The head loss and change of water level due to inflow are generally calculated by the following formula in case of hydrostatic surface in which the velocity of inflow cannot be neglected.

$$h_{en} = f_e \frac{V^2}{2g}$$

$$dh_{en} = h_{en} + \frac{V^2}{2g}$$

Where,

h_{en}	:	Head loss due to inflow (m)
dh_{en}	:	Change of water level (m)
V	:	Mean velocity after inflow (m/s)
g	:	Acceleration of gravity (m/s^2)
f_e	:	Coefficient of head loss due to inflow

Head loss and change of water levels due to outflow are generally calculated as follows:

$$h_{ou} = f_o \frac{V^2}{2g}$$

$$dh_{ou} = h_{ou} + \frac{V^2}{2g}$$

Where,

h_{ou}	:	Head loss due to outflow (m)
dh_{ou}	:	Change of water level (m)
V	:	Mean velocity before outflow (m/s)
g	:	Acceleration of gravity (m/s^2)
f_o	:	Coefficient of head loss due to outflow which is generally taken to be 1.0 considering that all velocity energies in the channel are lost

Head loss and change of water levels due to inflow and outflow between open channel and syphon was considered at 10% of friction loss in the basic design stage. Head loss and change of water levels for others were judged neglectible.

(3) Head loss and change of water level due to change of channel section

Head loss and change of water level due to change of the channel section are generally calculated as follows:

(a) Gradual contraction

$$h_{gc} = h_c + h_f = f_{gc}\left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g}\right) + I_m L$$

$$dh_{gc} = h_{gc} + \left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g}\right)$$

Where,

h_{gc}	:	Head loss due to gradual contraction (m)
h_c	:	Head loss due to gradual contraction of transition (m)
h_f	:	Head loss due to friction in transition (m)
dh_{gc}	:	Change of water level (m)
V_1	:	Mean velocity before gradual contraction (m/s)
V_2	:	Mean velocity after gradual contraction (m/s)
g	:	Acceleration of gravity (m/s^2)
I_m	:	Mean hydraulic gradient in length of transition L

$$I_m = \frac{I_1 + I_2}{2}$$

I_1	:	Hydraulic gradient before transition
I_2	:	Hydraulic gradient after transition
L	:	Length of transition
f_{gc}	:	Coefficient of head loss due to gradual contraction

$$L = \frac{B - b}{2} \cot \theta$$

Where,	L	:	Length of an open transition (m)
	B	:	Water surface of an open channel (m)
	b	:	Water surface of a closed transition, culvert or flume (m)
	θ	:	Angle of contraction (°) (generally less than 10°)

The head loss due to gradual contraction normally increases sharply as the angle of transition increases more than 12°30'. In this basic design, around 10° of the angle transition was employed, therefore, the head loss due to gradual contraction was judged neglectible. The results of hydraulic calculation is presented in Table I.9.

3.3 Basic Design

3.3.1 Esperanza dam (Severino) – Poza Honda dam water transbasin scheme

(1) Severino pumping station

Geological condition closed to the pumping station is good. Relatively hard sandstone, class CL - CM outcrops in the backside of the proposed pumping station site can be observed. Although some boulder layer overlies near the riverside, foundation of the structure is easily placed on the fresh rock layer. Uncompressive strength and permeability are 130 kg/cm^2 and 1 x 10^{-5} cm/sec, respectively.

General feature of Severino pumping station is presented below.

Item	Unit	Feature
Total Discharge	m^3/s	16.0
Nos. of Pump Planned	Nos.	5
Nos. of Standby Pump	Nos.	1
Discharge of 1 Pump	m^3/min	192
	m^3/sec	3.2
Length of Pipeline	m	250
Lane	-	2
Diameter of Pipeline	mm	2,100
Total head	m	76
Type of Pump	-	Double Section Volute Type
Ds	mm	1,100
Dd	mm	750
Motor	kw	3,400
	Pole	14
	Voltage	6,400
	Hz	60

Basic design of the water transbasin scheme "Esperanza Dam (Severino) – Poza Honda Dam" is presented in Fig. I.25. Basic design of Severino pumping station, intake scheme and single line diagram for the pumping station are shown in Fig. I.26, I.27 and I.28. Outdoor equipment was planned to locate in the hilly area closed to the pumping station as shown in Fig. I.29 (See Fig. I.25). Electric power for the pumping station will be supplied from the Daule Peripa Dam, which will have a capacity of 130 MW in near future. Route map of the 138 kV transmission line is illustrated in Fig. I.30. Access road with an effective width of 6 m is shown in Fig. I.31.

(2) Open channel and syphon (See Fig. I.32, I.33 and I.34)

Geological type in the open channel formation consist of colluvial decomposed soil (heavily weathered mudstone) and weathered rock layer. As a result of test pitting and geo-surface inspection, this soil layer have approximately 4 m to 5 m in thickness and gradually transferred into weathered rock layer.

General features of engineering properties of the soil obtained from the soil mechanical tests are shown as follows:

(a) The soil is classified into CH and MH (Clay-silt) based on the unified soil classification.

(b) There is a possiblity of expansive soil from the view point of shrinkage and swelling factor in some places. From the results of PVC (Potential Volume Change) factor and swelling test, some countermeasures such as replacing of swelling soil with non swelling soil will be needed.

(c) Weathered rock layer underlying below the clay-silt layer is firm enough for the foundation of the open channel.

(d) The silt and clay are not suitable for embankment material because severe shrinkage are expected. However, weathered rock and tunnel excavation rock are useful for embankment.

(e) Silt and clay show the permeability coefficient of some 1×10^{-6} cm/sec to 1×10^{-7} cm/sec, therefore, no seepage can be expected from the open channel.

(f) As for syphon site, the results of standard penetration test and laboratory test of borehole (B2) were referred. The N-value goes from 7 to 25 in the alluvial layer of 9 m. The permeability is quite high ($k = 3.7 \times 10^{-3}$ cm/sec).

From the results of these above, concrete lining with a fabric mesh for the open channel was designed.

Lining thickness .... 10 cm
Side slope .... 1 : 1.5
Bottom width (B)......................... 2.2 m (B = h; water depth)
Height (H)................................. 2.5 m (0.3 m for free board)

Then, inspection road with an effective width of 3.5 m and side drain were also planned. Besides, the following three (3) types of foundation treatment were considered.

Type I .... Replacement with a selected filter mateiral (15 cm), if weathered rock line is above the open channel formation

Type II........... Replacement with a selected filter material (15 cm) and excavated tunnel fragments (35 cm), if weathered rock line is slightly below the open channel formation, and set of geotextile mat in the base

Type III.......... Replacement with a selected filter mateiral (30 cm) and excavated tunnel fragments (90 cm), if weathered rock line is below the open channel formation, and set of geotextile mat in the base

As for the design of syphons, box culvert in case that water drop height is lower than 20 m, and concrete pipe type in case that the height above is higher than 20 m were adopted in the basic design.

(3) Tunnel

The tunnel with a 3.5 m diameter and 10.7 km length was planned. Tunnel route is located in the mountainous area from 200 m to 400 m in elevation. Rock type is composed of mainly mudstone in the tunnel formation, however, colluvial and weathered mudstone (soil layer) of 10 to 20 m in thickness cover the ground surface in the portal portion. Rock classification and main engineering properties are shown as follows:

Engineering Properties		Portal portion	Inner part of tunnel
Rock type		Colluvial	Sandy mudstone
Rock class		D (soil)	CL (soft rock)
P wave velocity	Vp (km/sec)	1.5	2.1 - 2.3
Unit weight	γ (g/cm^3)	1.7	2.1
Unconfined compressive strength	qu (kgf/cm^2)	10 - 20	60 - 100
Static elastic modulus	Es (kgf/cm^2)	2,000	10,000 - 12,000
Permeability coefficient	k (cm/sec)	1×10^{-3} - 1×10^{-4}	1×10^{-5}

The sandy mudstone shows soft solidity to some extent, but massive and rarely cracked. As a result of rock test, unconfined compressive strength (qu) is relatively small contrary to the appearance of solidity (30 kg/cm^2) in minimum, (60 kg/cm^2) on average. Since this core sample was obtained in the portal portion (overburden 30 m in thickness), the value of qu can be expected to increase in the inner part of the tunnel (assumed to be 150 kg/cm^2). Water flow by tunnel excavation seems to be a little based on the permeability coefficient ($k = 1 \times 10^{-5}$ cm/sec).

From the results above, New Austrian Tunnelling Method (NATM) was considered most suitable for this site. Load header was planned for tunnel excavation. After the excavation, shotcrete with a wiremesh will be worked out. Then, several rockbolts are to be driven. Lastly, concrete lining with a 30 cm thickness for whole stretches and H-steel support for colluvial and weathered rock zone was designed. Besides, three (3) drain holes were planned for water pressure in this stage.

Following four (4) types of the tunnel sections were planned in consideration of the rock conditions in the tunnel (See Fig. I.25).

	Type I	Type II	Type III	Type IV
Section	Inner Part	Inner Part	Inner Part	Portal & Fractured Zone
Rock Condition	Fresh	Soft	A little bit weathered	Colluvial and weathered
Distance (m)	4,500	4,500	1,300	350
Shotcrete (cm)	10	10	15	15
Wire Mesh	ø 3.2 x 100 x 100	ø 3.2 x 100 x 100	ø 3.2 x 100 x 100	ø 3.2 x 100 x 100
Rock bolt	ø 22 x 4^{Nos} x 2^{m} (1.2 m pitch)	ø 22 x 8^{Nos} x 2^{m} (1.2 m pitch)	ø 22 x 8^{Nos} x 2^{m} (1.2 m pitch)	ø 22 x 8^{Nos} x 2^{m} (1.2 m pitch)
Concrete lining (cm)	30 (w/o R. bar)	30 (w/o R. bar)	30 (w/ single R. bar)	30 (w/ double R. bar)
H-steel Support	-	-	H125 @ 1.2^{m}	H125 @ 1.2^{m}
Drain Hole	ø 50 x 3^{Nos} x 1.5^{m}	ø 50 x 3^{Nos} x 1.5^{m}	ø 50 x 3^{Nos} x 1.5^{m}	ø 50 x 3^{Nos} x 1.5^{m}

As for tunnel work adit which is planned mainly due to save a construction time, two(2) tunnels having shapes of circular with a diameter of 4.0 m in upper portion and rectangular with a length of 4.0 m in lower portion were planned. One is located in the outlet portion, which has a length of 500 m and the other is located at about 7.3 km point from the outlet, which has a length of 630 m and is connected from Rio Pata de Pajaro. Type II and type III were adopted for this tunnel work adit.

(4) Tunnel inlet and outlet

There is no special structure in the tunnel inlet portion. Type of structure is gradually changed from the open channel to tunnel in the transit section having a 20 m length.

In the outlet portion, controlled gate due to fluctuation of water level in the Poza Honda reservoir was designed. From the results of reservoir operation study (See Annex - F), the gate was planned to close when the reservoir water level is higher than EL. 102.50 m (See Fig. I.35).

3.3.2 Poza Honda - Mancha Grande river water transbasin scheme

(1) Tunnel

The tunnel with a 2.5 m in diameter and 3.9 km in length was planned. Tunnel route is located in the steep mountainous area from 200 m to 400 m in elevation, however, topographic condition around the portal portion (both inlet and outlet) shows gentle slope where the colluvial deposit (landslide-like talus) and heavily weathered rock layer cover the ground surface.

From the results of seismic refraction survey and boring, geological composition in the tunnel formation is divided into two (2) kinds, (1) colluvium or weathered mudstone in the portal portion and (2) mudstone in the inner part of the tunnel as follows:

Engineering Properties		Portal position 450 m in length	Inner part of tunnel
Rock type		Colluvial weathered rock	Mudstone
Rock class		D	CL
P wave velocity	Vp (km/sec)	1.5	2.1 - 2.3
Unit weight	γ (g/cm^3)	1.7	2.1
Unconfined compressive strength	qu (kgf/cm^2)	10 - 20	60 - 100
Static elastic modulus	Es (kgf/cm^2)	2,000	10,000 - 12,000
Permeability coefficient	K (cm/sec)	1×10^{-4}	1×10^{-5}

The mudstone in the inner part of the tunnel shows crackless feature and large scale of fractured zone is not found, although minor shearing zone is seen locally. Since permeability is small, water flow by tunnel excavation will be a little.

From the results above, same method (NATM) was applied in this tunnel route. Following four (4) types of the tunnel sections were designed in consideration of the rock conditions in the tunnel (See Fig. I.36).

	Type I	Type II	Type III	Type IV
Section	Inner Part	Inner Part	Inner Part	Portal & Fractured Zone
Rock Condition	Fresh	Soft	A little bit weathered	Colluvial and weathered
Distance (m)	1,300	1,300	850	450
Shotcrete (cm)	10	10	15	15
Wire Mesh	ø 3.2 x 100 x 100	ø 3.2 x 100 x 100	ø 3.2 x 100 x 100	ø 3.2 x 100 x 100
Rock bolt	ø 22 x 4^{Nos} x 1.5^{m} (1.2 m pitch)	ø 22 x 6^{Nos} x 1.5^{m} (1.2 m pitch)	ø 22 x 6^{Nos} x 1.5^{m} (1.2 m pitch)	ø 22 x 6^{Nos} x 1.5^{m} (1.2 m pitch)
Concrete lining (cm)	30 (w/o R. bar)	30 (w/o R. bar)	30 (w/ single R. bar)	30 (w/ double R. bar)
H-steel Support	-	-	H125 @ 1.2^{m}	H125 @ 1.2^{m}
Drain Hole	ø 50 x 3^{Nos} x 1.5^{m}	ø 50 x 3^{Nos} x 1.5^{m}	ø 50 x 3^{Nos} x 1.5^{m}	ø 50 x 3^{Nos} x 1.5^{m}

As for the tunnel work adit, one(1) tunnel having a same size of Severino route with a length of 350 m was planned in the inlet portion. Access road with an effective width of 6 m is shown in Fig. I.31.

(2) Tunnel inlet and outlet

In the inlet portion, control structure of energy dissipator by sleeve valve was designed to make a free flow in the tunnel section, because intake water level of Poza Honda reservoir is fluctuated from EL. 108.50 m (normal water level) to EL. 93.5 m (emergency water level) through the year (See Fig. I.37).

In the outlet portion, there is no special structure. Tunnel section is gradually changed to open channel section, and connected with Mancha Grande river.

3.3.3 Daule Peripa - Esperanza dam water transbasin scheme

(1) Tunnel

This tunnel was planned from the Conguillo river in the Daule-Peripa reservoir to Membrillo river in the La Esperanza reservoir. Tunnel length is about 8.3 km and its diameter was planned at 3.7 m.

Rock type in the tunnel formation consists of fine sandstone and/or mudstone. In 1986 Brasilian team investigated the geology of tunnel route by borings. From the results of investigation, main engineering properties were obtained as follows:

Unit weight	γ = 2.1 g/cm^3
Unconfined compressive strength	qu = 60 - 100 kg/cm^2
Static elastic modulus	Es = 10,000 - 12,000 kg/cm^2
Permeability coefficient	K = 1 x 10^{-4} - 1 x 10^{-5} cm/sec

These results indicate the rock type is soft rock with massive and crackless conditions, and serious fractured zone is not found. Almost all section of the tunnel passes the soft rock layer above mentioned, however, in the portal portion of the tunnel, rock is weathered and loosened (D class in classification).

From the results of the geological investigation and boring tests above, the following five(5) typical tunnel sections having a 4.4 m diameter of semi-standard horse-shoe type were designed by the Brasillian team as follows (See Fig. I.38, average roughness coefficient of shotcrete = 0.019) :

Type I Shotcrete w/ Wiremesh + Drain
(20 cm) (1.5 m @1.2 m, 7 Nos.)
Type II Shotcrete w/ Wiremesh + Rockbolt + Drain
(20 cm) (1.5 m @1.2 m, 4 Nos.)
Type III Shotcrete w/ Wiremesh & R. bar + Steel support + Drain
(30 cm) (@1.5 m)
Type IV Shotcrete w/ Wiremesh & R. bar + Rockbolt + Steel support + Drain
(30 cm)
Type V Shotcrete w/ Wiremesh + Cocrete lining w/ double R. bar + Drain
(5 cm) (25 cm)

Of these, about 77 % of the total tunnel section covers by type I, 19 % by typeII and remaining 4 % by others. From the result that the unconfined compressive strength is around 100 kg/cm^2 in the tunnel, only shotcrete with a thickness of 20 cm for 77 % of the total tunnel section seems inadequate. Rockbolt for the whole stretches will be needed at least. Besides, concrete lining having a roughness coefficient of 0.015 was judged necessary from the view point of hydraulic advantage and maintenance. Therefore, the following four (4) types of the tunnel sections were recommended in consideration of the rock conditions in the tunnel (See Fig. I.39).

	Type I	Type II	Type III	Type IV
Section	Inner Part	Inner Part	Inner Part	Portal & Fractured Zone
Rock Condition	Fresh	Soft	A little bit weathered	Colluvial and weathered
Distance (m)	3,000	3,000	2,000	300
Shotcrete (cm)	10	10	15	15
Wire Mesh	ø 3.2 x 100 x 100	ø 3.2 x 100 x 100	ø 3.2 x 100 x 100	ø 3.2 x 100 x 100
Rock bolt	ø 22 x 4^{Nos} x 2^{m} (1.2 m pitch)	ø 22 x 8^{Nos} x 2^{m} (1.2 m pitch)	ø 22 x 8^{Nos} x 2^{m} (1.2 m pitch)	ø 22 x 8^{Nos} x 2^{m} (1.2 m pitch)
Concrete lining (cm)	30 (w/o R. bar)	30 (w/o R. bar)	30 (w/ single R. bar)	30 (w/ double R. bar)
H-steel Support	-	-	H125 @ 1.2^{m}	H125 @ 1.2^{m}
Drain Hole	ø 50 x 3^{Nos} x 1.5^{m}	ø 50 x 3^{Nos} x 1.5^{m}	ø 50 x 3^{Nos} x 1.5^{m}	ø 50 x 3^{Nos} x 1.5^{m}

As for the tunnel work adit, three(3) tunnels having the same size of Severino route were planned. They are located in the inlet portion with a length of 400 m, the outlet portion with a length of 500 m, and about 4 km point from the inlet with a length of 350 m connected from Rio Conguillo.

(2) Tunnel inlet and outlet

In the inlet portion, control structure of energy dissipater by sleeve valve was designed to make a free flow in the tunnel section, because reservoir water level of Daule - Peripa dam is fluctuated from EL. 85.0 m (normal water level) to EL. 60.0 m (low water level).

In the outlet portion, stop log was designed for maintenance of the tunnel. It will be closed for the maintenance when the reservoir water level of Esperanza dam is higher than the outlet elevation. However, no operation by the stop log is generally needed through the year (See Fig. I.40). Access road with an effective width of 6 m is shown in Fig. I.31.

TABLES

Table I.1 List of Data Collected

	Title	Source
(1)	Estudios Adicionales para el Rediseno de la Presa "La Esperanza" del Aprovechamiento Multiple Carrizal-Chone (Additional Studies on the Redesign of the Esperanza Dam for the Multipurpose Use of Carrizal-Chone)	CRM INTECSA GEOSISA June, 1984
	Volumen VI Rediseno de las Obras de Desvio y de las Obras de Entrada (Redesign of Diversion and Inlet Works) Volumen VII Rediseno de la Presa y de sus Fundaciones (Redesign of Dam and Foundation) Volumen VIII Rediseno del Vertedero (Redesign of Spillway) Volumen IX Rediseno de las Obras de Salida (Redesign of Outlet Works)	
(2)	Estudios Para El Desarrollo de la Cuenca del Rio Guayas (Daule-Peripa Dam Guayas Multiple Project)	TAMS-AHT-INTEGRAL March, 1979
	(Report on Preliminary Design and Cost, and Final Report on Technical Feasibility)	
(3)	Trasvase de Rio Daule a los Embalses de Poza Honda y La Esperanza (Transbasin from Daule Peripa to La Esperanza and Poza Honda Dam)	Consorcio Ecuatoriano - Brasileno 1987
	Diseno Definitivo (Definitive Design) Documentos (Reports)	
(4)	Proyecto Multiple Carrizal-Chone (Carrizal-Chone Multipurpose Project)	CCAI Sep., 1989
	Documento No.15 Estudio de las Conducciones Principales (Study on Principal Conditions) Documento No.16a Estudio de las Redes de Riego, Drenaje y Vial, Guarrango-Los Amarillos) (Guarrango-Los Amarillos Irrigation and Drainage Study) Documento No.17 Estudio del Trasvase al valle de Portoviejo) (Study on Transbasin to Portoviejo)	

Table I.2 General Features of Dam (1/3)

(Poza Honda Dam, constructed in 1971)

(1)	Hydrology	
	Catchment area	175 km^2
	Annual mean basin rainfall	1,300 mm
	Annual mean inflow	95 MCM
	Runoff coefficient	42%
	Probable max. flood	1,120 m^3/s
(2)	Reservoir	
	Gross storage capacity	98 MCM
	Dead storage	13 MCM
	Emergency storage	10 MCM
	Effective storage	75 MCM
	Flood water level	EL.112.3 m
	Normal high water level	EL.108.5 m
	Emergency water level	EL. 93.5 m
	Low water level	EL. 90.3 m
	Riverbed level	EL. 75.0 m
	Reservoir area at HWL	4.9 km^2
(3)	Dam	
	Type	Homogeneous earthfill with asphalt facing
	Height	40 m
	Crest elevation	EL.114.3 m
	Crest length	531 m
(4)	Spillway	
	Type, Control structure	Non-gated overflow weir
	Water conveyance	Open chute
	Energy dissipator	Stilling basin
	Length of overflow weir	70 m
	Overflow weir level	EL.108.5 m
	Outflow peak discharge	875 m^3/s
(5)	Intake and Outlet	
	Intake level	EL. 89 m
	Outlet capacity	30 m^3/s

Table I.2 General Features of Dam (2/3)

(Daule-Peripa Dam, constructed in 1987)

(1)	Hydrology	
	Catchment area	4,200 km^2
	Annual mean basin rainfall	2,700 mm
	Annual mean inflow	5,000 MCM
	Runoff coefficient	44%
	Probable max. flood	14,350 m^3/s
(2)	Reservoir	
	Gross storage capacity	5,300 MCM
	Dead storage	1,300 MCM
	Effective storage	4,000 MCM
	Flood water level	EL. 88.0 m
	Normal high water level	EL. 85.0 m
	Low water level	EL. 60.0 m
	Riverbed level	EL. 12.0 m
	Reservoir area at FWL	290 km^2
	Reservoir area at HWL	270 km^2
(3)	Allocation of Reservoir Capacity	
	Flood space	700 MCM
	Power generation	3,500 MCM
	Irrigation	1,800 MCM
	Water supply	500 MCM
	Use in Manabi province	500 MCM
(4)	Main Dam	
	Type	Zoned earthfill
	Height from foundation	90 m
	Crest elevation	EL. 90.0 m
	Crest length	250 m
	Dam volume	3,000,000 m^3
(5)	Sub-dam	
	Type	Homogeneous earthfill
	Length	18 km
	Average height	10 m (max. 27 m)
	Embankment volume	5,900,000 m^3
(6)	Spillway	
	Type, Control structure	Gated overflow weir
	Water conveyance	Open chute
	Energy dissipator	Stilling basin
	Width of overflow weir	59 m
	Overflow weir level	EL. 77.0 m
	Design peak discharge	3,480 m^3/s
	Spillway gates	
	Nº of gates	3 nºs
	Type	Tainter gate
	Dimensions	H = 8.0 m, W= 17.0 m
(7)	Power facilities (Not yet installed as of end 1991)	
	Installed capacity	65 MW x2 units=130MW
	Annual energy output	510 GWh (firm)
	Design head	58.2 m
	Design discharge	132.3 m^3/s per unit
(8)	Outlet facilities	
	Tunnel diameter and length	9.0 m, 530 m
	Outlet capacity	400 m^3/s

Table I.2 General Features of Dam (3/3)

(Esperanza Dam, construction suspended)

(1)	Hydrology	
	Catchment area	445 km^2
	Annual mean basin rainfall	1,520 mm
	Annual mean inflow	376 MCM
	Runoff coefficient	56%
	Probable max. flood	3,040 m^3/s
(2)	Reservoir	
	Gross storage capacity	455 MCM
	Dead storage	64 MCM
	Effective storage	391 MCM
	Flood water level	EL. 67.7 m
	Normal high water level	EL. 66.0 m
	Low water level	EL. 37.0 m
	Riverbed level	EL. 22.0 m
	Reservoir area at FWL	24.0 km^2
	Reservoir area at HWL	22.7 km^2
(3)	Dam	
	Type	Zoned earthfill
	Height from foundation	57.0 m
	Crest elevation	69.0 m
	Crest length	696.0 m
	Dam volume	3,700,000 m^3
(4)	Spillwa	
	Type, Control structure	Gated overflow weir
	Water conveyance	Open chute
	Energy dissipator	Stilling basin
	Width of overflow weir	39.0 m
	Overflow weir level	62.0 m
	Design peak discharge	900.0 m^3/s
	Spillway gates	
	Nº of gates	4 nºs
	Type	Tainter gate
	Dimensions	H = 4.0 m, W = 7.5 m
(5)	Outlet facilities	
	Irrigation outlet	Capacity 25 - 38 m^3/s
	Low level outlet	Capacity 110 m^3/s
	Outlet for river maintenance	Capacity 5 m^3/s

Table I.3 Hydraulic Calculation for Water Transbasin Scheme "Esperanza Dam (Severino) - Poza Honda Dam (Q=10 m3/s)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
						113.676	2.834	1.764	0.159			0.000	
0+ 0	10.0	250	Pipeline		0.428								D=1,900
	5					113.248		0.000	0.000				
0+ 250			Head Tank		0.100								
						113.148	8.344	1.198	0.073	113.075	1.800	111.275	
0+ 250		600	Open Channel	1/3,000	0.200								B=h=1.8 m
						112.948			0.073	112.875	1.800	111.075	
0+ 850			Tank		0.000								
						112.948	5.723	1.747	0.156	112.793			
0+ 850		210	Syphon		0.202								D=2,700
						112.591				112.591			
0+ 1060			Tank		0.000								
						112.591	8.344	1.198	0.073	112.517	1.800	110.717	
0+ 1060		2700	Open Channel	1/3,000	0.900								B=h=1.8 m
						111.691			0.073	111.617	1.800	109.817	
0+ 3760			Tank		0.000								
						111.691	5.723	1.747	0.156	111.535			
0+ 3760		260	Syphon		0.250								D=2,700
						111.285							
0+ 4020			Tank		0.000								
						111.285	8.344	1.198	0.073	111.211	1.800	109.411	
0+ 4020		3050	Open Channel	1/3,000	1.017								B=h=1.8 m
						110.268			0.073	110.195	1.800	108.395	
0+ 7070			Tank		0.000								
						110.268	5.723	1.747	0.156	110.112			
0+ 7070		170	Syphon		0.164								D=2,700
						109.949							
0+ 7240			Tank		0.000								
						109.949	8.344	1.198	0.073	109.875	1.800	108.075	
0+ 7240		550	Open Channel	1/3,000	0.183								B=h=1.8 m
						109.765			0.073	109.692			
0+ 7790			Transition		0.000								
						109.765	6.219	1.608	0.132	109.633	2.320	107.313	
0+ 7790		10700	Tunnel	1/1,500	7.133								D=2,900
						102.632	6.219	1.608	0.132	102.500	2.320	100.180	
0+ 18490			Outlet		0.000								
						102.632	6.219	1.608	0.132	102.500	2.320	100.180	

Table I. 4 Hydraulic Calculation for Water Transbasin Scheme
" Esperanza Dam (Altamira) - Rio Portoviejo (Q=12 m3/s) " (1/3)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
						95.229	3.140	1.911	0.186				
0+ 0	12.0	220	Pipeline		0.411								D=2,000
	6.0					94.818		0.000	0.000				
0+ 220			Head Tank		0.100								
						94.718	9.525	1.260	0.081	94.637	1.940	92.697	
0+ 220		500	Open Channel	1/3,000	0.167								B=h=1.9 m
						94.551			0.081	94.470	1.940	92.530	
0+ 720			Tank		0.000								
						94.551	6.602	1.818	0.169	94.382			
0+ 720		70	Syphon		0.067								D=2,900
						94.316							
0+ 790			Tank		0.000								
						94.316	9.525	1.260	0.081	94.235	1.940	92.295	
0+ 790		220	Open Channel	1/3,000	0.073								B=h=1.9 m
						94.242			0.081	94.161	1.940	92.221	
0+ 1010			Transition		0.005								
						94.237	6.770	1.772	0.160	94.077	2.480	91.597	
0+ 1010		690	Tunnel	1/1,500	0.460								D=3,100
						93.777	6.770	1.772	0.160	93.617	2.480	91.137	
0+ 1700			Transition		0.005								
						93.772	9.525	1.260	0.081	93.691	1.940	91.751	
0+ 1700		1020	Open Channel	1/3,000	0.340								B=h=1.9 m
						93.432			0.081	93.351	1.940	91.411	
0+ 2720			Tank		0.000								
						93.432	6.602	1.818	0.169	93.264			
0+ 2720		750	Syphon		0.714								D=2,900
						92.550							
0+ 3470			Tank		0.000								
						92.550	9.525	1.260	0.081	92.469	1.940	90.529	
0+ 3470		380	Open Channel	1/3,000	0.127								B=h=1.9 m
						92.423			0.081	92.342	1.940	90.402	
0+ 3850			Tank		0.000								
						92.423	6.602	1.818	0.169	92.255			
0+ 3850		360	Syphon		0.343								D=2,900
						91.912							
0+ 4210			Tank		0.000								
						91.912	9.525	1.260	0.081	91.831	1.940	89.891	
0+ 4210		1500	Open Channel	1/3,000	0.500								B=h=1.9 m
						91.412			0.081	91.331	1.940	89.391	
0+ 5710			Transition		0.005								
						91.407	6.770	1.772	0.160	91.247	2.480	88.767	
0+ 5710		2500	Tunnel	1/1,500	1.667								D=3,100
						89.740	6.770	1.772	0.160	89.580	2.480	87.100	

Table I. 4 Hydraulic Calculation for Water Transbasin Scheme
" Esperanza Dam (Altamira) - Rio Portoviejo (Q=12 m3/s) " (2/3)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
0+ 8210			Transition		0.005								
						89.735	9.525	1.260	0.081	89.654	1.940	87.714	
0+ 8210		1040	Open Channel	1/3,000	0.347								B=h=1.9 m
						89.389			0.081	89.308	1.940	87.368	
0+ 9250			Tank		0.000								
						89.389	6.602	1.818	0.169	89.220			
0+ 9250		180	Syphon		0.171								D=2,900
						89.049							
0+ 9430			Tank		0.000								
						89.049	9.525	1.260	0.081	88.968	1.940	87.028	
0+ 9430		1860	Open Channel	1/3,000	0.620								B=h=1.9 m
						88.429			0.081	88.348	1.940	86.408	
0+ 11290			Transition		0.005								
						88.424	6.770	1.772	0.160	88.263	2.480	85.783	
0+ 11290		9830	Tunnel	1/1,500	6.553								D=3,100
						81.870	6.770	1.772	0.160	81.710	2.480	79.230	
0+ 21120			Transition		0.005								
						81.865	5.653	1.061	0.057	81.808	1.500	80.308	
0+ 21120	6.0	200 *350	Open Channel	1/3,000	0.067								B=h=1.5 m
						81.799			0.057	81.741	1.500	80.241	
0+ 21320			Tank		0.000								
						81.799	3.462	1.733	0.153	81.645			
0+ 21320		500	Syphon		0.635								D=2,100
						81.010							
0+ 21820			Tank		0.000								
						81.010	5.653	1.061	0.057	80.953	1.500	79.453	
0+ 21820		400	Open Channel	1/3,000	0.133								B=h=1.5 m
						80.877			0.057	80.819	1.500	79.319	
0+ 22220			Transition		0.005								
						80.872	4.026	1.490	0.113	80.758	1.920	78.838	
0+ 22220		2930	Tunnel	1/1,500	1.953								D=2,500
						78.918	4.026	1.490	0.113	78.805	1.920	76.885	
0+ 25150			Transition		0.005								
						78.913	5.653	1.061	0.057	78.856	1.500	77.356	
0+ 25150		220	Open Channel	1/3,000	0.073								B=h=1.5 m
						78.840			0.057	78.783	1.500	77.283	
0+ 25370			Tank		0.000								
						78.840	3.462	1.733	0.153	78.687			
0+ 25370		120	Syphon		0.152								D=2,100
						78.534							
0+ 25490			Tank		0.000								
						78.534	5.653	1.061	0.057	78.477	1.500	76.977	

Table I. 4 Hydraulic Calculation for Water Transbasin Scheme
" Esperanza Dam (Altamira) - Rio Portoviejo (Q=12 m3/s) " (3/3)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	Energy Line EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
0+ 25490		720	Open Channel	1/3,000	0.240								B=h=1.5 m
						78.294			0.057	78.237	1.500	76.737	
0+ 26210			Tank		0.000								
						78.294	3.462	1.733	0.153	78.141			
0+ 26210		50	Syphon		0.064								D=2,100
						78.078							
0+ 26260			Tank		0.000								
						78.078	5.653	1.061	0.057	78.020	1.500	76.520	
0+ 26260		410	Open Channel	1/3,000	0.137								B=h=1.5 m
						77.941			0.057	77.884	1.500	76.384	
0+ 26670			Transition		0.005								
						77.936	4.026	1.490	0.113	77.823	1.920	75.903	
0+ 26670		5070	Tunnel	1/1,500	3.380								D=2,500
						74.556	4.026	1.490	0.113	74.443	1.920	72.523	
0+ 31740			Transition		0.005								
						74.551	5.653	1.061	0.057	74.551	1.500	73.051	
0+ 31740		70	Open Channel	1/3,000	0.023								B=h=1.5 m
						74.528	9.000	0.667	0.023	74.505	1.500	73.005	
0+ 31810			Outlet		0.005								
						74.523	9.000	0.667	0.023	74.500	1.500	73.000	

Table I. 5 Hydraulic Calculation for Water Transbasin Scheme
" Esperanza Dam Outlet - Guarango (Q=23 m3/s - 5m3/s) " (1/3)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
	22.75		Outlet			35.414	16.500	1.379	0.097	35.317	3.000	32.317	EL. 32.0
0+ 0	22.00	6390	Open Channel	1/3,000	2.130								
						33.284			0.097	33.187	3.000	30.187	
0+ 6390													
						33.284	16.500	1.333	0.091	33.193	3.000	30.193	
0+ 6390		3100	Open Channel	1/3,000	1.033								
						32.250			0.091	32.159	3.000	29.159	
0+ 9490			Transition		0.000								
						32.250	16.500	1.333	0.091	32.159	3.000	29.159	
0+ 9490		250	Open Channel	1/3,000	0.083								
						32.167	16.500	1.333	0.091	32.076	3.000	29.076	
0+ 9740			Transition		0.100								
						32.067	16.200	1.358	0.094	31.973	3.000	28.973	
0+ 9740		310	Open Channel	1/3,000	0.103								
						31.964			0.091	31.873	3.000	28.873	
0+ 10050			Tank		0.000								
						31.964	3.462	1.878	0.180	31.784			
0+ 10050	13.00	350	Syphon		0.516								D=2,100 * 2 Lanes
						31.268							
0+ 10400			Tank		0.000								
						31.268	14.509	0.896	0.041	31.227	2.650	28.577	
0+ 10400		5380	Open Channel	1/5,000	1.076								
						30.192	14.509	0.896	0.041	30.151	2.650	27.501	
0+ 15780			Transition		0.100								
						30.092	13.780	0.907	0.042	30.050	2.600	27.450	
0+ 15780	12.50	1040	Open Channel	1/5,000	0.208								
						29.884							
0+ 16820			Tank		0.000								
						29.884	3.462	1.805	0.166	29.718			
0+ 16820		900	Syphon		1.233								D=2,100 * 2 Lanes
						28.485							
0+ 17720			Tank		0.100								
						28.385	12.625	0.871	0.039	28.346	2.500	25.846	
0+ 17720	11.00	4430	Open Channel	1/5,000	0.886								
						27.499	12.625	0.871	0.039	27.460	2.500	24.960	EL. 24.96 Start
0+ 22150		650	DI-2		0.000								
						25.360	11.640	0.816	0.034	25.338	2.400	22.938	EL. 22.96
0+ 22800	9.50	950	Open Channel	1/5,000	0.190								
						25.170			0.034	25.136	2.400	22.736	
0+ 23750			Transition		0.100								
						25.070	10.695	0.818	0.034	25.036	2.300	22.736	
0+ 23750	8.75	4600	Open Channel	1/5,000	0.920								
						24.150	10.695	0.818	0.034	24.116	2.300	21.816	EL. 21.85
0+ 28350			Transition		0.300								

Table I. 5 Hydraulic Calculation for Water Transbasin Scheme
" Esperanza Dam Outlet - Guarango (Q=23 m3/s - 5m3/s) " (2/3)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
						23.850	8.000	0.688	0.024	23.826	2.000	21.826	
0+ 29300	5.50	950	Open Channel	1/5,000	0.190								
			Grid Chamber			23.660				23.660	2.000	21.66	EL. 21.66 Start
0+ 0			Pumping St.		0.000							19.660	
						69.429	1.539	1.625	0.135	69.295			
0+ 0	5.00	300	Pipe		0.543								D=1,400
						68.887							
0+ 300			Head Tank		0.000								
						68.887	8.000	0.688	0.024	68.863	2.000	66.863	
0+ 300		880	Open Channel	1/3,000	0.293								
						68.593							
0+ 1180			Tank		0.000								
						68.593	3.140	1.672	0.143	68.451			
0+ 1180	5.25	550	Syphon		0.692								D=2,000
						67.759							
0+ 1730			Tank		0.000								
						67.759	8.000	0.656	0.022	67.737	2.000	65.737	
0+ 1730	5.25	4220	Open Channel	1/3,000	1.407								
						66.352							
0+ 5950			Transition		0.000								
						66.352	4.723	1.112	0.063	66.289	2.080	64.209	
0+ 5950	5.25	6600	Tunnel	1/3,000	2.200								D=2,600
						64.152	4.723	1.112	0.063	64.089	2.080	62.009	
0+ 12550			Transition		0.130								
						64.022	8.000	0.656	0.022	64.000	2.000	62.000	EL. 62.0
0+ 12550		1800	Open Channel	1/3,000	0.600								
						63.422	8.000	0.656	0.022	63.400	2.000	61.400	EL. X Start
0+ 14350		300	Dam Guarango		0.000								
						58.924	8.925	0.756	0.029	58.895	2.100	56.795	EL. 56.80 (=61.4-4.6)
0+ 14650	6.75	1550	Open Channel	1/3,000	0.517								
						58.408							
0+ 16200			Tank		0.050								
						58.358	3.140	2.070	0.219	58.139			
0+ 16200	6.50	500	Syphon		0.934								D=2,000
						57.205	8.925	0.700	0.025	57.180	2.100	55.080	
0+ 16700	6.25	1000	Open Channel	1/3,000	0.333								
						56.872			0.025	56.847	2.100	54.747	
0+ 17700			Tank		0.050								
						56.822	3.140	1.911	0.186	56.635			
0+ 17700	6.00	540	Syphon		0.870								D=2,000
						55.765							

Table I. 5 Hydraulic Calculation for Water Transbasin Scheme
" Esperanza Dam Outlet - Guarango (Q=23 m3/s - 5m3/s) " (3/3)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
0+ 18240			Tank		0.000								
						55.765	8.354	0.688	0.024	55.741	2.050	53.691	
0+ 18240	5.75	960	Open Channel	1/3,000	0.320								
						55.445	8.354	0.688	0.024	55.421	2.050	53.371	
0+ 19200			Transition		0.050								
						55.395	8.000	0.688	0.024	55.371	2.000	53.371	
0+ 19200	5.50	500	Open Channel	1/3,000	0.167								
						55.229							
0+ 19700			Tank		0.000								
						55.229	3.140	1.672	0.143	55.086			
0+ 19700		430	Syphon		0.541								D=2,000
						54.545							
0+ 20130			Tank		0.000								
						54.545	8.000	0.625	0.020	54.525	2.000	52.525	
0+ 20130	5.25	1010	Open Channel	1/3,000	0.337								
						54.208			0.219	53.990	2.000	51.990	
0+ 21140			Transition		0.050								
						54.158	7.654	0.653	0.022	54.137	1.950	52.187	
0+ 21140	5.00	1010	Open Channel	1/3,000	0.337								
						53.822	7.654	0.653	0.022	53.800	1.950	51.850	
0+ 22150			Outlet										
						53.822	7.654	0.653	0.022	53.800	1.950	51.850	

Table I. 6 Hydraulic Calculation for Water Transbasin Scheme
" Esperanza Dam Outlet - Guarango - Portoviejo (Q=33 m3/s - 15m3/s) " (1/4)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
	32.75		Outlet			36.651	19.432	1.685	0.145	36.506	4.408	32.098	EL. 32.0
0+ 0	32.00	6390	Open Channel	1/3.000	2.130								
						34.521			0.145	34.376	4.408	29.968	
0+ 6390													
						34.521	19.097	1.676	0.143	34.378	4.370	30.008	
0+ 6390		3100	Open Channel	1/3.000	1.033								
						33.488			0.143	33.344	4.370	28.974	
0+ 9490			Transition		0.000								
						33.488	19.097	1.676	0.143	33.344	4.370	28.974	
0+ 9490		250	Open Channel	1/3.000	0.083								
						33.404	19.097	1.676	0.143	33.261	4.370	28.891	
0+ 9740			Transition		0.100								
						33.304	19.097	1.676	0.143	33.161	4.370	28.791	
0+ 9740		310	Open Channel	1/3.000	0.103								
						33.201			0.143	33.058	4.370	28.688	
0+ 10050			Tank		0.000								
						33.201	6.602	1.742	0.155	33.046			
0+ 10050	23.00	350	Syphon		0.308								D=2,900 * 2 Lanes
						32.738							
0+ 10400			Tank		0.000								
						32.738	17.789	1.293	0.085	32.653	2.668	29.985	
0+ 10400		5380	Open Channel	1/5,000	1.076								
						31.662	17.789	1.293	0.085	31.577	2.668	28.909	
0+ 15780			Transition		0.100								
						31.562	17.498	1.286	0.084	31.478	2.646	28.832	
0+ 15780	22.50	1040	Open Channel	1/5,000	0.208								
						31.354							
0+ 16820			Tank		0.000								
						31.354	6.602	1.704	0.148	31.206			
0+ 16820		900	Syphon		0.760								D=2,900 * 2 Lanes
						30.446							
0+ 17720			Tank		0.100								
						30.346	16.616	1.264	0.081	30.264	2.578	27.686	
0+ 17720	21.00	4430	Open Channel	1/5,000	0.886								
						29.460	16.616	1.264	0.081	29.378	2.578	26.800	EL. X Start
0+ 22150		650	DI-2		0.000								
						25.661	15.718	1.241	0.079	25.582	2.507	23.075	
0+ 22800	19.50	950	Open Channel	1/5,000	0.190								
						25.471			0.079	25.392	2.507	22.885	
0+ 23750			Transition		0.100								
						25.371	15.262	1.229	0.077	25.294	2.471	22.823	
0+ 23750	18.75	4600	Open Channel	1/5,000	0.920								
						24.451	15.262	1.229	0.077	24.374	2.471	21.903	
0+ 28350			Transition		0.300								

Table I. 6 Hydraulic Calculation for Water Transbasin Scheme

" Esperanza Dam Outlet - Guarango - Portoviejo (Q=33 m3/s - 15m3/s) " (2/4)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
						24.151	13.232	1.171	0.070	24.081	2.301	21.780	
0+ 29300	15.50	950	Open Channel	1/5,000	0.190								
			Grid Chamber			23.961			0.000	23.961	2.301	21.660	EL. 21.66 Start
0+ 0			Pumping St.		0.000							19.660	
						72.153	3.462	2.166	0.239	71.913			
0+ 0	15.00	300	Pipe		0.576								D=2,100
						71.577							
0+ 300			Head Tank		0.000								
						71.577	10.925	1.419	0.103	71.474	2.090	69.384	
0+ 300	15.50	880	Open Channel	1/3,000	0.293								
						71.284							
0+ 1180			Tank		0.000								
						71.284	8.549	1.784	0.162	71.121			
0+ 1180	15.25	550	Syphon		0.435								D=3,300
						70.686							
0+ 1730			Tank		0.000								
						70.686	10.793	1.413	0.102	70.584	2.078	68.507	
0+ 1730	15.25	4220	Open Channel	1/3,000	1.407								
						69.280							
0+ 5950			Transition		0.000								
						69.280	8.104	1.882	0.181	69.099	2.720	66.379	
0+ 5950	15.25	6600	Tunnel	1/1,500	4.400								D=3,400
						64.880	8.104	1.882	0.181	64.699	2.720	61.979	EL. 62.0
0+ 12550			Transition		0.100								
						64.780	10.793	1.413	0.102	64.678	2.078	62.600	
0+ 12550	15.25	1800	Open Channel	1/3,000	0.600								
						64.180	10.793	1.413	0.102	64.078	2.078	62.000	EL. X Start
0+ 14350		300	Dam Guarango		0.000								
						59.005	11.579	1.447	0.107	58.898	2.152	56.746	EL. 56.7 (62-5.3)
0+ 14650	16.75	1550	Open Channel	1/3,000	0.517								
						58.488							
0+ 16200			Tank		0.050								
						58.438	9.075	1.818	0.169	58.270			
0+ 16200	16.50	500	Syphon		0.396								D=3,400
						57.874	11.319	1.436	0.105	57.769	2.128	55.641	
0+ 16700	16.25	1000	Open Channel	1/3,000	0.333								
						57.541			0.105	57.435	2.128	55.308	
0+ 17700			Tank		0.050								
						57.491	9.075	1.763	0.159	57.332			
0+ 17700	16.00	540	Syphon		0.404								D=3,400
						56.928							

Table I. 6 Hydraulic Calculation for Water Transbasin Scheme
" Esperanza Dam Outlet - Guarango - Portoviejo (Q=33 m3/s - 15m3/s) " (3/4)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
0+ 18240			Tank		0.000								
						56.928	11.057	1.424	0.104	56.825	2.103	54.722	
0+ 18240	15.75	960	Open Channel	1/3,000	0.320								
						56.608	11.057	1.424	0.104	56.505	2.103	54.402	
0+ 19200			Transition		0.050								
						56.558	10.925	1.419	0.103	56.456	2.090	54.365	
0+ 19200	15.50	500	Open Channel	1/3,000	0.167								
						56.392							
0+ 19700			Tank		0.000								
						56.392	8.549	1.784	0.162	56.229			
0+ 19700		430	Syphon		0.340								D=3,300
						55.889							
0+ 20130			Tank		0.000								
						55.889	10.660	1.407	0.101	55.788	2.065	53.723	
0+ 20130	15.25	1010	Open Channel	1/3,000	0.337								
						55.553			0.169	55.384	2.065	53.319	
0+ 21140			Transition		0.050								
						55.503	10.660	1.407	0.101	55.402	2.065	53.337	
0+ 21140	15.00	1010	Open Channel	1/3,000	0.337								
						55.166	10.660	1.407	0.101	55.065	2.065	53.000	
0+ 22150													
						55.166	10.660	1.407	0.101	55.065	2.065	53.000	EL. X Start

Table I. 6 Hydraulic Calculation for Water Transbasin Scheme
" Esperanza Dam Outlet - Guarango - Portoviejo (Q=33 m3/s - 15m3/s) " (4/4)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
						55.178	6.602	1.500	0.115	55.063	2.065	52.998	EL.53.0
0~ 0	9.90	2800	Syphon		1.867								D=2.900
						53.196							
0~ 2800			Tank		0.050								
						53.146	9.453	1.047	0.056	53.090	1.945	51.145	
0+ 4070		1270	Open Channel	1/5,000	0.254								
						52.892							
0+ 4070			Tank		0.000								
						52.892	6.602	1.500	0.115	52.777			
0+ 4410		340	Syphon		0.227								D=2.900
						52.550							
0- 4410			Tank		0.000								
						52.550	9.453	1.047	0.056	52.495	1.945	50.550	
0+ 5200		790	Open Channel	1/5,000	0.158								
						52.392			0.000	52.392	1.945	50.448	
0+ 5200			Diversion Tank		0.050								
						52.342	6.166	0.908	0.042	52.300	1.570	50.730	
0+ 8380	5.60	3180	Open Channel	1/5,000	0.636								
						51.706	6.166	0.908	0.042	51.664	1.570	50.094	
0+ 8380			Tank		0.000								
						51.706	3.140	1.783	0.162	51.544			
0+ 8980		600	Syphon		0.851								D=2,000
						50.693	3.140	1.783	0.162	50.601			
0+ 8980			Tank		0.050								
						50.643	6.166	0.908	0.042	50.601	1.570	49.031	
0+ 11530		2550	Open Channel	1/5,000	0.510								
						50.133				50.133	1.570	48.563	
0+ 11530			Tank		0.000								
						50.133	3.140	1.656	0.140	49.994			
0+ 13610	5.20	2080	Syphon		2.571								D=2.000
						47.422							
0+ 13610			Tank		0.000								
						47.422	5.833	0.892	0.041	47.382	1.527	45.854	
0+ 21200		7590	Open Channel	1/5,000	1.518								
						45.904				45.904	1.527	44.377	
0+ 21200			Tank		0.000								
						45.904	4.209	0.784	0.031	45.873	2.052	43.821	
0+ 21330	3.30	130	Culvert	1/5,000	0.026								
						45.878	4.209	0.784	0.031	45.847	2.052	43.795	
0+ 21330			Tank		0.050								
						45.828	4.147	0.796	0.032	45.796	1.288	44.508	
0+ 23730		2400	Open Channel	1/5,000	0.480								
						45.348				45.348	1.288	44.060	
0+ 23730			Tank		0.000								
						45.348	4.209	0.784	0.031	45.317	2.052	43.265	
0+ 23930		200	Culvert	1/5,000	0.040								
						45.308							
0+ 23930			Tank		0.000								
						45.308	4.147	0.796	0.032	45.276	1.288	43.988	
0+ 27960		4030	Open Channel	1/5,000	0.806								
						44.502				44.502	1.288	43.214	
0+ 27960			Tank		0.050								
						44.452	4.147	0.796	0.032	44.420	1.288	43.132	
0+ 28560		600	Open Channel	1/5,000	0.120								
						44.332		0.796	0.032	44.300	2.000	42.300	
0+ 28560			Tank										

Table I. 7 Hydraulic Calculation for Water Transbasin Scheme
" Guarango - Rocafuerte (Q=3 m3/s) "

(Alt-4)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL. m)	Water Depth (m)	EL. of Structure (EL. m)	Dimension of Structure
						51.812	1.275	2.353	0.282	51.529	1.129	50.400	EL. 50.4
0+ 0	3.00	300	Open Channel	1/3,000	0.100								
						51.712	1.275	2.353	0.282	51.429	1.129	50.300	
0+ 300					0.100								
0+ 300		300	Groundsill	1/13	23.077								
						28.269			0.282	27.987	1.129	26.858	
0+ 600			Tank		0.000								
						28.269	1.766	1.699	0.147	28.122			
0+ 600		3650	Syphon		6.614								D=1,500
						21.508							
0+ 4250			Tank		0.000								
						21.508	3.188	0.941	0.045	21.463	1.129	20.333	
0+ 4250		1000	Open Channel	1/3,000	0.333								
						21.174	3.188	0.941	0.045	21.129	1.129	20.000	
0+ 5250			W.T.P		0.000								
						21.174	3.188	0.941	0.045	21.129	1.129	20.000	

Table I.8 General Features of Pump

Item	Unit	Severino	Severino	Altamira	Amarillos	Amarillos
Total Discharge	m3/s	9.0	10.0	12.0	5.0	15.0
Nos.of Pump Planned	Nos.	5	5	5	2	4
Nos. of Standby Pump	Nos.	1	1	1	1	1
Discharge of 1 Pump	m3/min	108	120	144	300	225
	m3/s	1.8	2.0	2.4	2.5	3.8
Length of Pipeline	m	250	250	220	300	300
Lane		2	2	2	2	2
Diameter of Pipeline	mm	1,800	1,900	2,000	1,400	2,100
Flow Velocity of Pipeline	m/s	2.13	2.12	2.29	1.62	2.17
Total Head	m	75	75	57	49	52
Type of Pump		Double Suction Volute Type	Double Suction Volute Type	Double Suction Volute Type	Double Suction Volute Type	Double Suction Volute Type
Ds	mm	900	900	1,000	1,000	1,200
Dd	mm	600	600	700	700	800
Motor	Kw	2,650	2,750	2,750	2,850	2,550
	Pole	12	12	12	12	14
	Hz	60	60	60	60	60

Table 1.9 Results of Hydraulic Calculation

(Esperanza - Poza Honda)

Sta. No.	Discharge (m3/s)	Length (m)	Type of Structure	Slope	Energy Line Loss (m)	Energy Line EL (m)	Flow Area A (m2)	Flow Velocity V (m/s)	V^2/2g (m)	Water Level (EL m)	Water Depth (m)	EL. of Structure (EL m)	Dimension of Structure
						114.362	3.462	2.311	0.272	114.090			
0 + 000	16.0	250	Pipeline		0.627								D=2,100
	8	(250)				113.462		0.000	0.000				
0 + 250		20	Head Tank		0.100								
						113.362	11.786	1.358	0.094	113.268	2.170	111.098	
0 + 270		210	Open Channel	1/3,000	0.070								
						113.292			0.094	113.198	2.170	111.028	
0 + 480			Tank		0.000								
						113.292	8.230	1.944	0.193	113.100			
0 + 480		55	Syphon		0.043								B=H=2.9 m
		(62)				113.056							
0 + 535			Tank		0.000								
						113.056	11.786	1.358	0.094	112.962	2.170	110.792	
0 + 535		190	Open Channel	1/3,000	0.063								B=h=2.2 m
						112.993			0.094	112.899	2.170	110.729	
0 + 725			Tank		0.000								
						112.993	8.230	1.944	0.193	112.800			
0 + 725		210	Syphon		0.157								B=H=2.9 m
		(225)				112.643							
0 + 935			Tank		0.000								
						112.643	11.786	1.358	0.094	112.549	2.170	110.379	
0 + 935		2030	Open Channel	1/3,000	0.677								B=h=2.2 m
						111.966			0.094	111.872	2.170	109.702	
2 + 965			Tank		0.000								
						111.966	8.230	1.944	0.193	111.773			
2 + 965		310	Syphon		0.227								B=H=2.9 m
		(325)				111.546							
3 + 275			Tank		0.000								
						111.546	11.786	1.358	0.094	111.452	2.170	109.282	
3 + 275		1645	Open Channel	1/3,000	0.548								B=h=2.2 m
						110.998			0.094	110.904	2.170	108.734	
4 + 920			Tank		0.000								
						110.998	8.230	1.944	0.193	110.805			
4 + 920		50	Syphon		0.038								B=H=2.9 m
		(55)				110.766							
4 + 970			Tank		0.000								
						110.766	11.786	1.358	0.094	110.672	2.170	108.502	
4 + 970		240	Open Channel	1/3,000	0.080								B=h=2.2 m
						110.686			0.094	110.592	2.170	108.422	
5 + 210			Tank		0.000								
						110.686	8.230	1.944	0.193	110.494			
5 + 210		45	Syphon		0.035								B=H=2.9 m
		(50)				110.459							
5 + 255			Tank		0.000								
						110.459	11.786	1.358	0.094	110.365	2.170	108.195	
5 + 255		590	Open Channel	1/3,000	0.197								B=h=2.2 m
						110.262			0.094	110.168	2.170	107.998	
5 + 845			Tank		0.000								
						110.262	8.230	1.944	0.193	110.069			
5 + 845		185	Syphon		0.132								B=H=2.9 m
		(189)				109.937							
6 + 030			Tank		0.000								
						109.937	11.786	1.358	0.094	109.843	2.170	107.673	
6 + 030		510	Open Channel	1/3,000	0.170								B=h=2.2 m
						109.767			0.094	109.673	2.170	107.503	
6 + 540			Transition		0.000								
						109.767	8.847	1.809	0.167	109.600	2.800	106.800	
6 + 540		10650	Tunnel	1/1,500	7.100								D=3,500
						102.667	8.847	1.809	0.167	102.500	2.800	99.700	
17 + 190			Outlet		0.000								
						102.667	8.847	1.809	0.167	102.500	2.800	99.700	

FIGURES

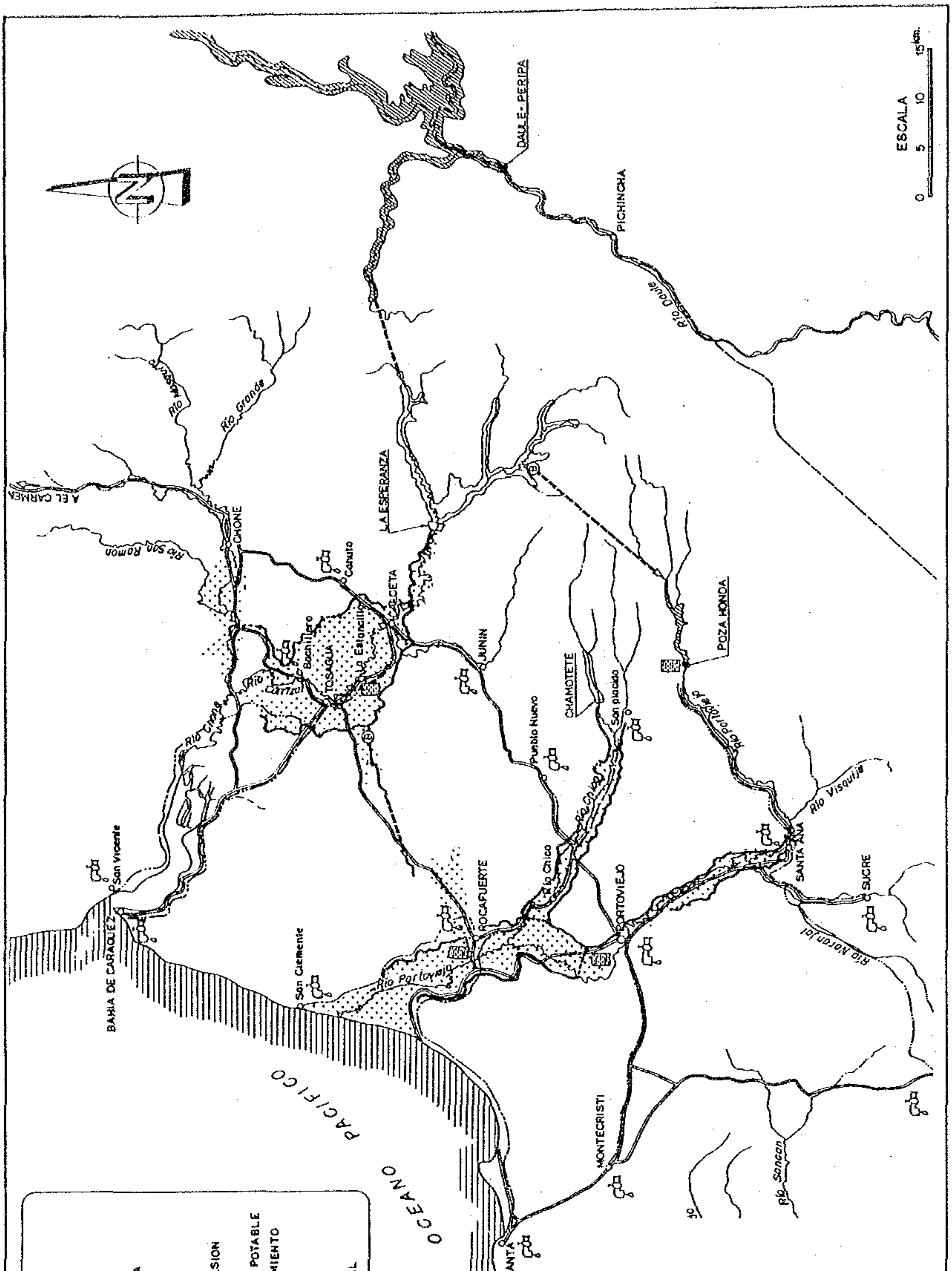


Fig I.1 Location Maps of Structures for Alternative-1

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

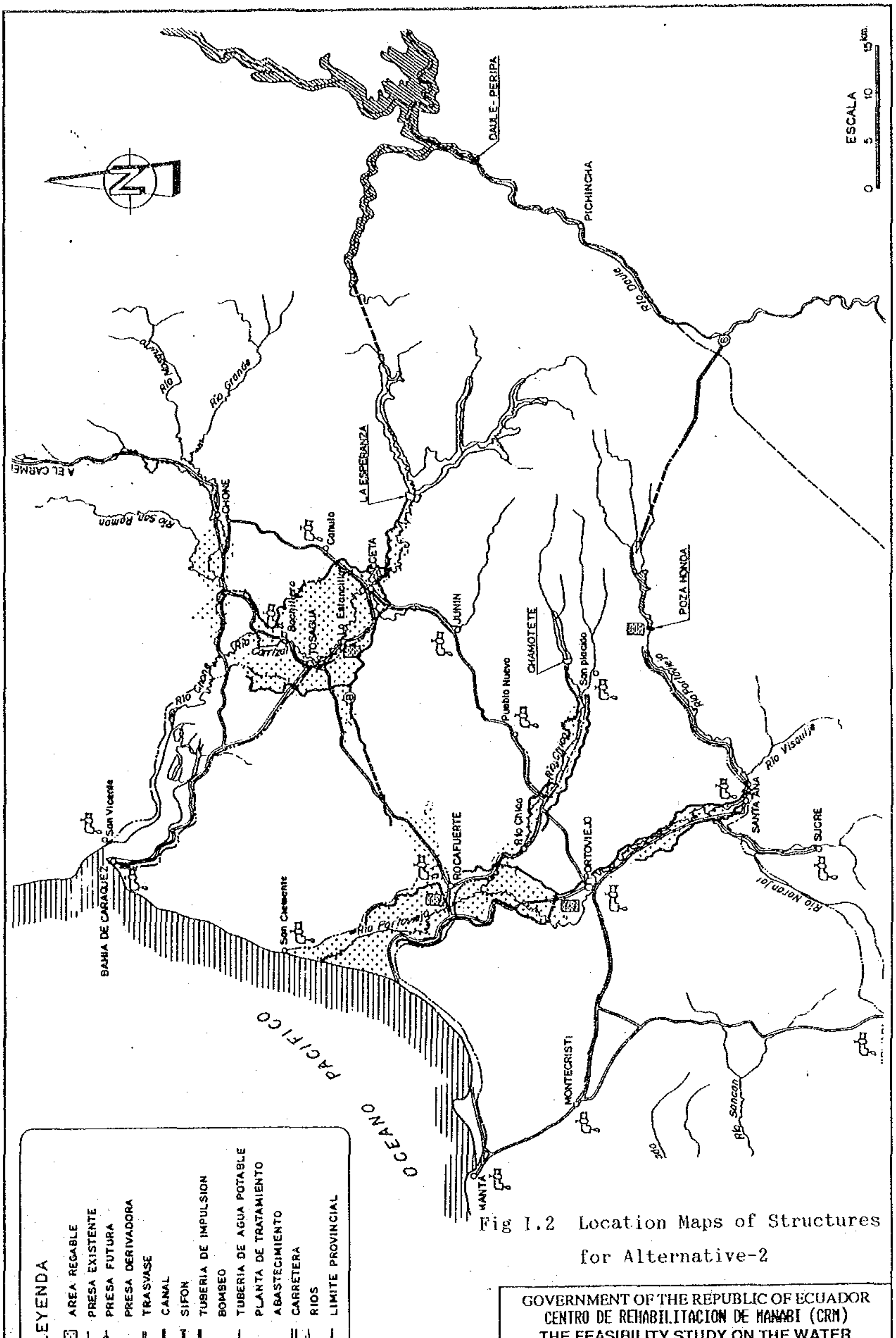


Fig I.2 Location Maps of Structures for Alternative-2

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

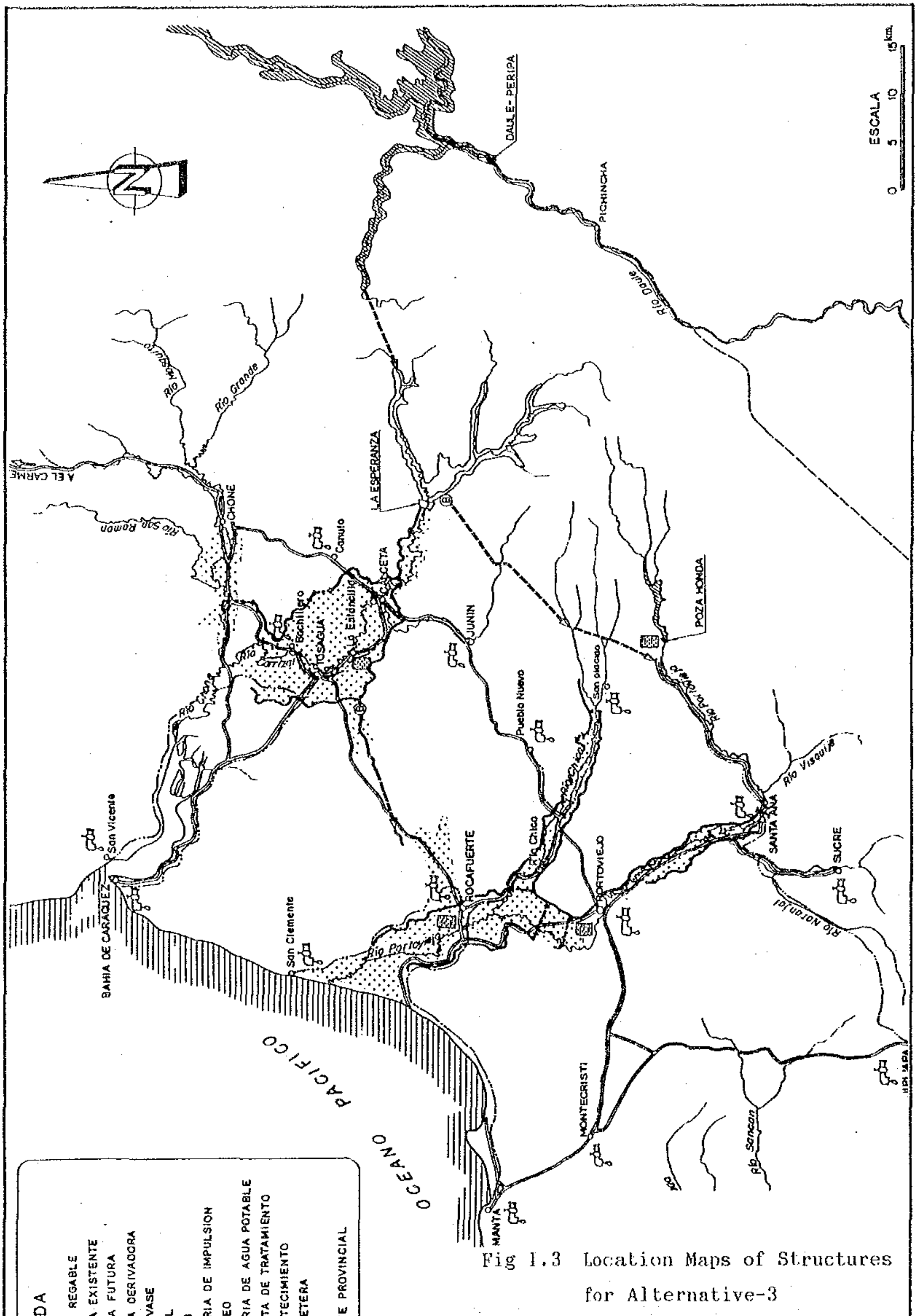


Fig 1.3 Location Maps of Structures for Alternative-3

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

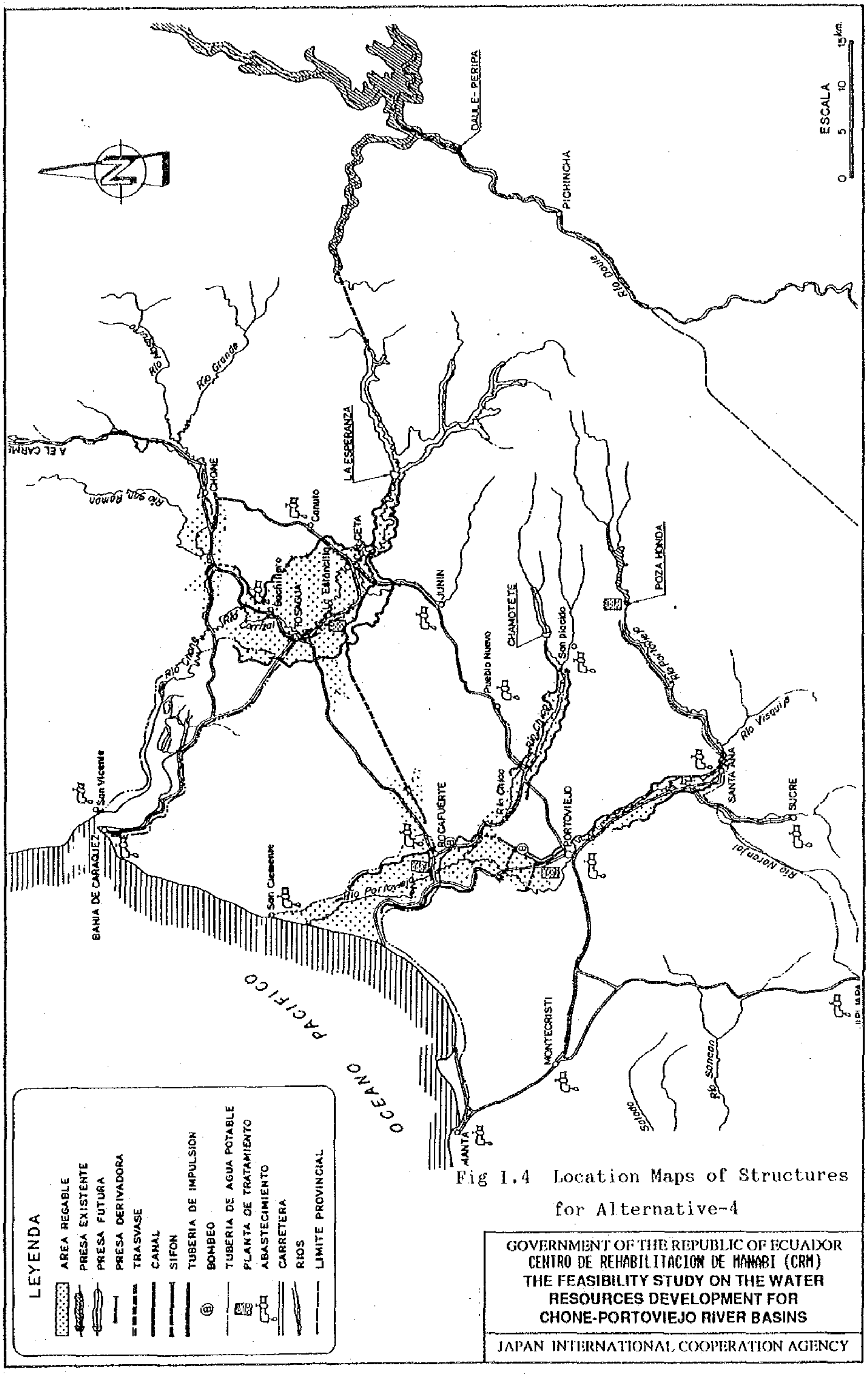


Fig I.4 Location Maps of Structures for Alternative-4

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

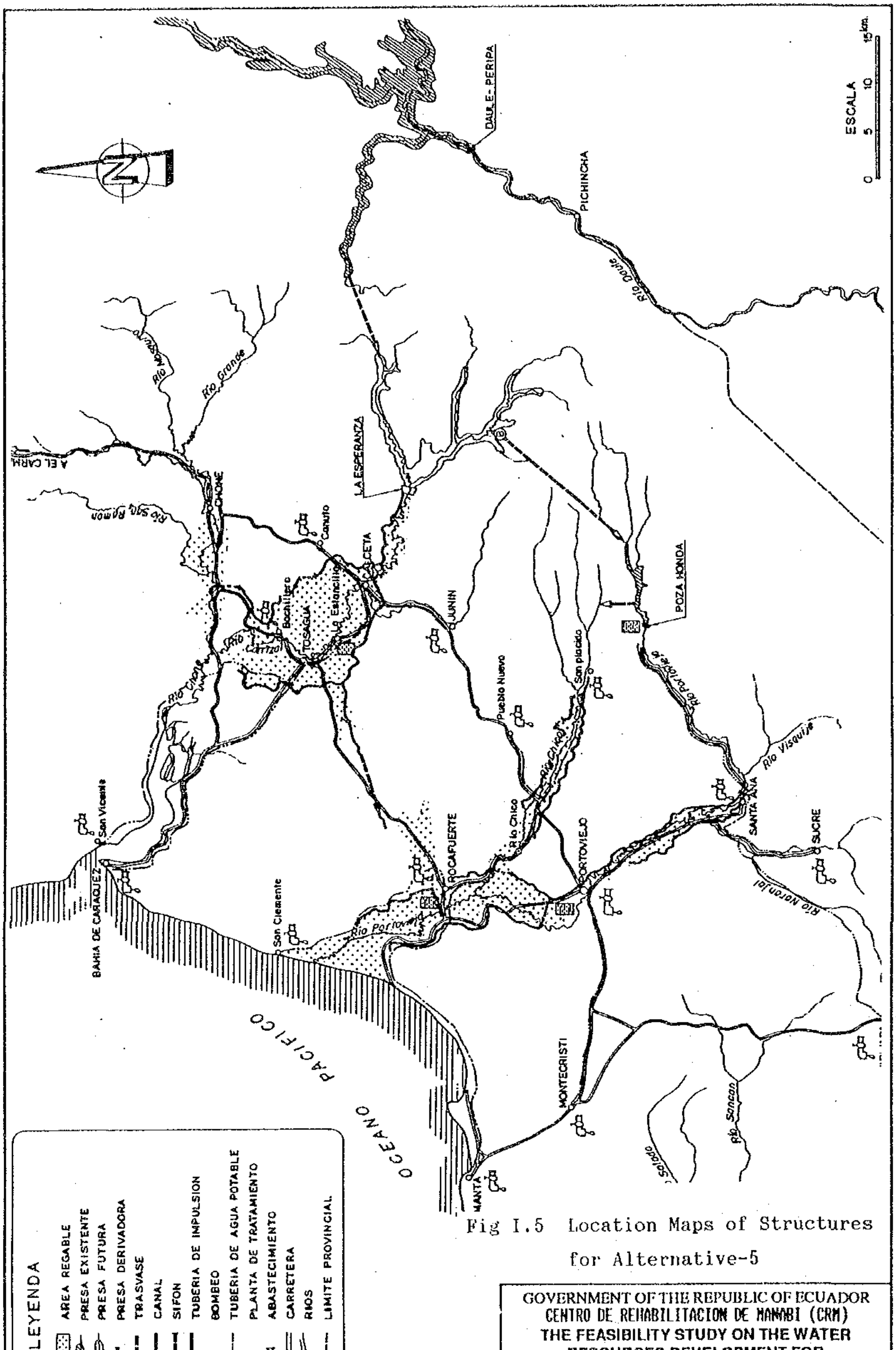


Fig I.5 Location Maps of Structures for Alternative-5

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

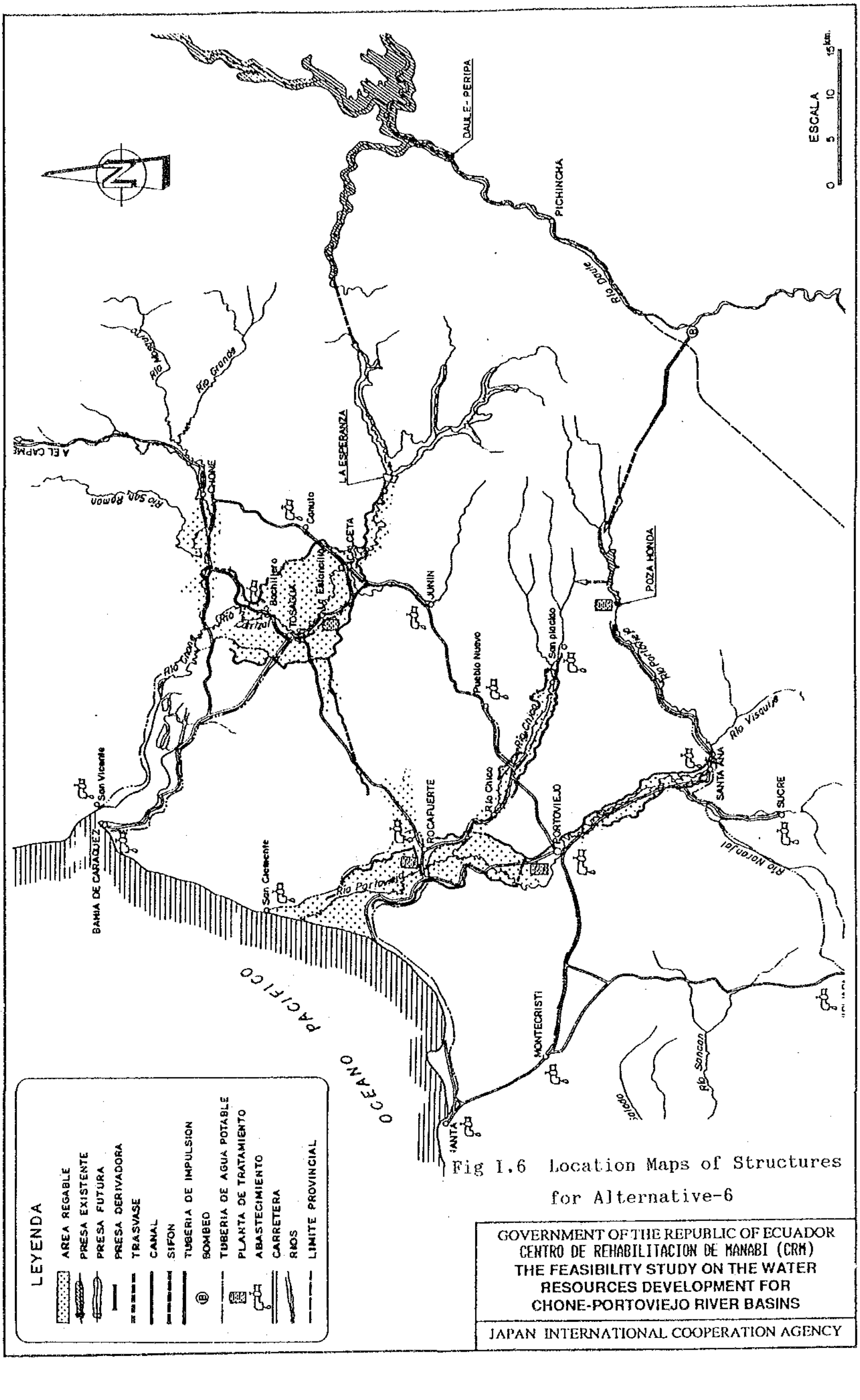


Fig I.6 Location Maps of Structures for Alternative-6

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

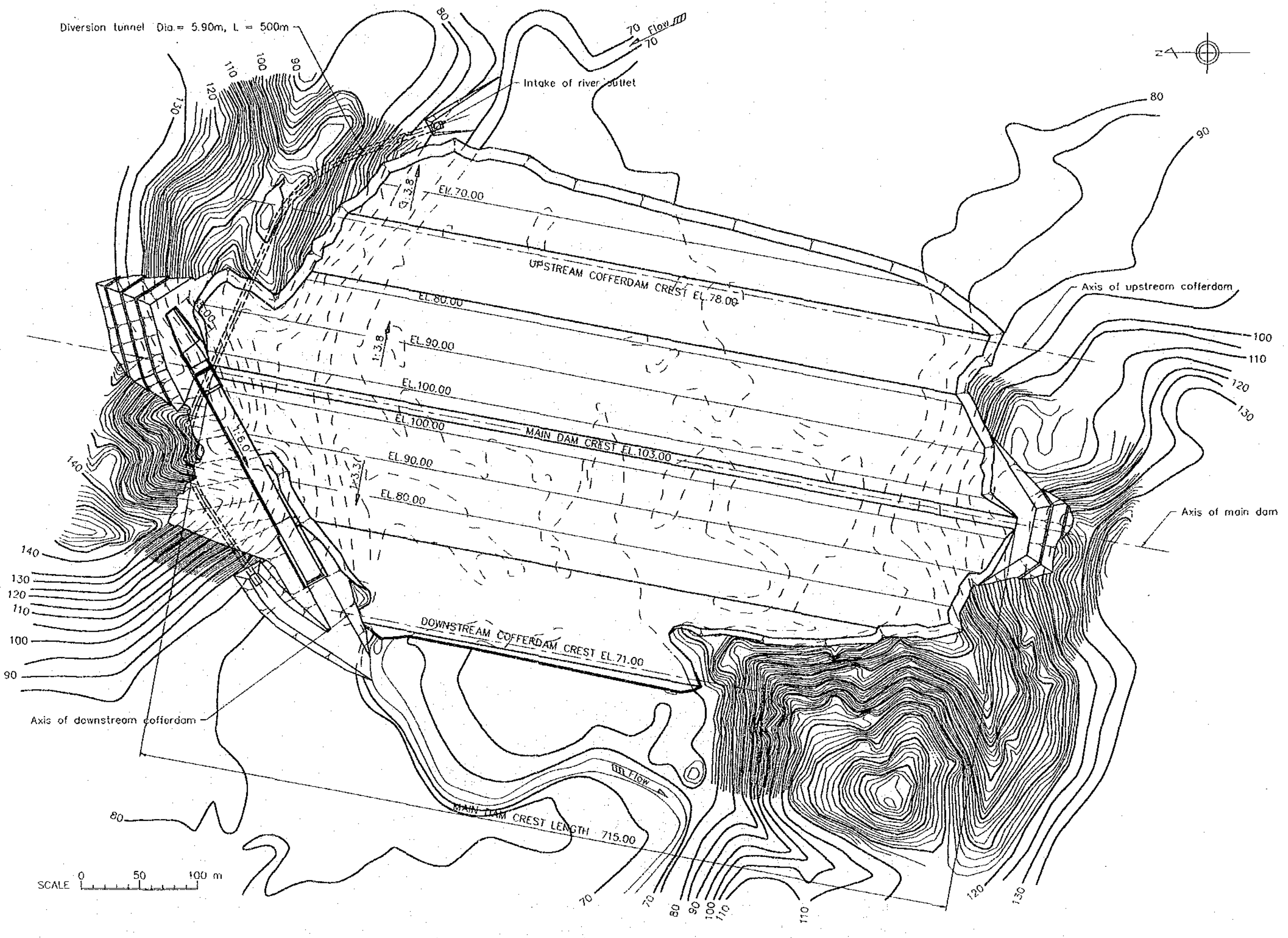
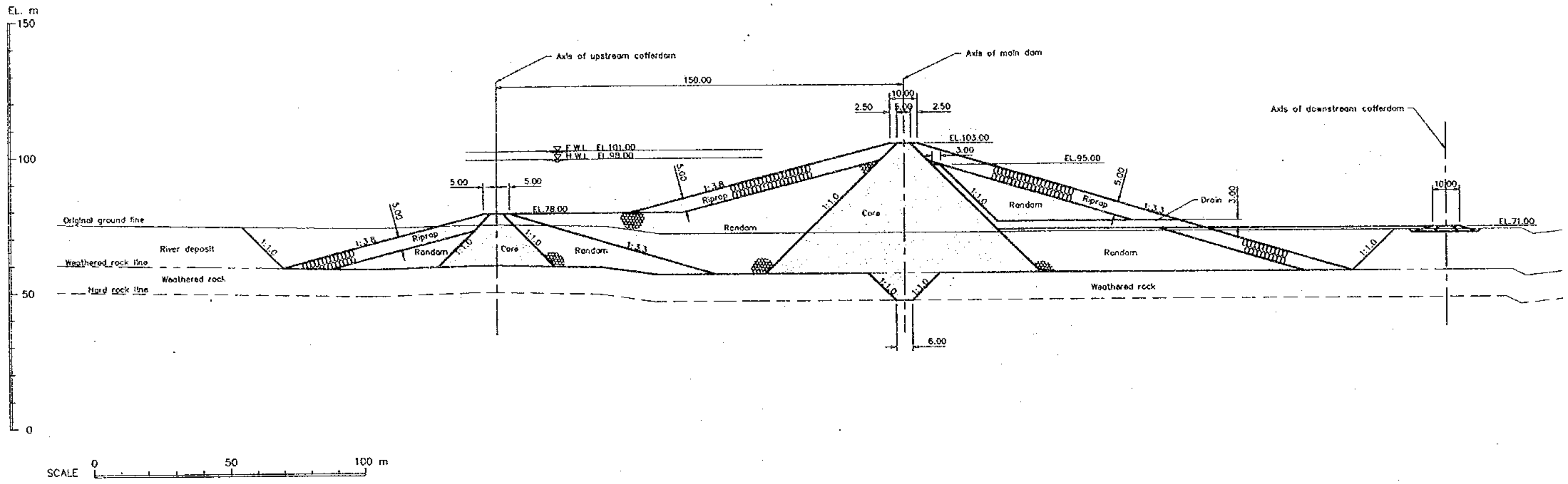


Fig. I.7 Preliminary Design of Chirijos Dam (1/2)

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY



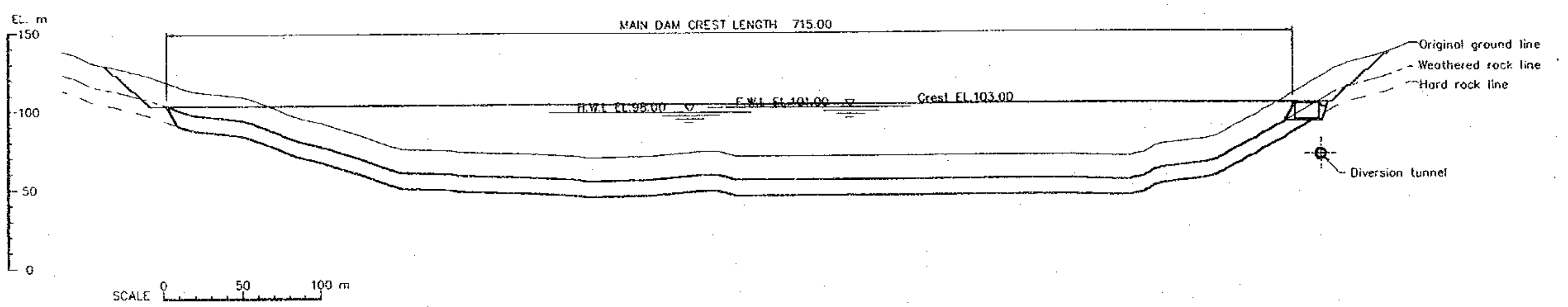
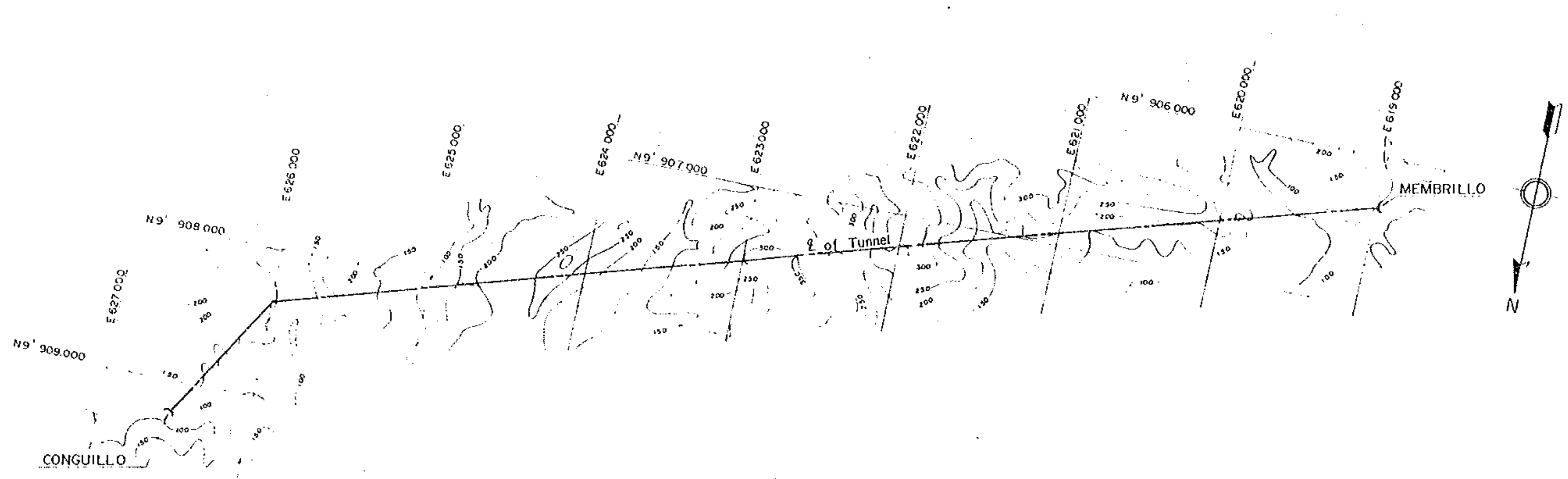


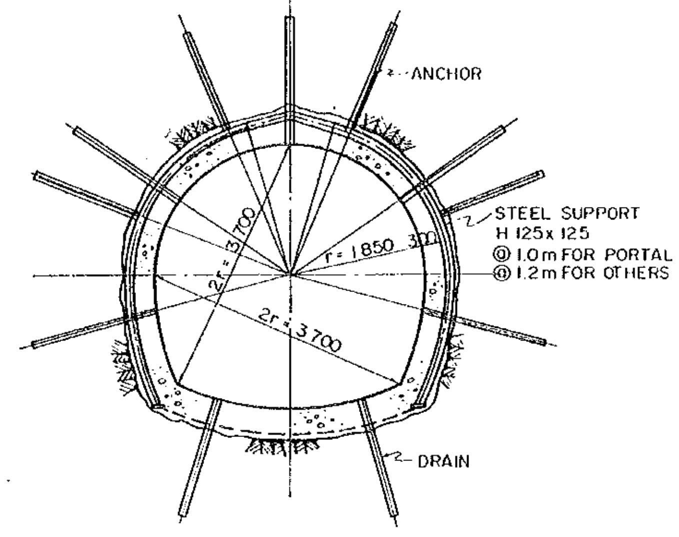
Fig. I.7 Preliminary Design of Chirijos Dam (2/2)

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

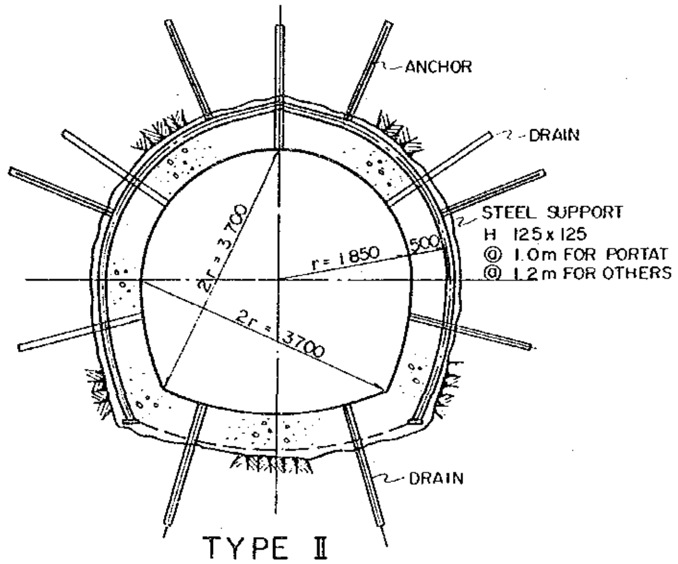
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN SCALE A

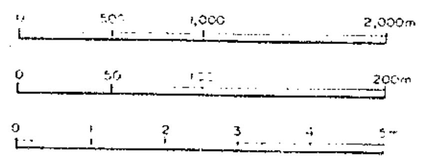


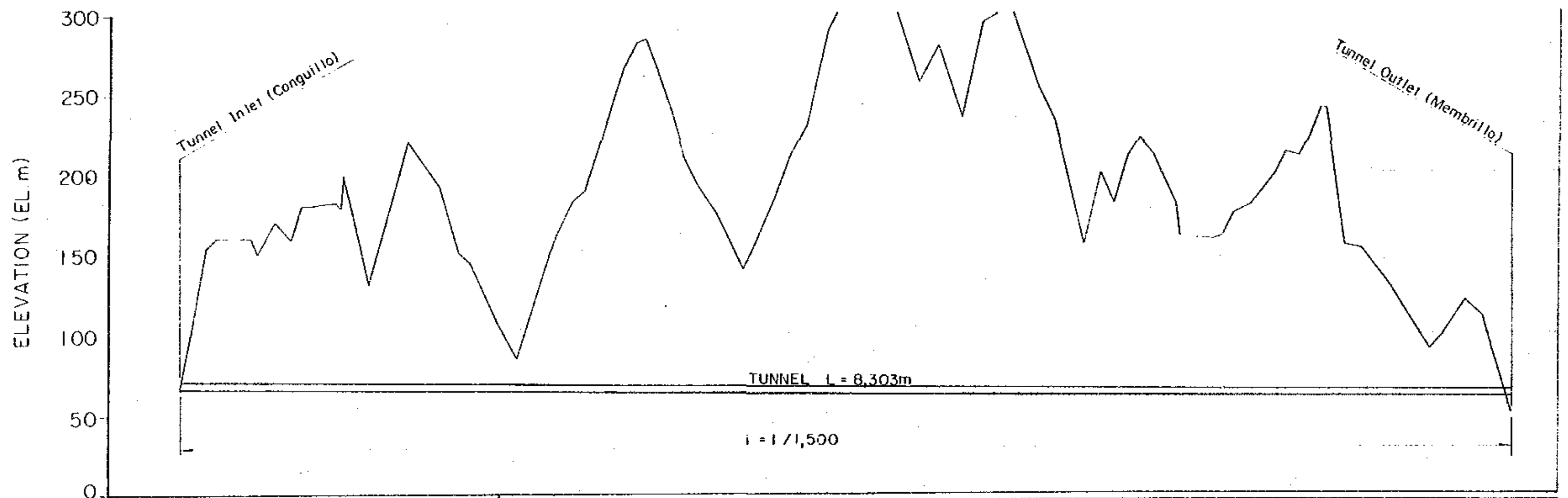
TYPE I



TYPE II

TYPICAL SECTION SCALE C



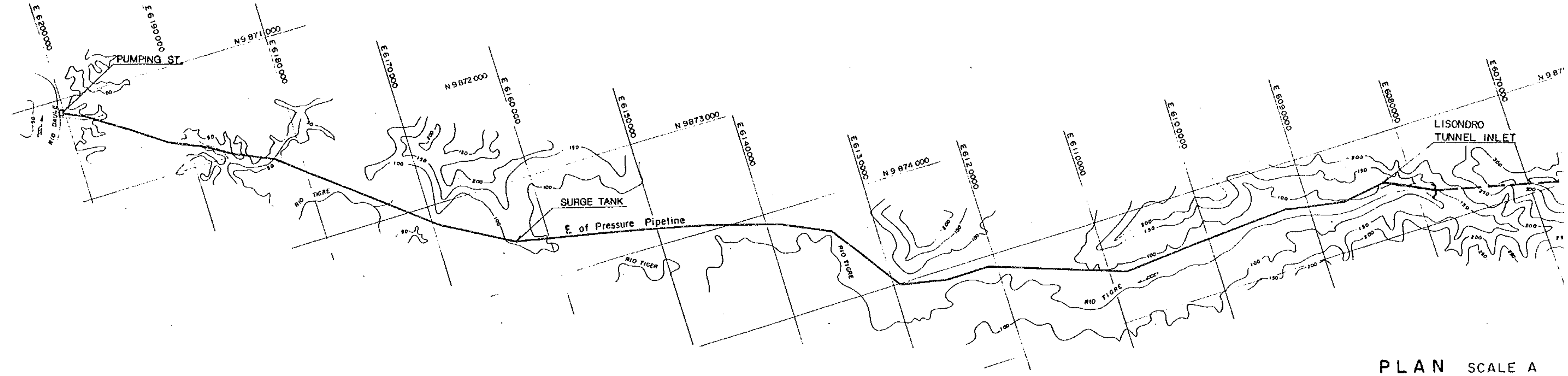


TYPE OF STRUCTURE	TUNNEL								
ELEVATION OF FORMATION (EL.m)	64.00	65.35	64.70	64.05	63.40	62.75	62.10	61.45	58.50
ELEVATION OF GROUND (EL.m)	66.00	180.00	105.00	264.00	258.00	290.00	220.00	212.00	60.60
ACCUMULATED DISTANCE (m)	0	1.000	2.000	3.000	4.000	5.000	6.000	7.000	8.303
DISTANCE (m)	0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.303
STATION	0+000	1+000	2+000	3+000	4+000	5+000	6+000	7+000	8+303

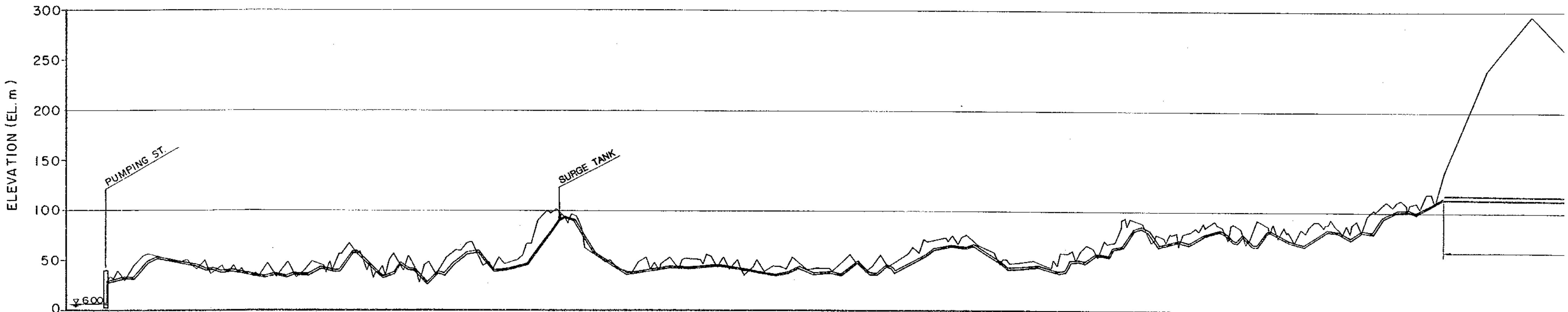
PROFILE H: SCALE A V: SCALE B

Fig. I.8 Preliminary Design of Water Transbasin Scheme "Daule Peripa - Esperanza Dam"

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

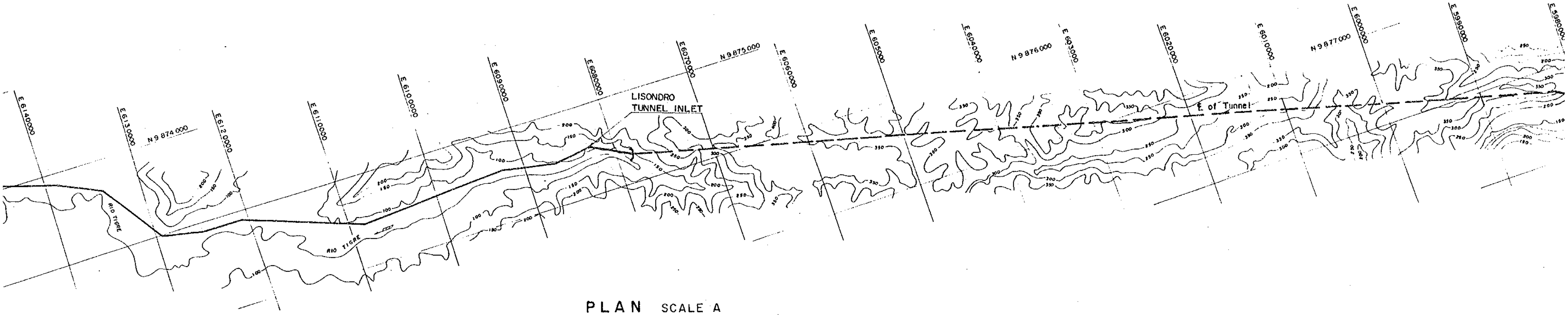


PLAN SCALE A

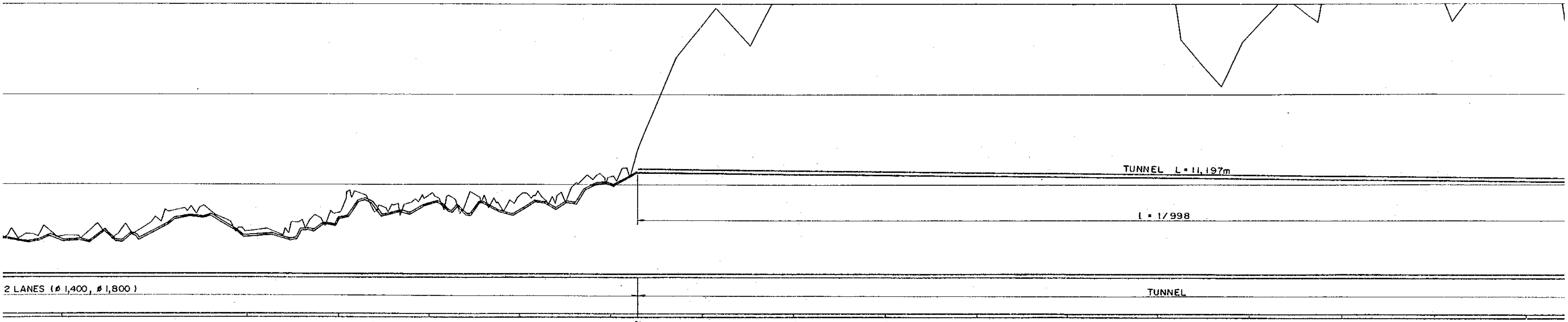


TYPE OF STRUCTURE	PRESSURE PIPE LINE L=13.3km, 2 LANES (ø 1,400, ø 1,800)															
ELEVATION OF FORMATION (EL.m)	30.00														113.72	112.98
ELEVATION OF GROUND (EL.m)	30.00	42.00	46.00	48.00	49.00	47.00	52.00	42.00	62.00	48.00	68.00	88.00	87.00	108.00	138.00	275.00
ACCUMULATED DISTANCE (m)	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	13000	13289	14000
DISTANCE (m)	0	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	289	711
STATION	0+000	1+000	2+000	3+000	4+000	5+000	6+000	7+000	8+000	9+000	10+000	11+000	12+000	13+000	13+289	14+000

PROFILE H : SCALE
V : SCALE

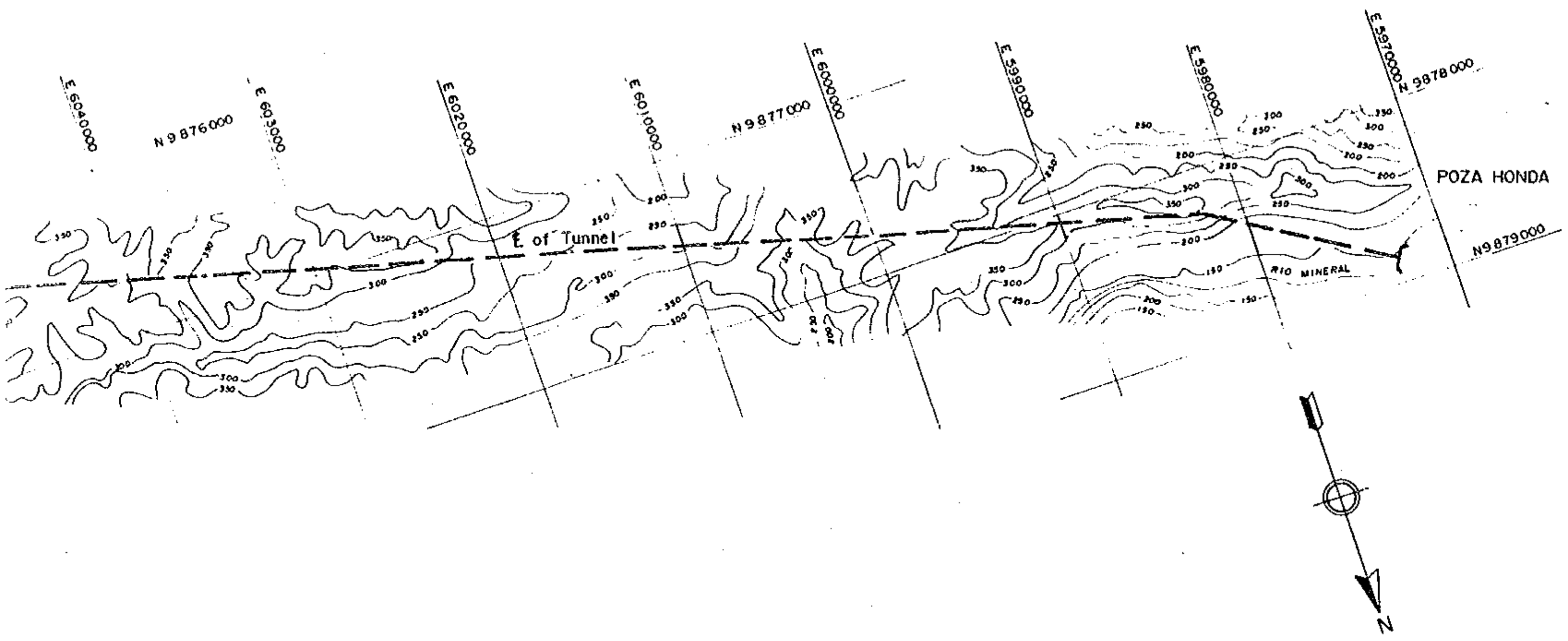


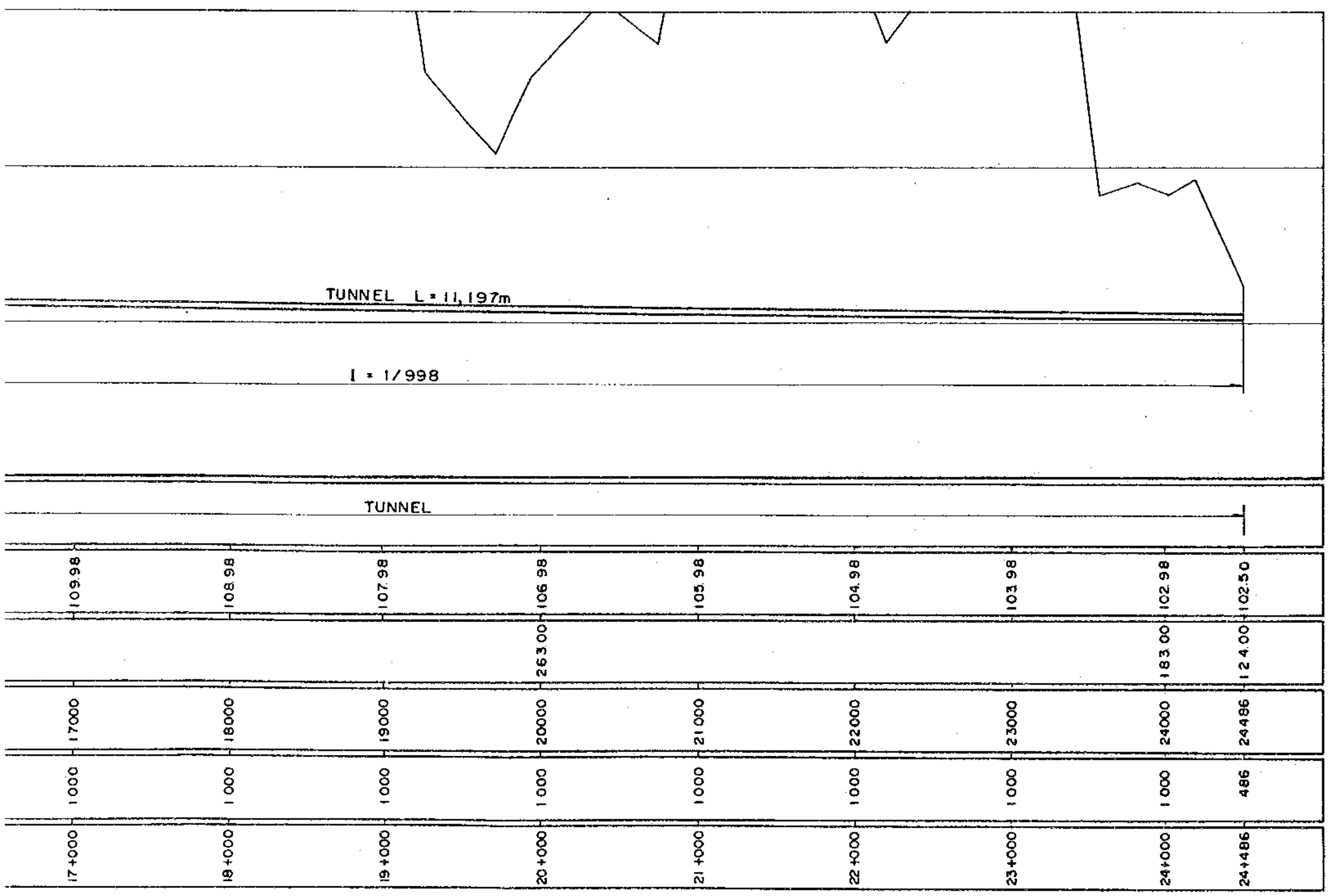
PLAN SCALE A

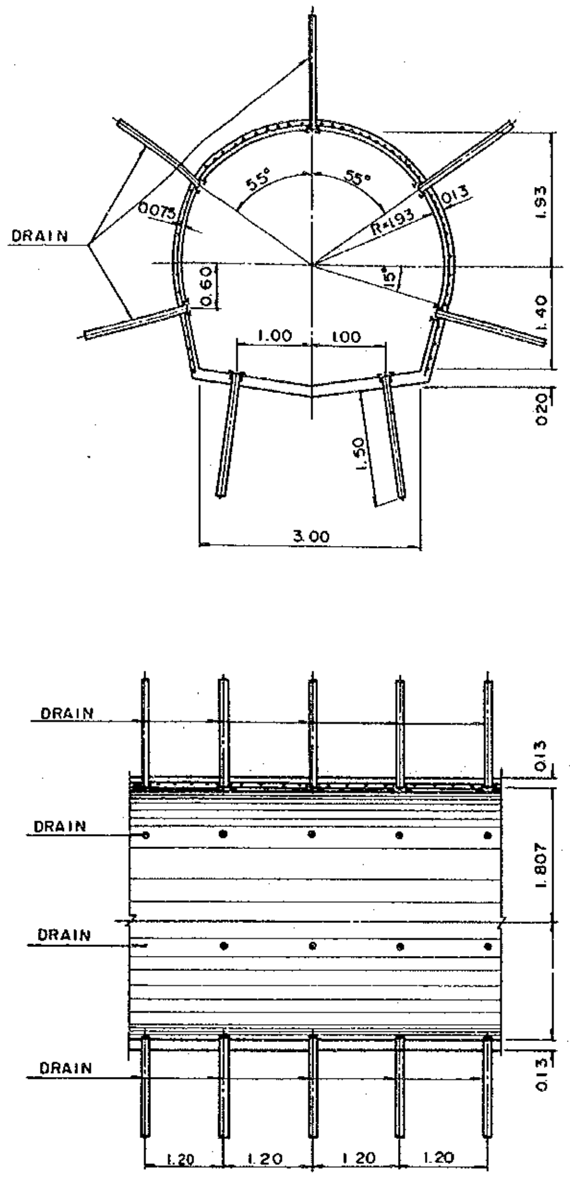


								113.72	112.98	111.98	110.98	109.98	108.98	107.98	106.98	105.98	104.98	103.98
	42.00	62.00	48.00	68.00	88.00	87.00	108.00	138.00	275.00						263.00			
	7000	8000	9000	10000	11000	12000	13000	13289	14000	15000	16000	17000	18000	19000	20000	21000	22000	23000
	1000	1000	1000	1000	1000	1000	1000	289	711	1000	1000	1000	1000	1000	1000	1000	1000	1000
	7+000	8+000	9+000	10+000	11+000	12+000	13+000	13+289	14+000	15+000	16+000	17+000	18+000	19+000	20+000	21+000	22+000	23+000

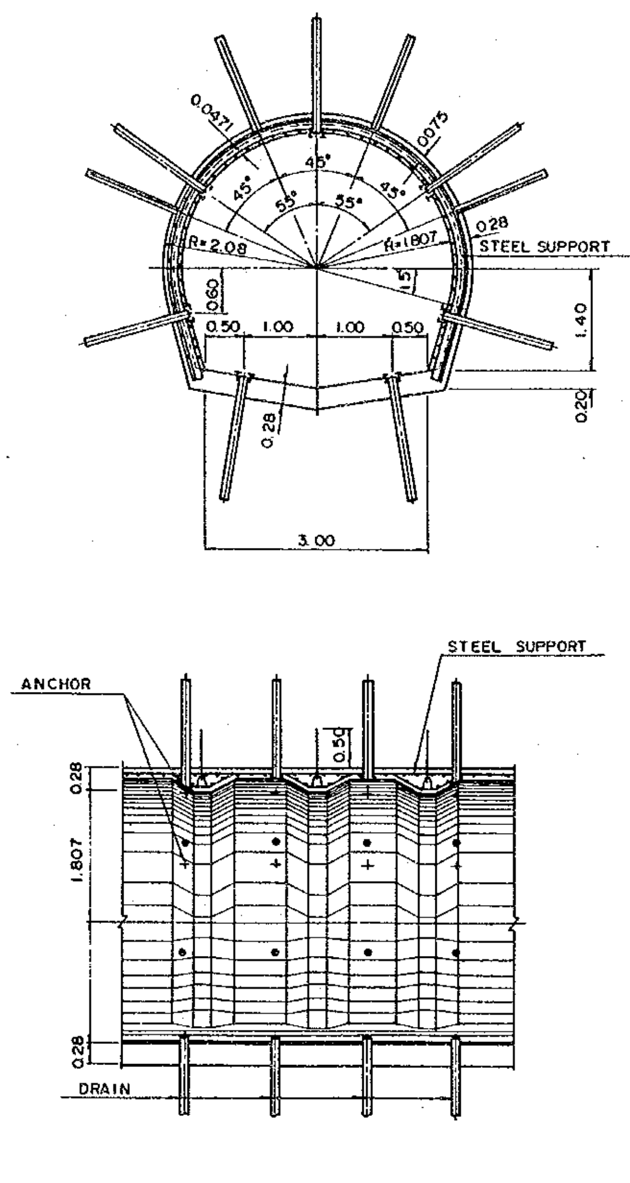
PROFILE H : SCALE A
V : SCALE B







SECTION (TUNNEL) SCALE C



SECTION (PORTAL) SCALE C

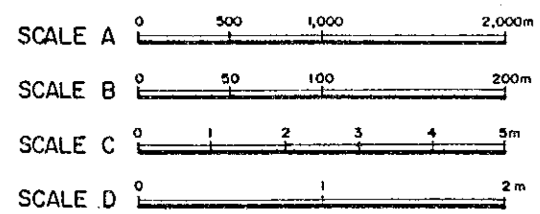
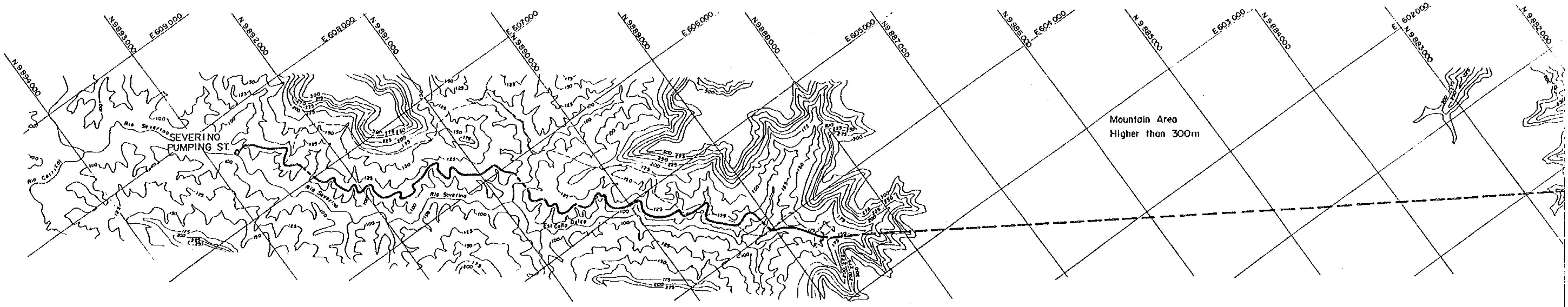
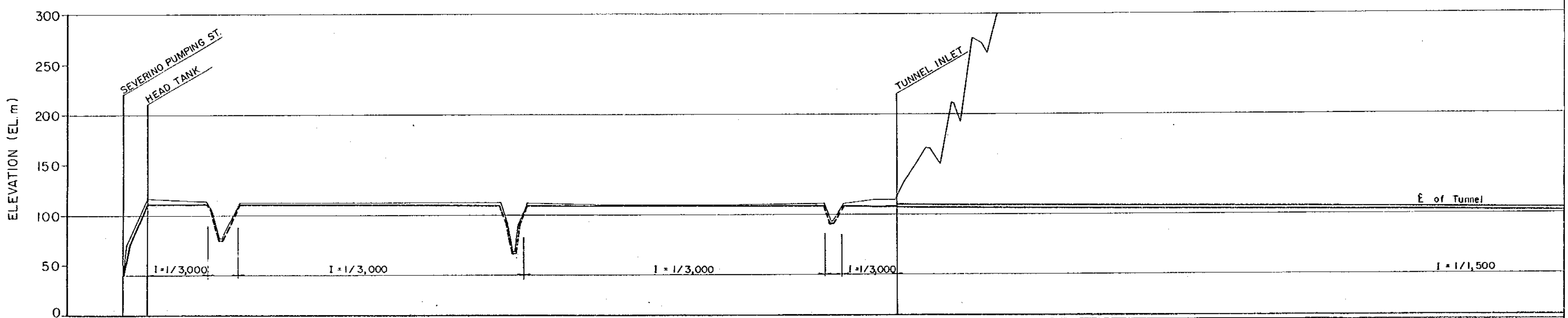


Fig. I.9 Preliminary Design of Water Transbasin Scheme "Rio Daule - Poza Honda Dam"

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

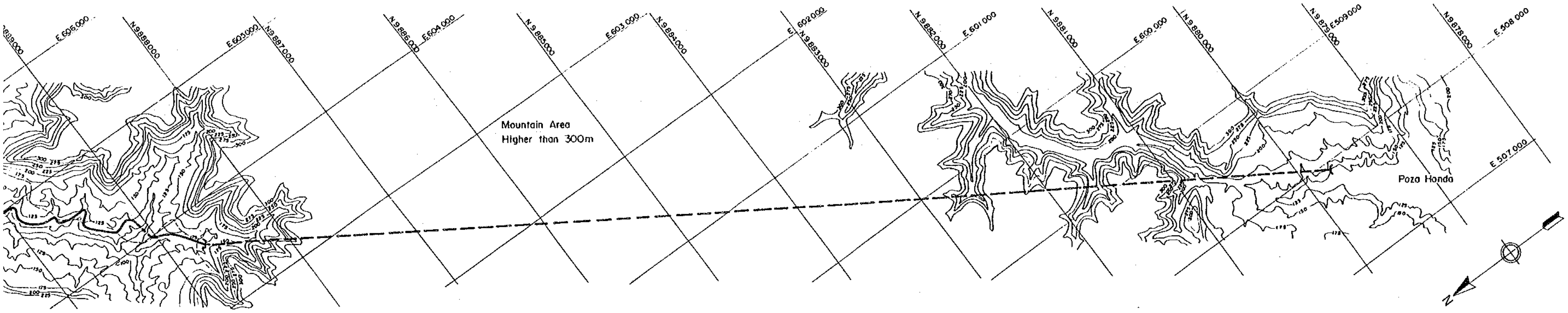


PLAN SCALE A

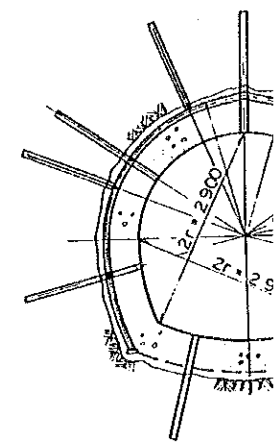


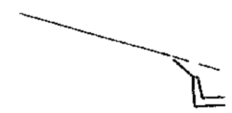
STATION	0+000	0+250	0+850	1+060	3+760	4+020	7+070	7+240	7+790	8+790	9+790	10+790	11+790	12+790	13+790
TYPE OF STRUCTURE	PIPELINE L=250m	OPEN CHANNEL L=600m	SYPHON L=210m ϕ2,700	OPEN CHANNEL L=2,700m	SYPHON L=260m ϕ2,700	OPEN CHANNEL L=3,050m	SYPHON L=170m ϕ2,700	OPEN CHANNEL L=550m	TUNNEL L=10.7km, D=3.1m						
ELEVATION OF FORMATION (EL.m)	38.20	111.29	110.09	110.73	109.83	109.43	108.41	108.02	107.31	106.64	105.98	105.31	104.64	103.98	103.31
ELEVATION OF GROUND (EL.m)	39.00	118.00							120.00						
ACCUMULATED DISTANCE (m)	0	250	850	1 060	3 760	4 020	7 070	7 240	7 790	8 790	9 790	10 790	11 790	12 790	13 790
DISTANCE (m)	0	250	600	210	2 700	260	3 050	170	550	1 000	1 000	1 000	1 000	1 000	1 000

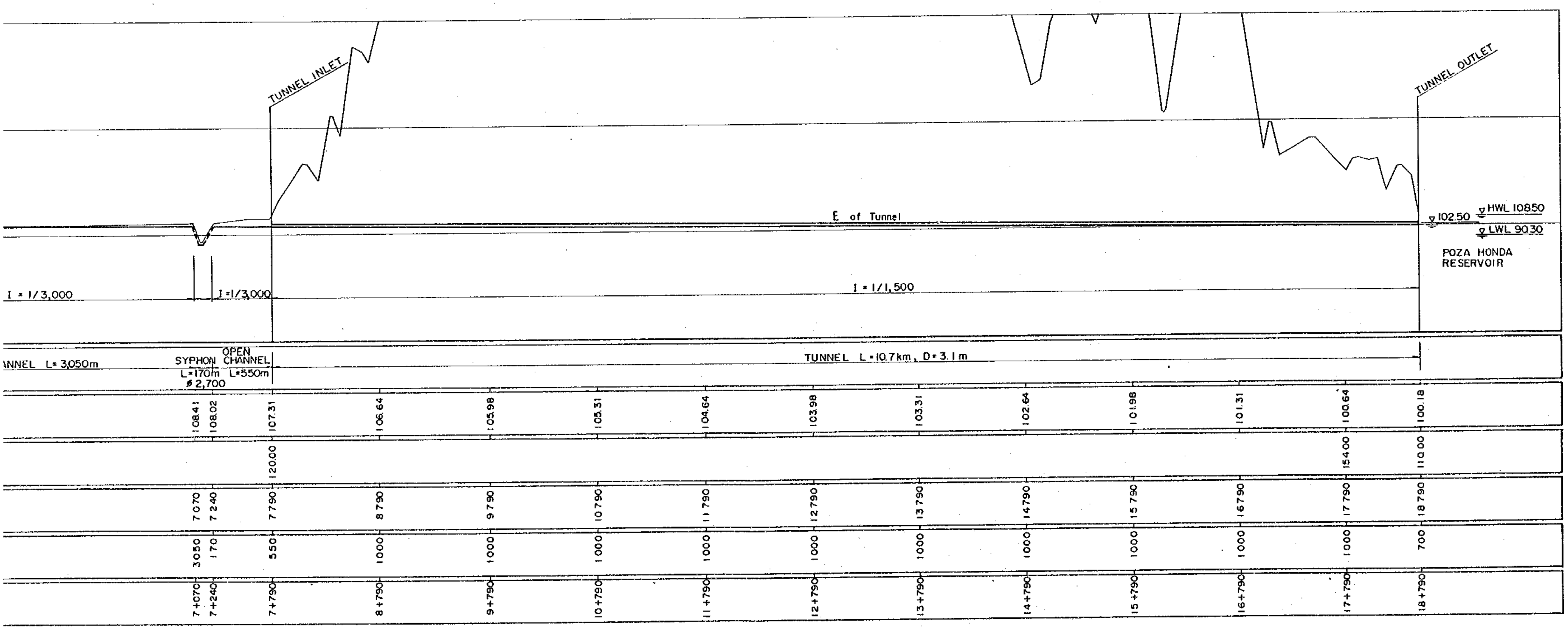
PROFILE H : SCALE A
V : SCALE B



PLAN SCALE A

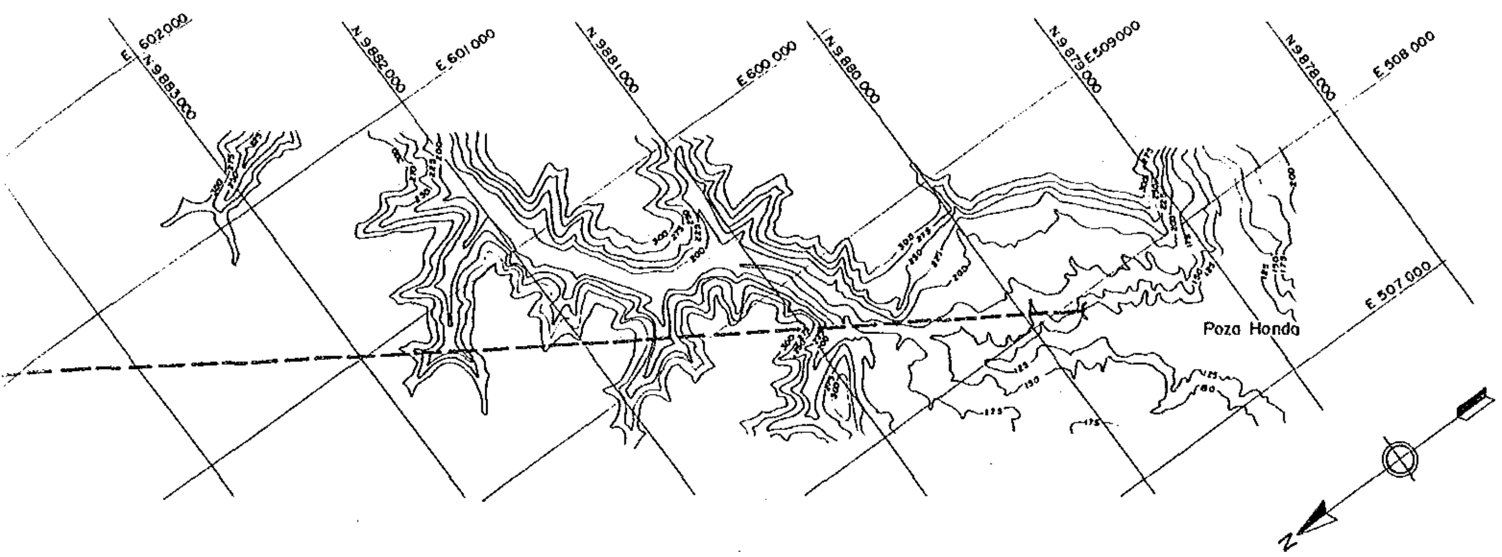


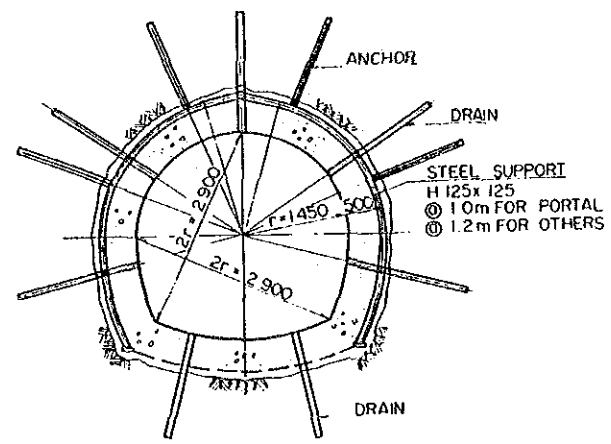




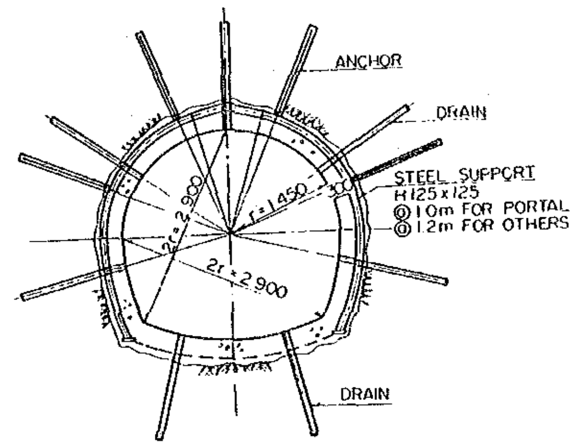
PROFILE H : SCALE A
V : SCALE B

SCALE A
SCALE B
SCALE C
SCALE D

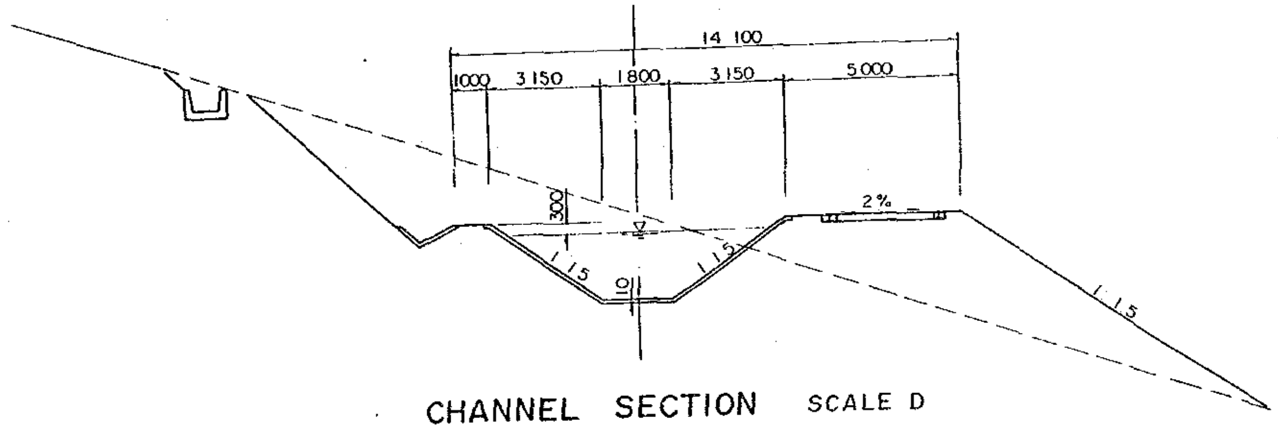




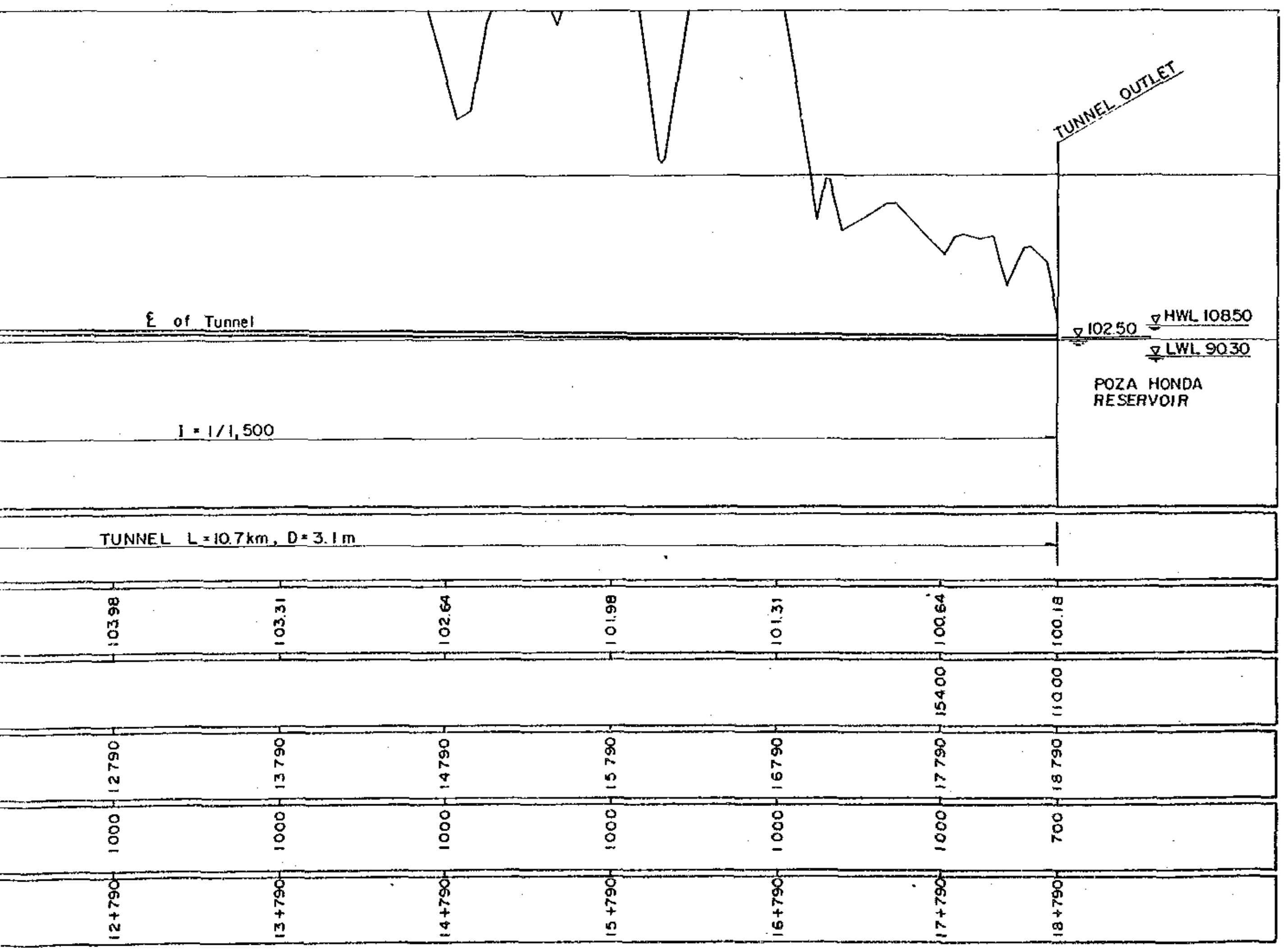
SECTION (PORTAL) SCALE C



SECTION (TUNNEL) SCALE C



CHANNEL SECTION SCALE D



SCALE A
SCALE B
SCALE C
SCALE D

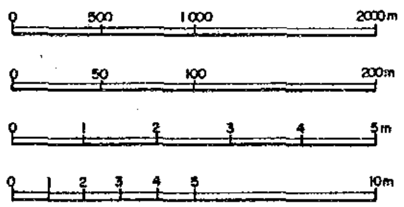
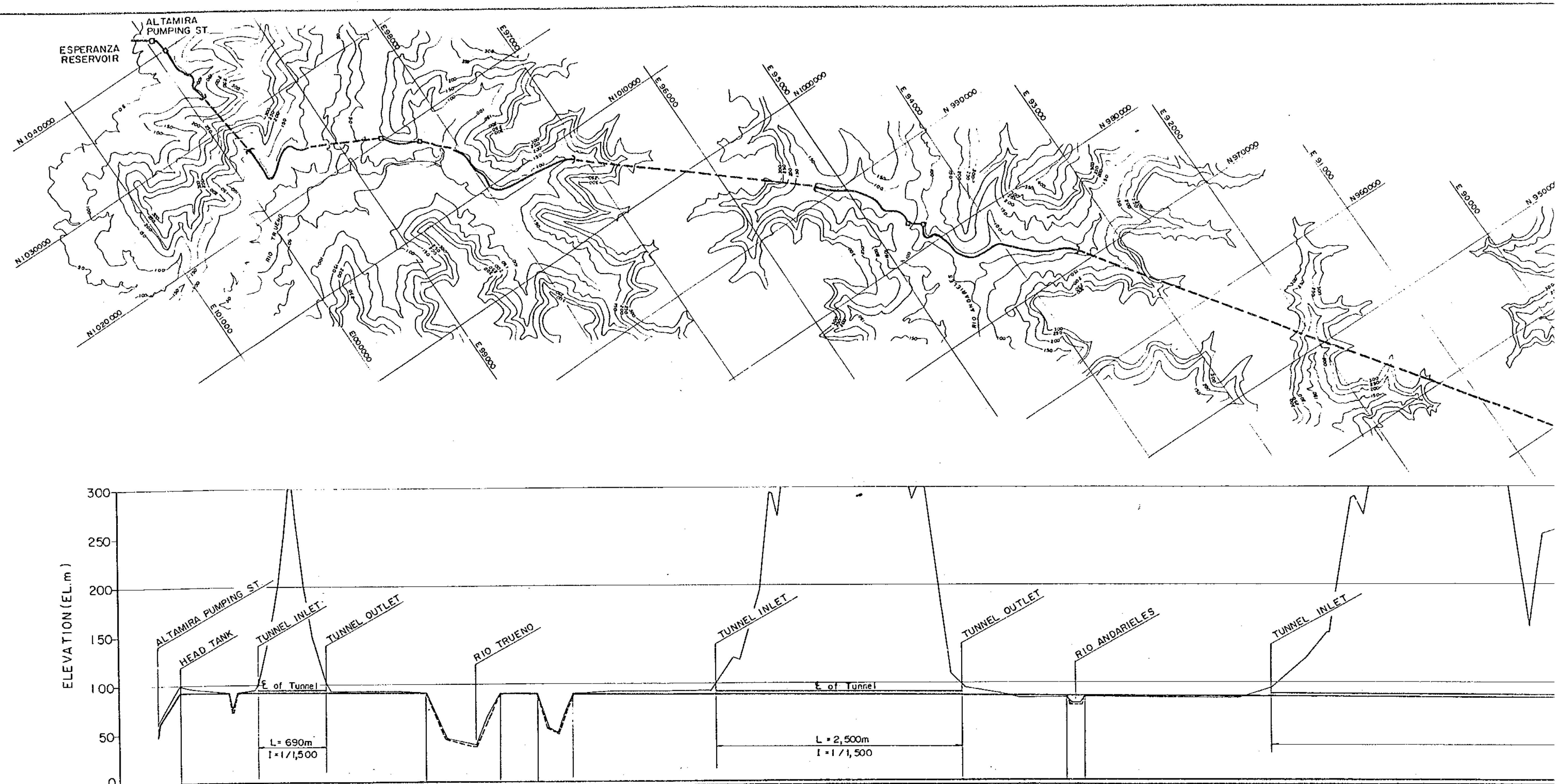


Fig. I.10 Preliminary Design of Water Transbasin Scheme "Esperanza Dam (Severino) - Poza Honda Dam"

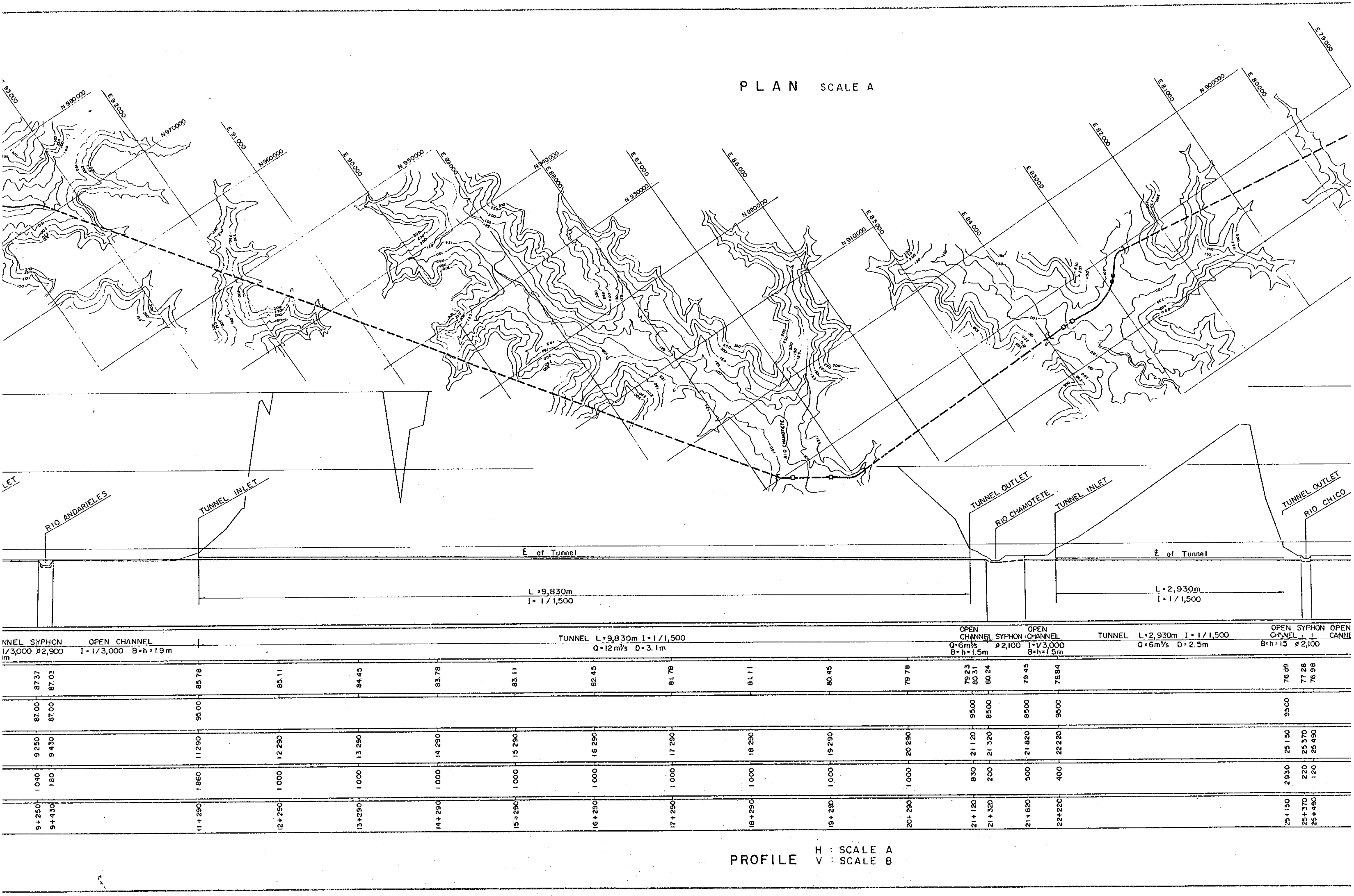
GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

JAPAN INTERNATIONAL COOPERATION AGENCY

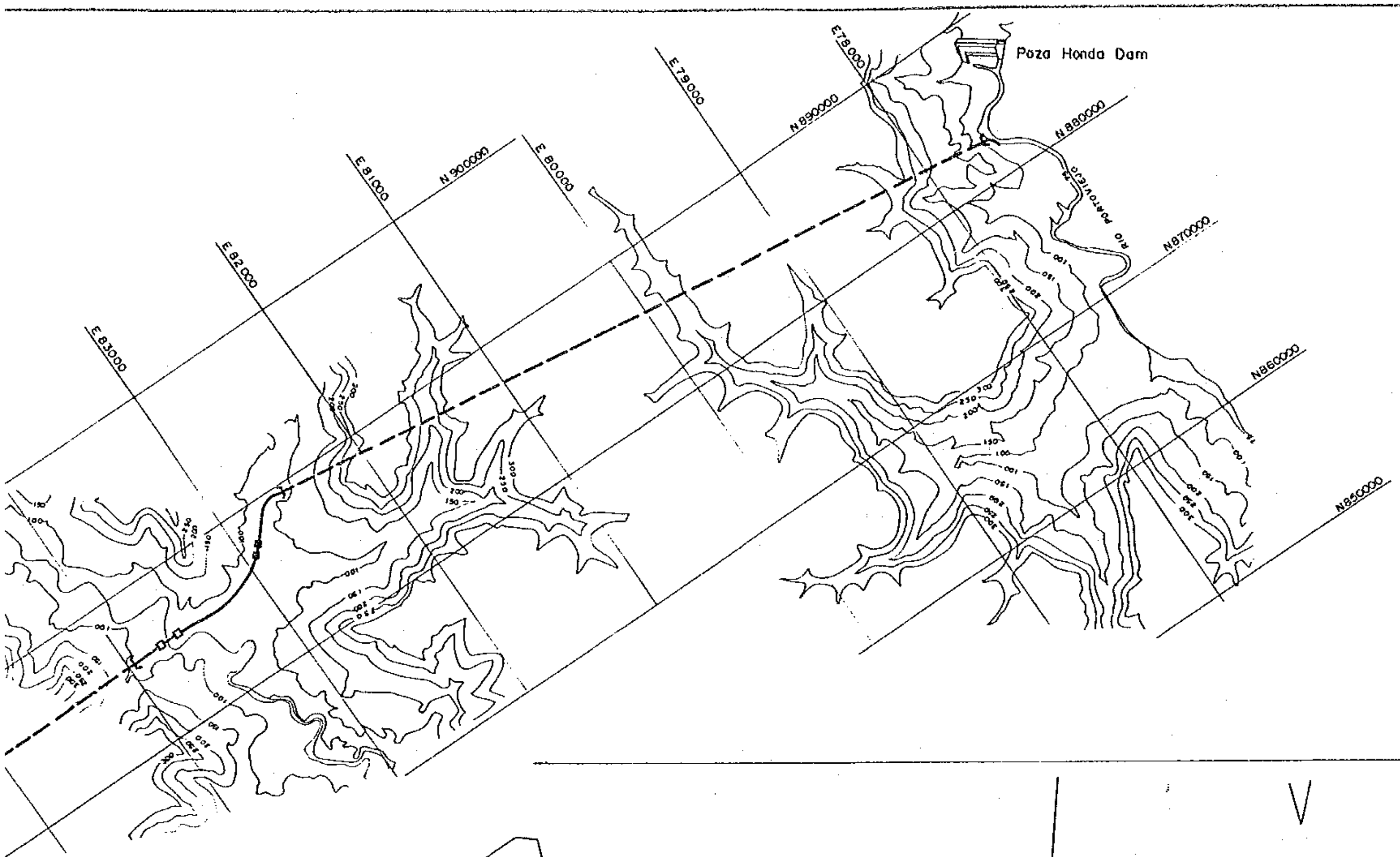


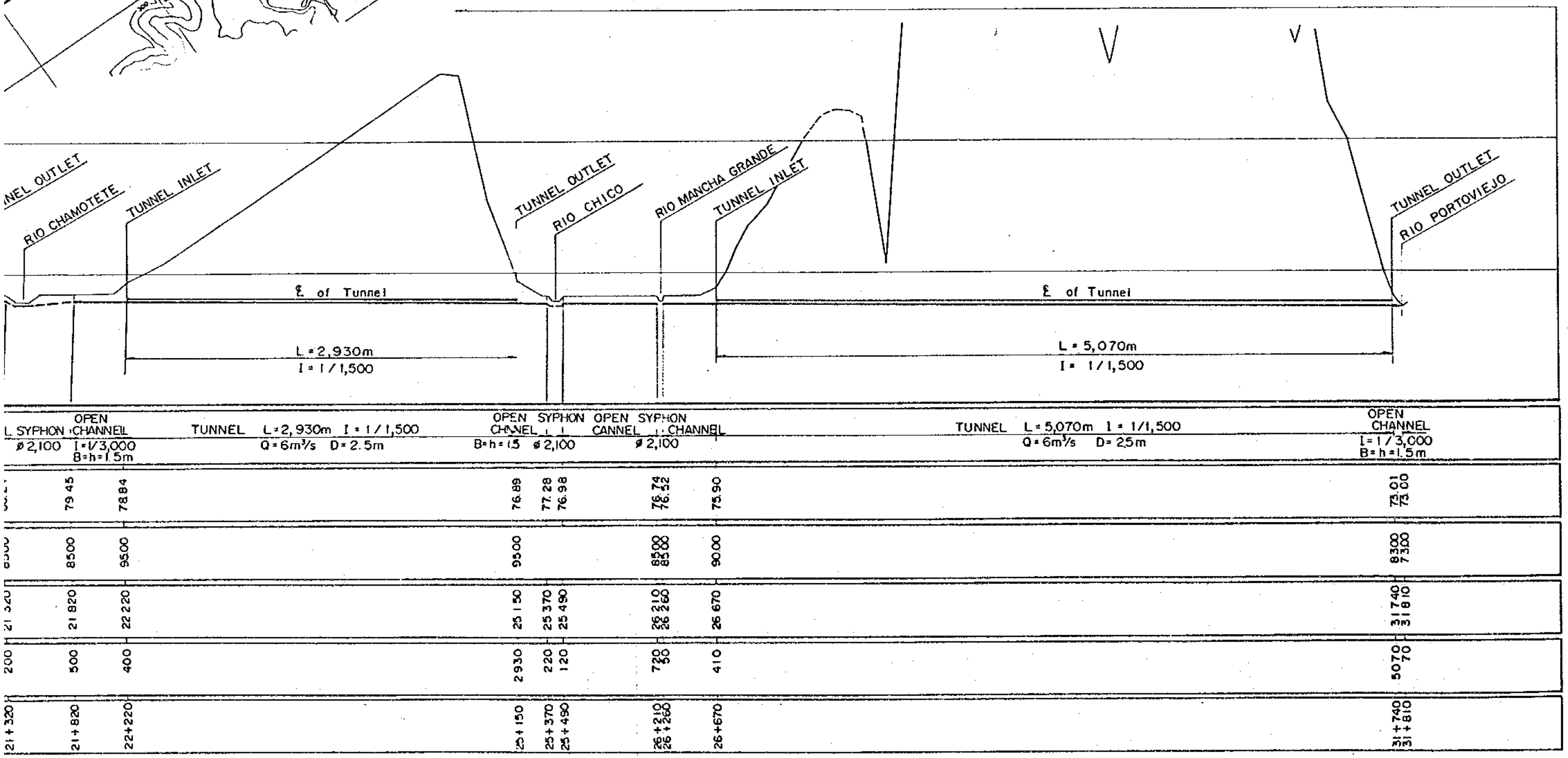
TYPE OF STRUCTURE: PIPE LINE (Q=12m³/s, 2ø2,000) | OPEN CHANNEL (I=3,000, B=h=1.9m) | OPEN CHANNEL SYPHON (ø2,900) | TUNNEL (I=1/1,500, D=3.1m) | OPEN CHANNEL (I=1/3,000, B=h=1.9m) | SYPHON (Q=14m³/s, ø 2,900) | OPEN CHANNEL (I=1/3,000, B=h=1.9m) SYPHON (ø2,900) OPEN CHANNEL (Q=12m³/s, I=1/3,000, B=h=1.9m) | TUNNEL (I=1/1,500, D=3.1m) | OPEN CHANNEL (Q=12m³/s, I=1/3,000, B=h=1.9m) SYPHON (ø2,900) OPEN CHANNEL (I=1/3,000, B=h=1.9m) |

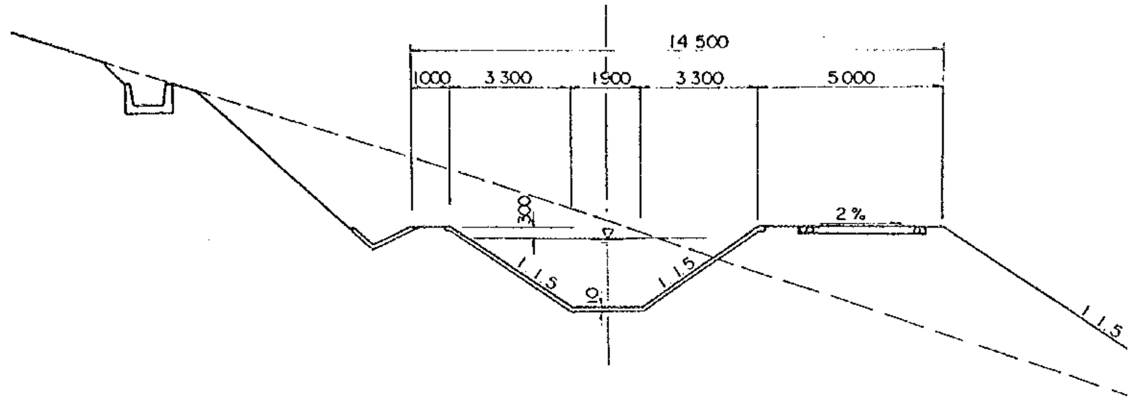
ELEVATION OF FORMATION (EL.m)	38.20	92.70	92.53	92.30	91.60	91.75	91.41	90.53	90.40	89.89	88.77	87.10	87.37	87.03	85.78	85.11	84.45
ELEVATION OF GROUND (EL.m)	62.00	100.00	93.00	93.00	100.00	100.00	91.00	90.00			100.00	100.00	87.00	87.00	95.00		
ACCUMLATED DISTANCE (m)	0	220	720	790	1 010	1 700	2 720	3 470	3 850	4 210	5 710	8 210	9 250	9 430	11 290	12 290	13 290
DISTANCE (m)	0	220	500	70	220	690	1 020	750	380	360	1 500	2 500	1 040	180	1 860	1 000	1 000
STATION	0+000	0+220	0+720	0+790	1+010	1+700	2+720	3+470	3+850	4+210	5+710	8+210	9+250	9+430	11+290	12+290	13+290



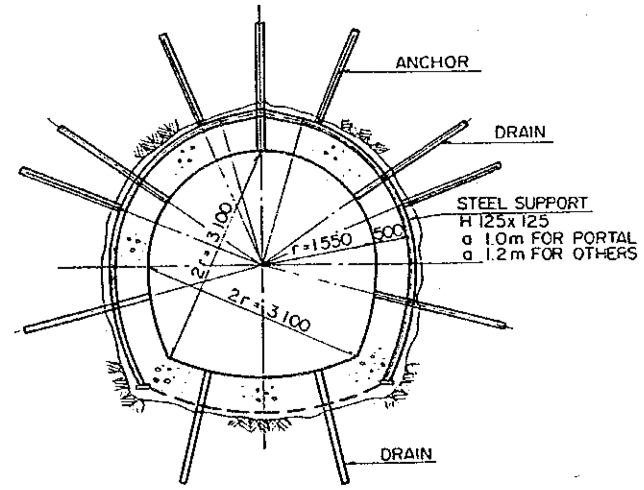
PLAN SCALE A
E 93000
N 980000
E 92000
N 970000
E 91000
N 960000
E 90000
N 950000
E 89000
N 940000
E 88000
N 930000
E 87000
E 86000
N 920000
E 85000
N 910000
E 84000
E 83000
E 82000
E 81000
N 900000
E 80000
E 79000
RIO CHAMOTETE
LET
RIO ANDARIELES
TUNNEL INLET
TUNNEL OUTLET
RIO CHAMOTETE
TUNNEL INLET
TUNNEL OUTLET
RIO CHICO
℄ of Tunnel
℄ of Tunnel
L =9,830m
I = 1/1,500
L = 2,930m
I = 1/1,500
NNEL SYPHON OPEN CHANNEL
1/3,000 ø2,900 I = 1/3,000 B=h = 1.9m
TUNNEL L = 9,830m I = 1/1,500
Q = 12m³/s D = 3.1m
OPEN CHANNEL SYPHON OPEN CHANNEL
Q = 6m³/s ø2,100 I = 1/3,000
B = h = 1.5m B = h = 1.5m
TUNNEL L = 2,930m I = 1/1,500
Q = 6m³/s D = 2.5m
OPEN SYPHON OPEN CHANNEL CANNE
B = h = 1.5 ø2,100
87.37 87.03 85.78 85.11 84.45 83.78 83.11 82.45 81.78 81.11 80.45 79.78 79.23 80.31 80.24 79.45 78.84 76.89 77.28 76.98
87.00 87.00 95.00 95.00 85.00 85.00 95.00 95.00
9 250 9 430 11 290 12 290 13 290 14 290 15 290 16 290 17 290 18 290 19 290 20 290 21 120 21 320 21 820 22 220 25 150 25 370 25 490
1 040 180 1 860 1 000 1 000 1 000 1 000 1 000 1 000 1 000 1 000 1 000 830 200 500 400 2930 220 120
9+250 9+430 11+290 12+290 13+290 14+290 15+290 16+290 17+290 18+290 19+290 20+290 21+120 21+320 21+820 22+220 25+150 25+370 25+490
PROFILE H : SCALE A
V : SCALE B



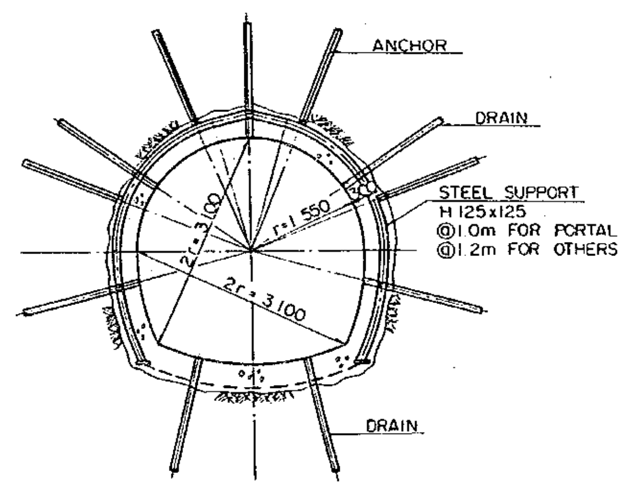




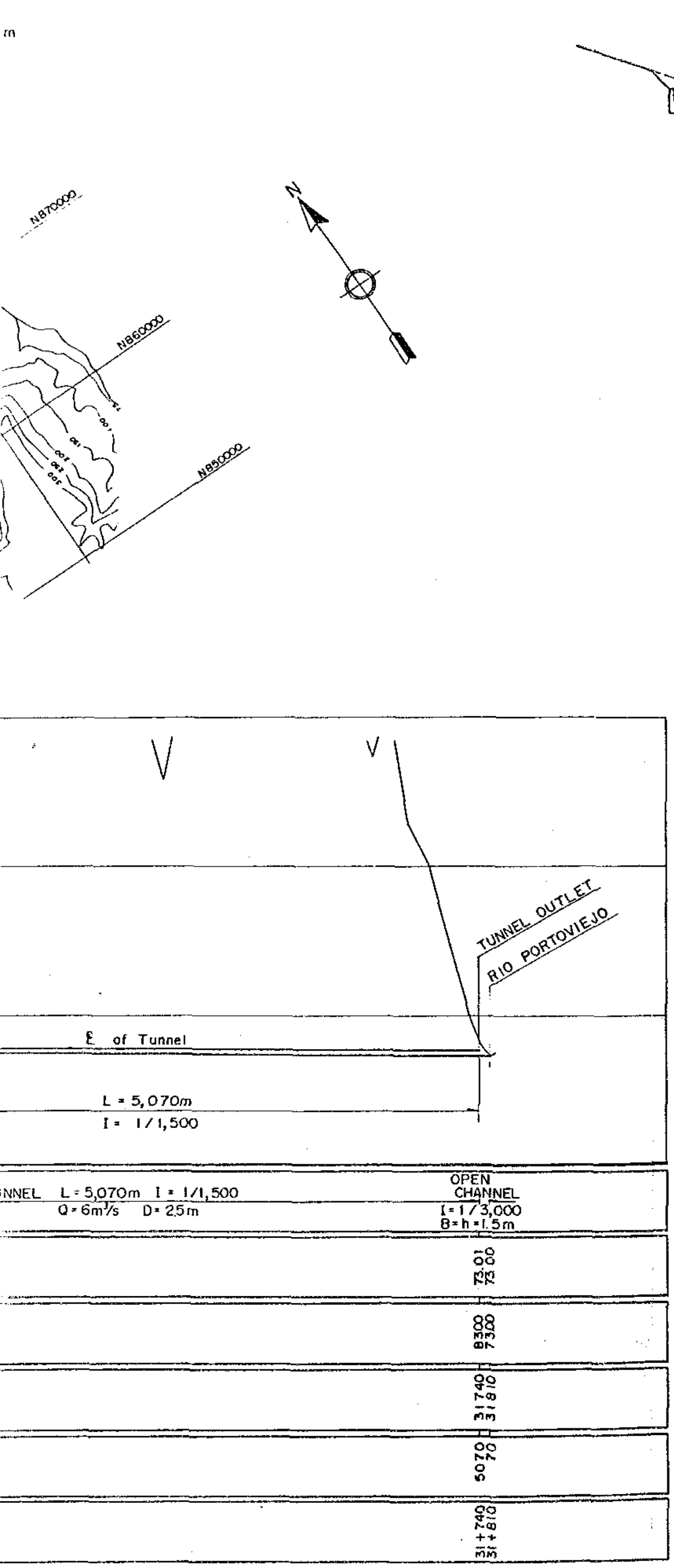
CHANNEL SECTION (Q=12 m³/s) SCALE D

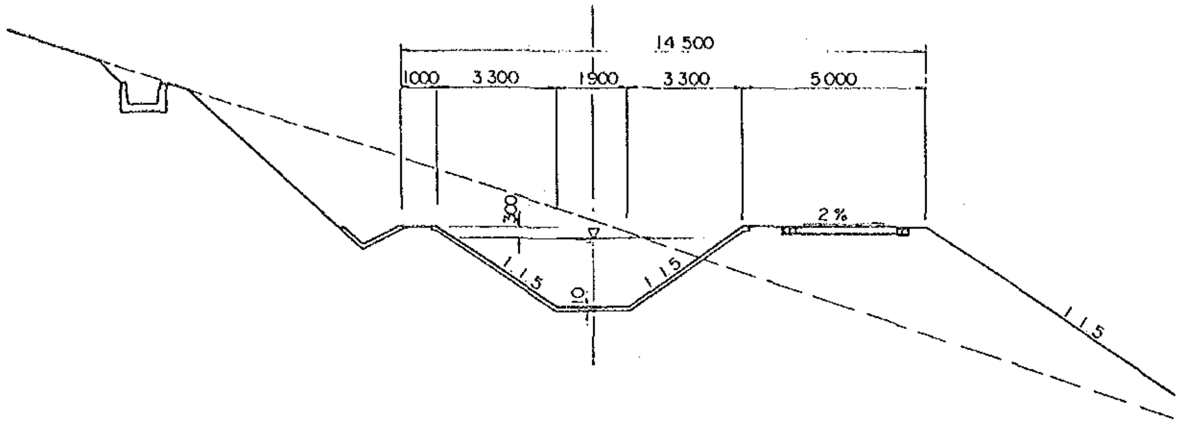


SECTION PORTAL (Q=12 m³/s) SCALE C

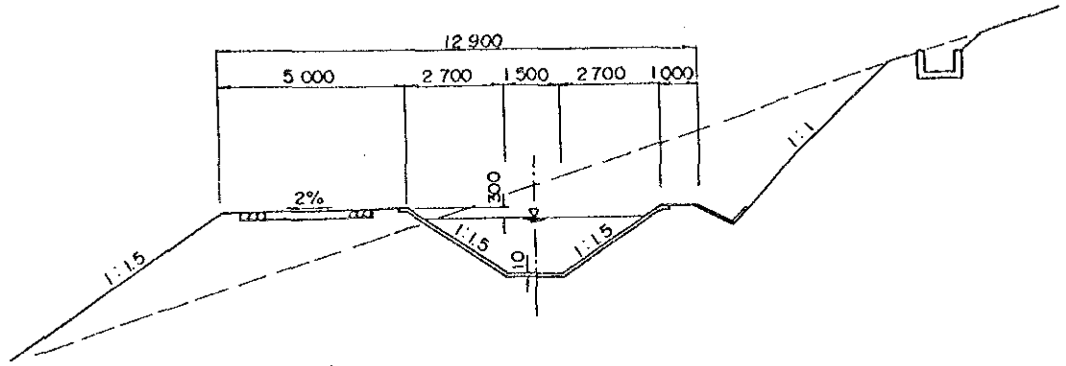


SECTION TUNNEL (Q=12 m³/s) SCALE C

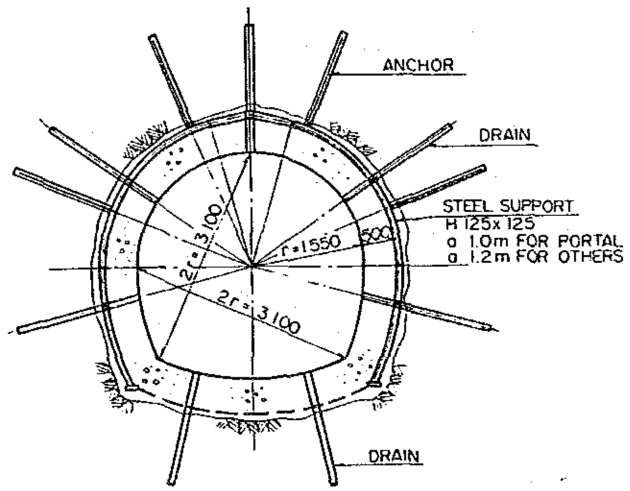




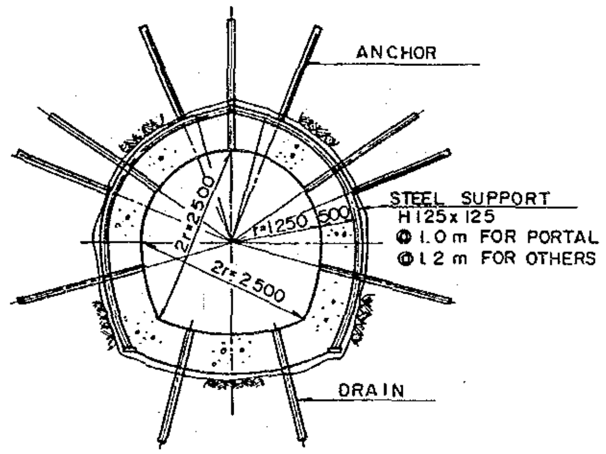
CHANNEL SECTION (Q=12m³/s) SCALE D



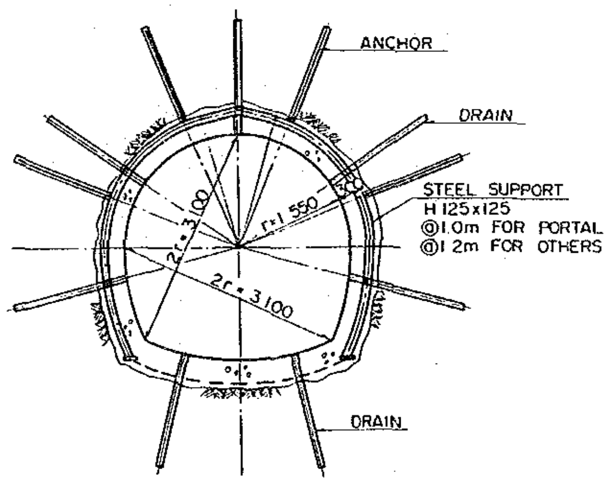
CANNEL SECTION (Q=6m³/s) SCALE D



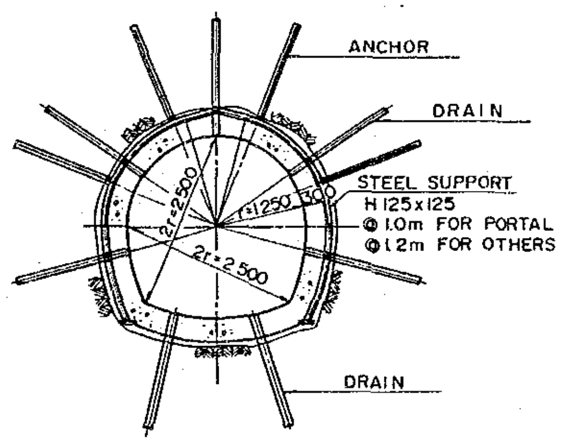
SECTION PORTAL (Q=12m³/s) SCALE C



SECTION PORTAL (Q=6m³/s) SCALE C



SECTION TUNNEL (Q=12m³/s) SCALE C



SECTION TUNNEL (Q=6m³/s) SCALE C

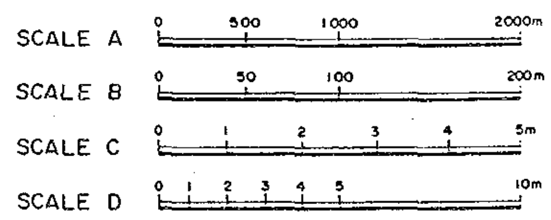


Fig.I.11 Preliminary Design of Water Transbasin Scheme "Esperanza Dam (Altamira) - Rio Portoviejo"

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS

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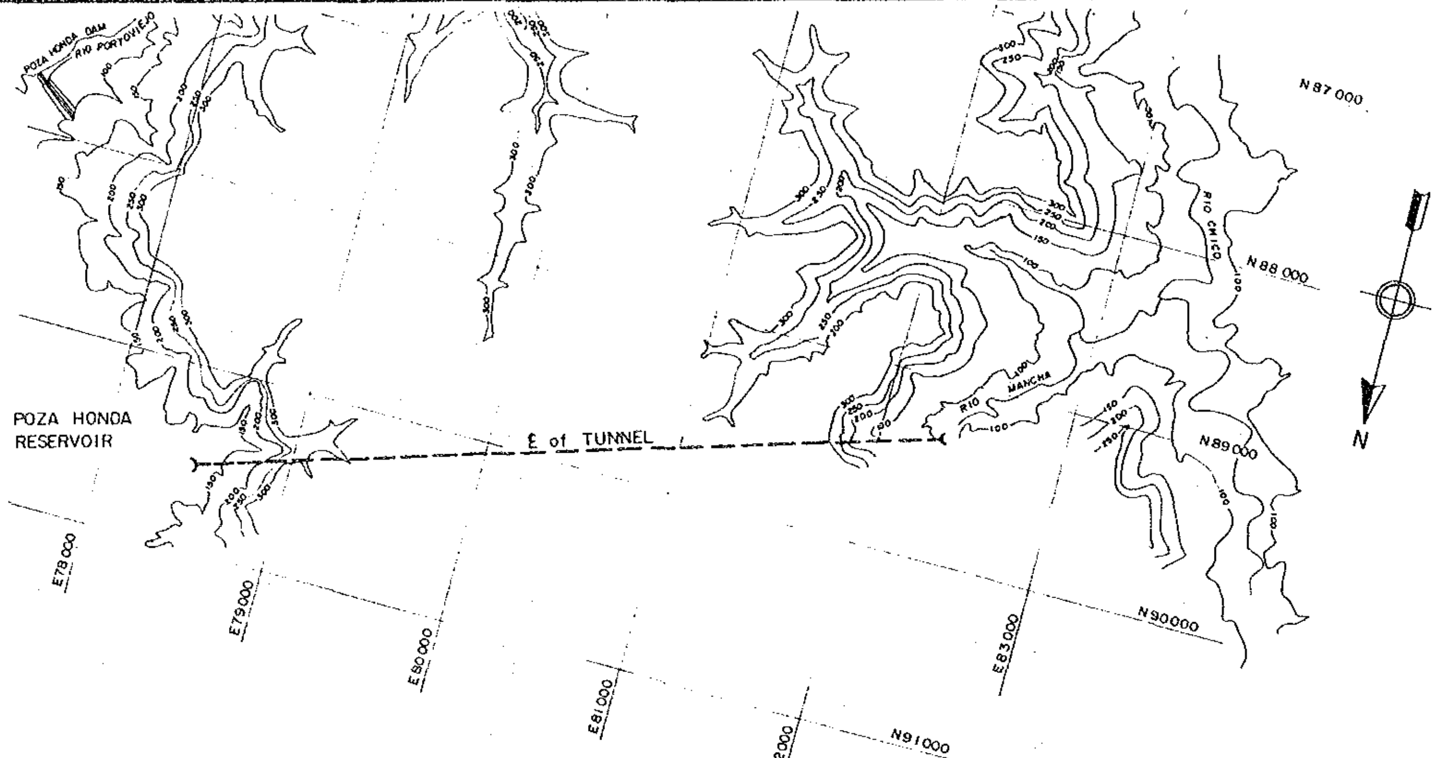
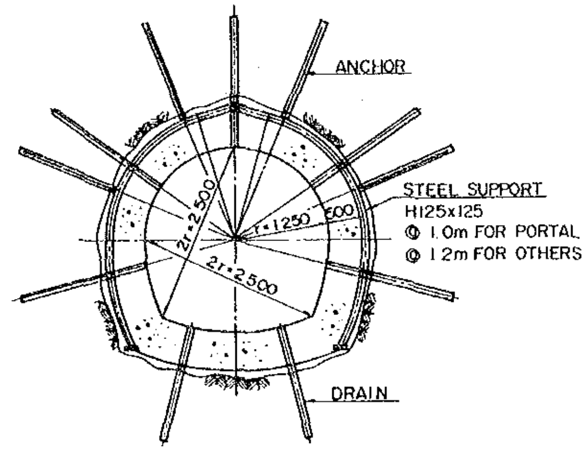
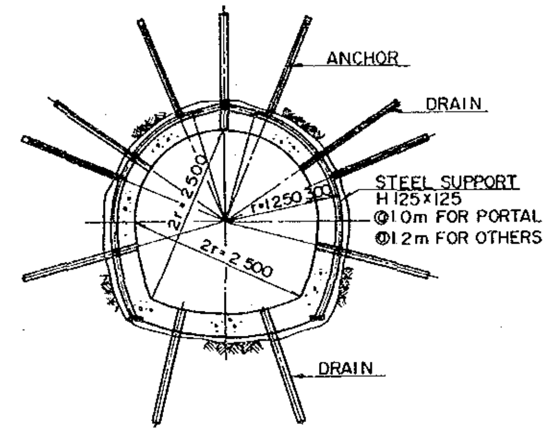


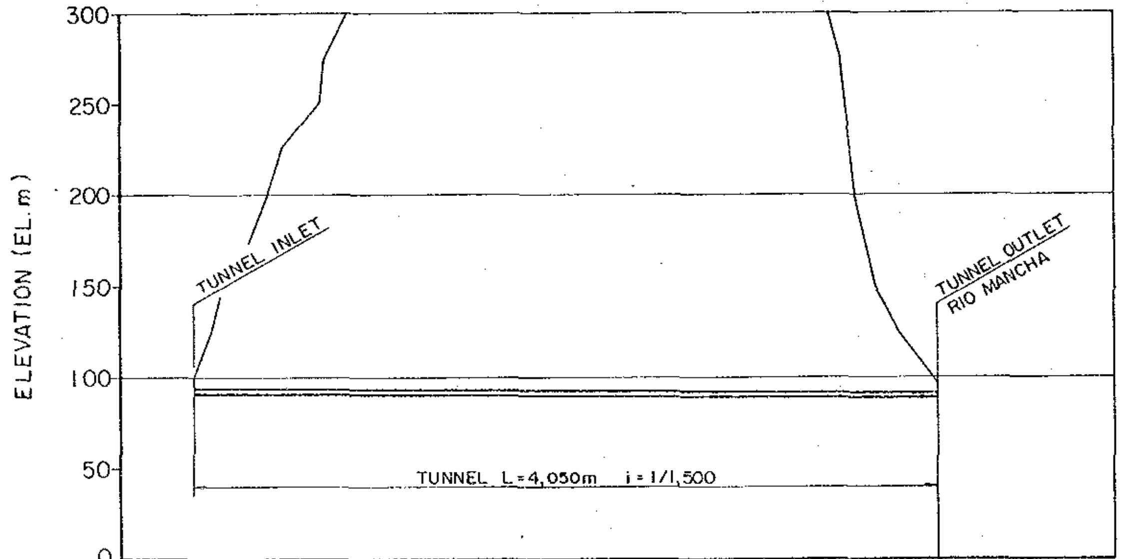
PLAN SCALE A



SECTION (PORTAL) SCALE C



SECTION (TUNNEL) SCALE C



TYPE OF STRUCTURE	TUNNEL				
ELEVATION OF FORMATION (EL. m)	91.25	90.58	89.92	89.25	88.55
ELEVATION OF GROUND (EL.m)	100.00				97.00
ACCUMULATED DISTANCE (m)	0	1000	2000	3000	4050
DISTANCE (m)	0	1000	1000	1000	1050
STATION	0+000	1+000	2+000	3+000	4+050

PROFILE H : SCALE A V : SCALE B

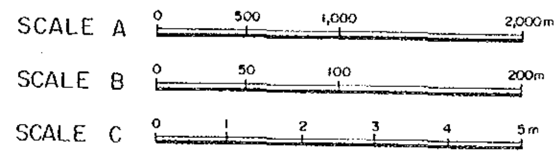
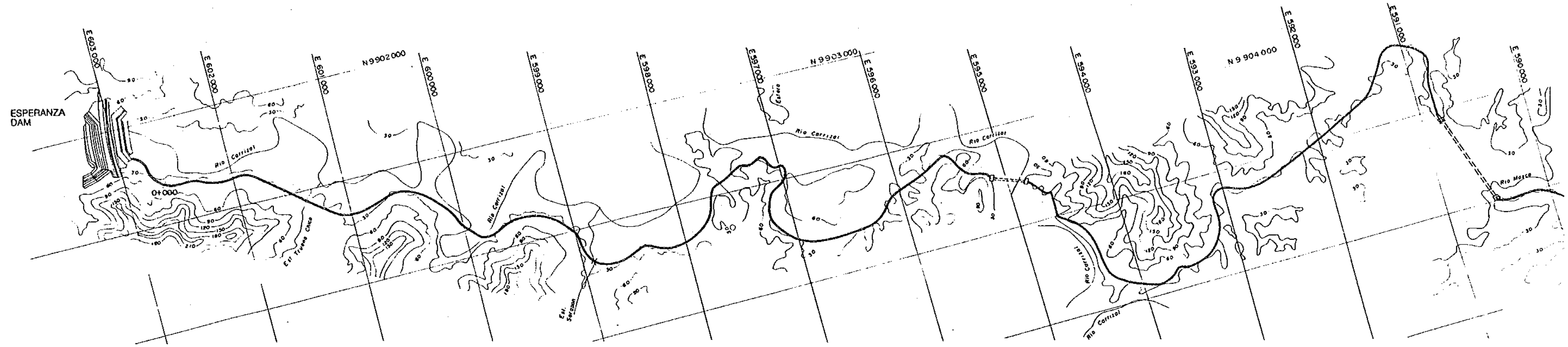
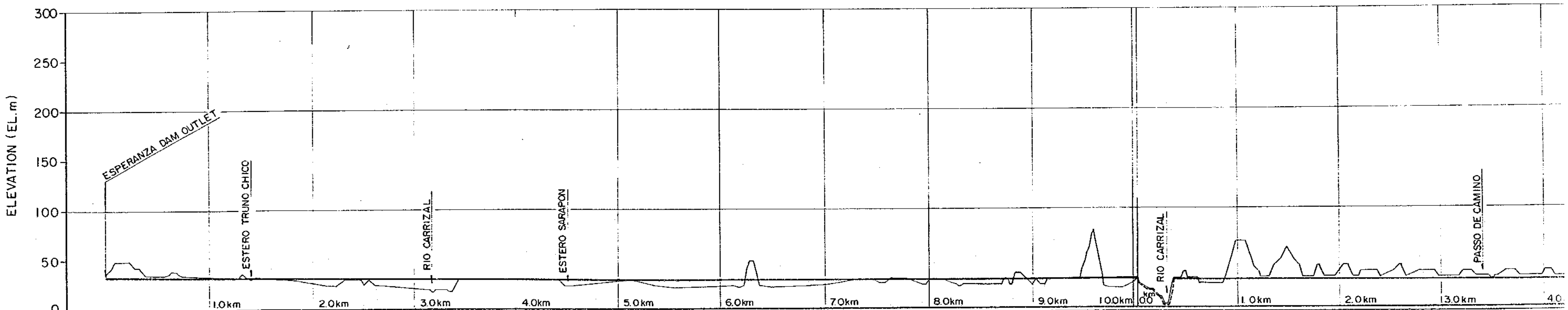


Fig. I.12 Preliminary Design of Water Transbasin Scheme "Poza Honda - Rio Mancha"

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

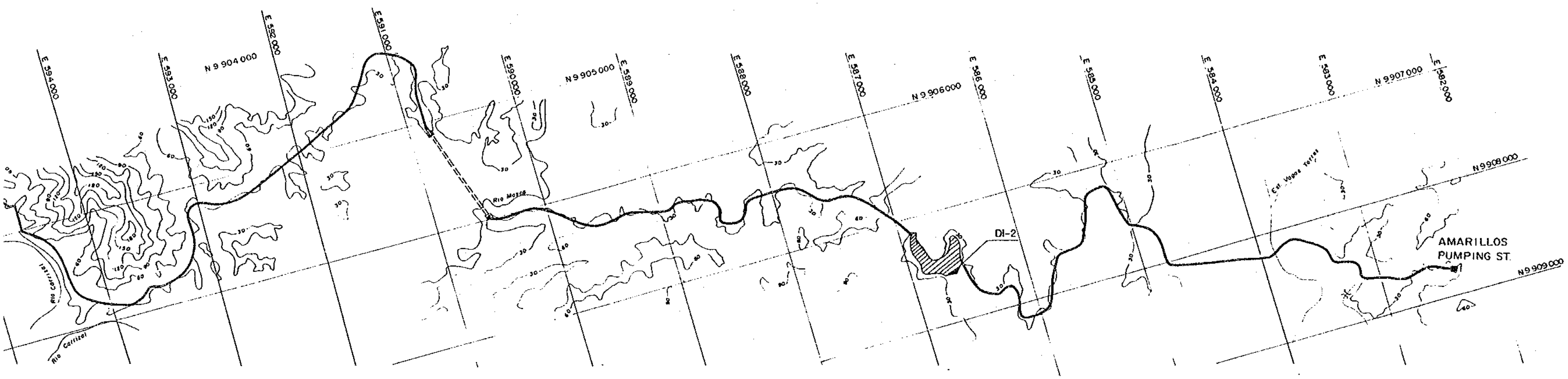


PLAN SCALE A



TYPE OF STRUCTURE	OPEN CHANNEL (RECTANGULAR) Q=22.75m³/s, B=5.50m, H=3.00m, I=1/3,000	OPEN CHANNEL (RECTANGULAR) Q=22.00m³/s, B=5.40m, H=3.00m, I=1/3,000		SYPHON Q=13m³/s 2ø 2,100		OPEN CHANNEL (TRAPEZOIDAL) Q=13m³/s, B=1.50m, H=2.65m, I=1/5,000
ELEVATION OF FORMATION (EL.m)	32.00	29.87	28.84	28.99	28.44	28.11
ELEVATION OF GROUND (EL.m)	46.00	24.00	38.00	29.00	28.50	37.00
ACCUMULATED DISTANCE (m)	0	6390	9490	10050	10400	12050
DISTANCE (m)	0	6390	3100	560	350	1650
STATION	0+000	6+390	9+490	0+000	0+350	2+000

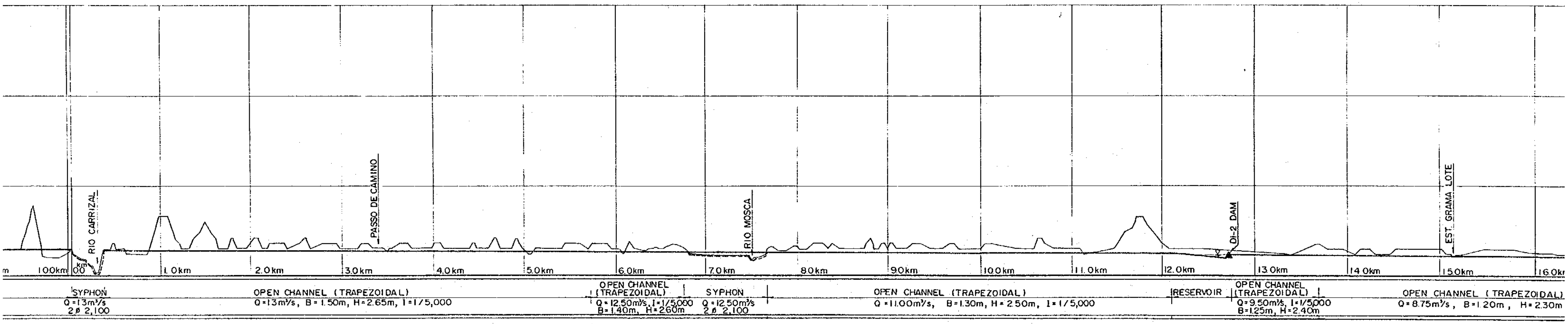
PROFILE H: SCALE A V: SCALE B



PLAN SCALE A

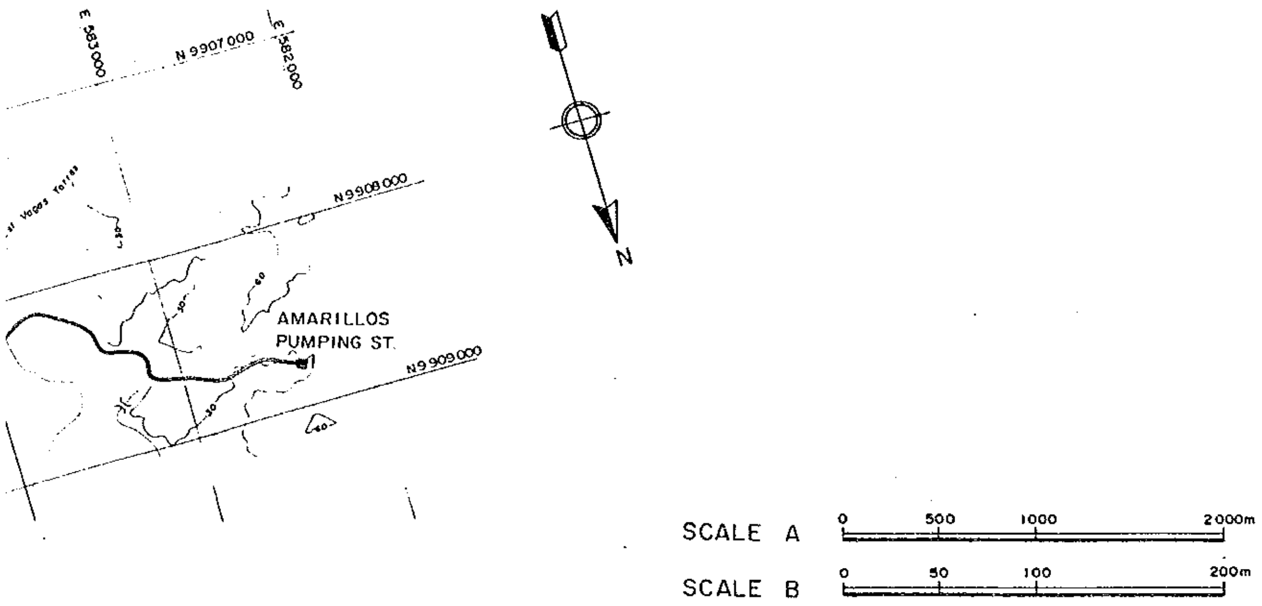
SCALE A 0 500 1000

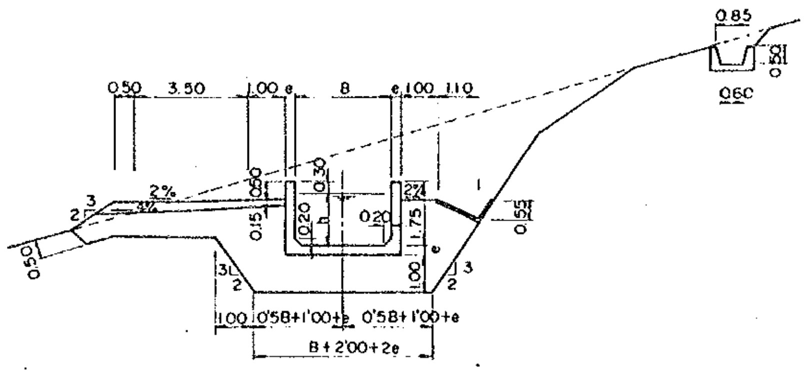
SCALE B 0 50 100



28.84	28.99	28.44	28.11	27.36	27.15	25.85	24.96	22.96	22.77
38.00	29.00	28.50	37.00	34.00	29.00	28.00	30.00	28.00	35.00
9490	10050	10400	12050	15780	16820	17720	22150	22800	23750
3100	560	350	1650	3730	1040	900	4430	650	950
9+490	0+000	0+350	2+000	5+730	6+770	7+670	12+100	12+750	13+700

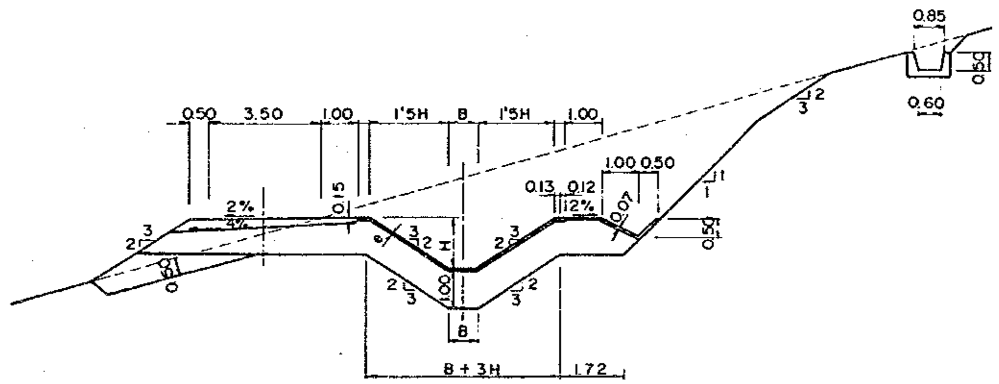
PROFILE H: SCALE A V: SCALE B





Q m³/s	V m³/s	I ‰	n	B (m)	H (m)	ha (m)
26.15	1.58	0.3	0.014	5.50	3.30	0.40
17.72	1.43	0.3	0.014	5.20	2.70	0.35
17.14	1.42	0.3	0.014	5.20	2.60	0.35
16.85	1.41	0.3	0.014	5.20	2.60	0.30
16.01	1.40	0.3	0.014	5.20	2.50	0.30
15.35	1.38	0.3	0.014	5.00	2.50	0.30
14.77	1.37	0.3	0.014	5.00	2.45	0.30

TYPICAL SECTION (RECTANGULAR)



Q m³/s	V m³/s	I ‰	n	B (m)	H (m)	ha (m)
14.41	1.15	0.2	0.014	1.50	2.75	0.15
12.85	1.12	0.2	0.014	1.40	2.65	0.15
11.74	1.09	0.2	0.014	1.40	2.55	0.15
11.25	1.08	0.2	0.014	1.40	2.50	0.15
10.42	1.06	0.2	0.014	1.30	2.45	0.15
9.68	1.04	0.2	0.014	1.30	2.40	0.12
8.85	1.02	0.2	0.014	1.20	2.30	0.12
8.05	1.00	0.2	0.014	1.20	2.30	0.12
7.30	0.97	0.2	0.014	1.10	2.20	0.10
6.72	0.97	0.2	0.014	1.10	2.15	0.10
5.92	0.93	0.2	0.014	1.00	2.05	0.10
5.64	0.91	0.2	0.014	1.00	2.00	0.10
4.77	0.88	0.2	0.014	1.00	1.90	0.07
3.39	0.80	0.2	0.014	1.00	1.70	0.07
2.87	0.77	0.2	0.014	0.80	1.60	0.07
1.68	0.80	0.2	0.014	0.60	1.30	0.07

TYPICAL SECTION (TRAPEZOIDAL)

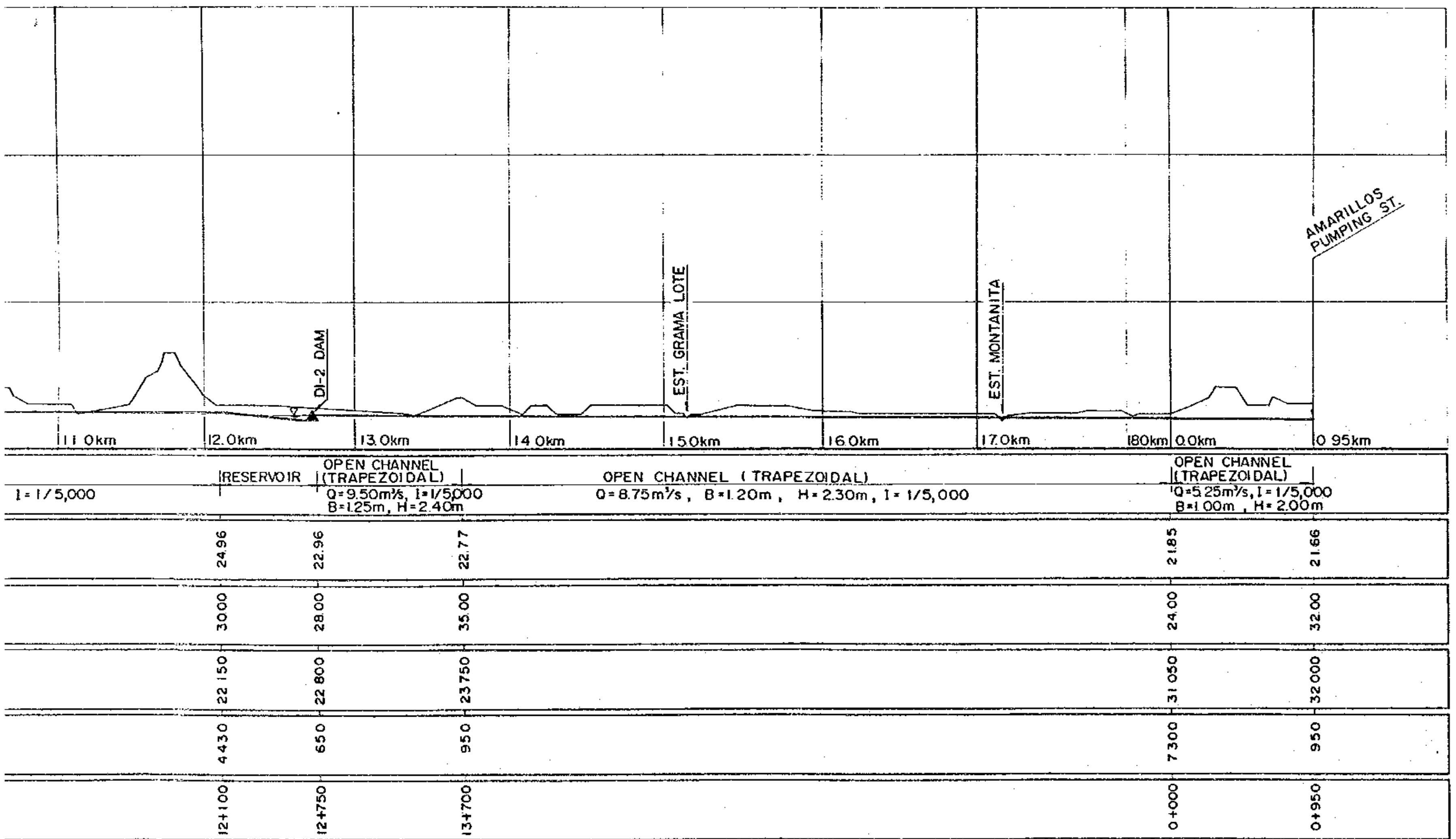


Fig. I.13 Preliminary Design of Water Transbasin Scheme "Esperanza Dam - Amarillos"

GOVERNMENT OF THE REPUBLIC OF ECUADOR
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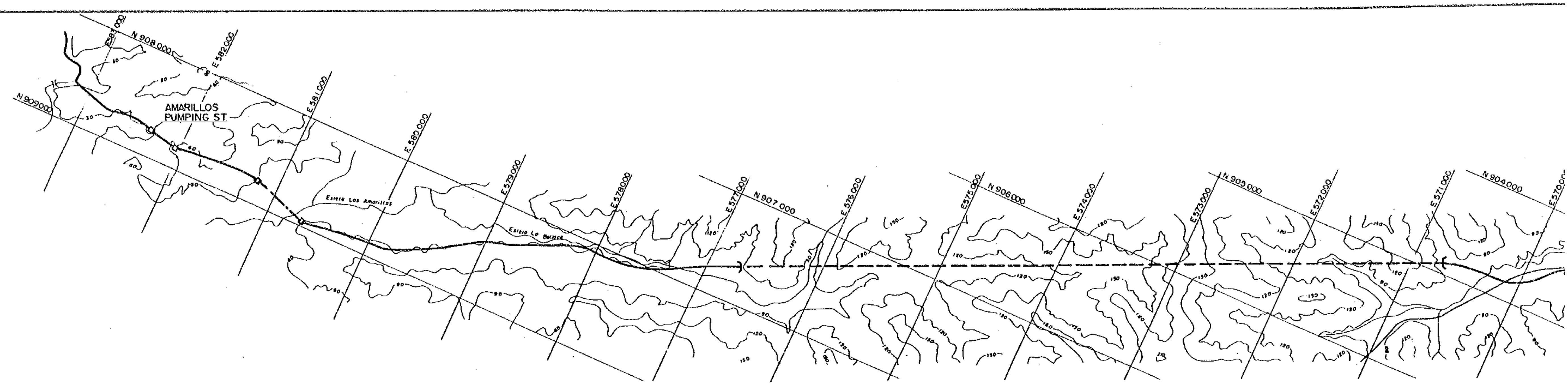
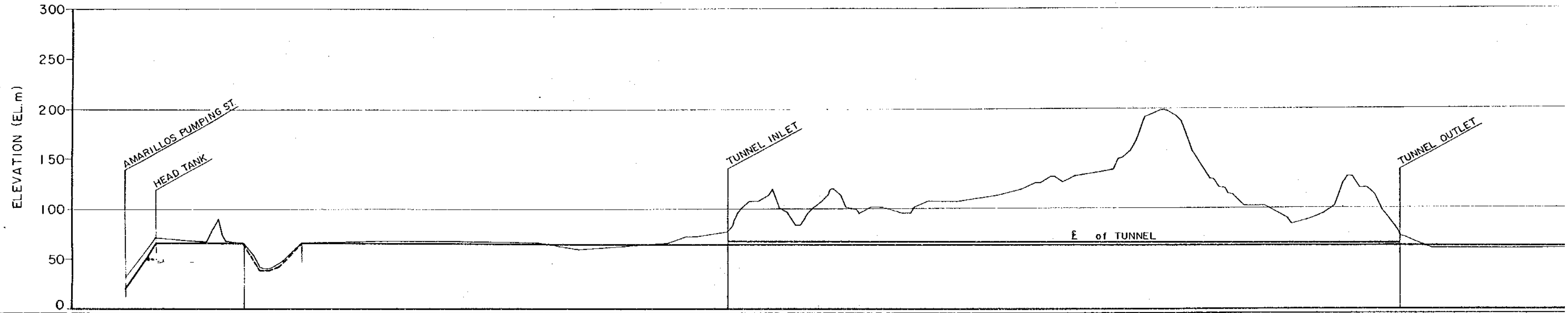
JAPAN INTERNATIONAL COOPERATION AGENCY



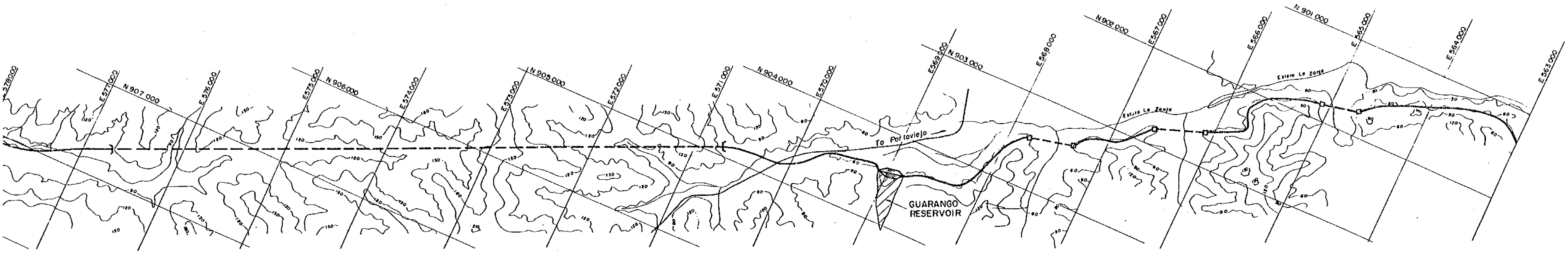
PLAN SCALE A



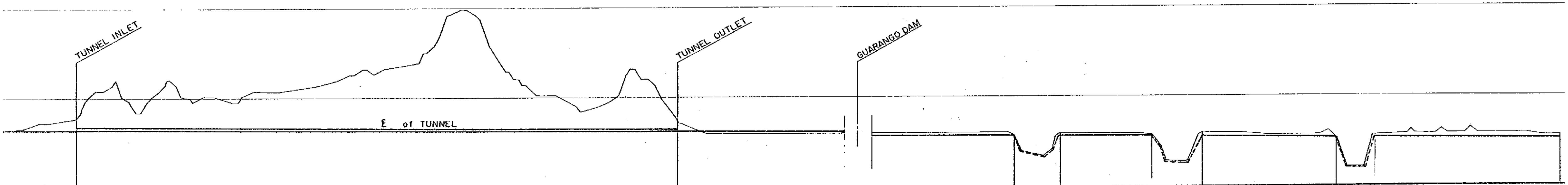
TYPE OF STRUCTURE: PIPELINE 2φ 1,400 | OPEN CHANNEL Q=5.5m³/s B=H=2.0m | SYPHON Q=5.3m³/s | OPEN CHANNEL Q=5.3m³/s I=1/3,000 B=H=2.0m | TUNNEL L=6,600m I=1/3,000 D=2.5m Q=5.3m³/s | OPEN CHANNEL L=1,800m I=1/3,000 B=H=2.0 CONCRETE CLOSE PROFIU L=6

STATION	ELEVATION OF FORMATION (EL. m)	ELEVATION OF GROUND (EL. m)	ACCUMULATED DISTANCE (m)	DISTANCE (m)
0+000	19.66	32.00	0	0
0+300	66.86	72.00	300	300
1+180	66.45	66.00	1180	880
1+730	65.74	66.00	1730	550
2+730	65.41	66.00	2730	1000
3+730	65.07	66.00	3730	1000
4+730	64.74	66.00	4730	1000
5+730	64.41	70.00	5730	1000
5+950	64.33 64.21	72.00	5950	220
6+950	63.88	120.00	6950	1000
7+950	63.54	108.00	7950	1000
8+950	63.21	126.00	8950	1000
9+950	62.88	170.00	9950	1000
10+950	62.54	110.00	10950	1000
11+950	62.21	114.00	11950	1000
12+550	62.00	72.00	12550	600
13+170 13+230	61.79 61.77	59.50 59.50	13170 13230	620 60

PROFILE H: SCALE A V: SCALE B



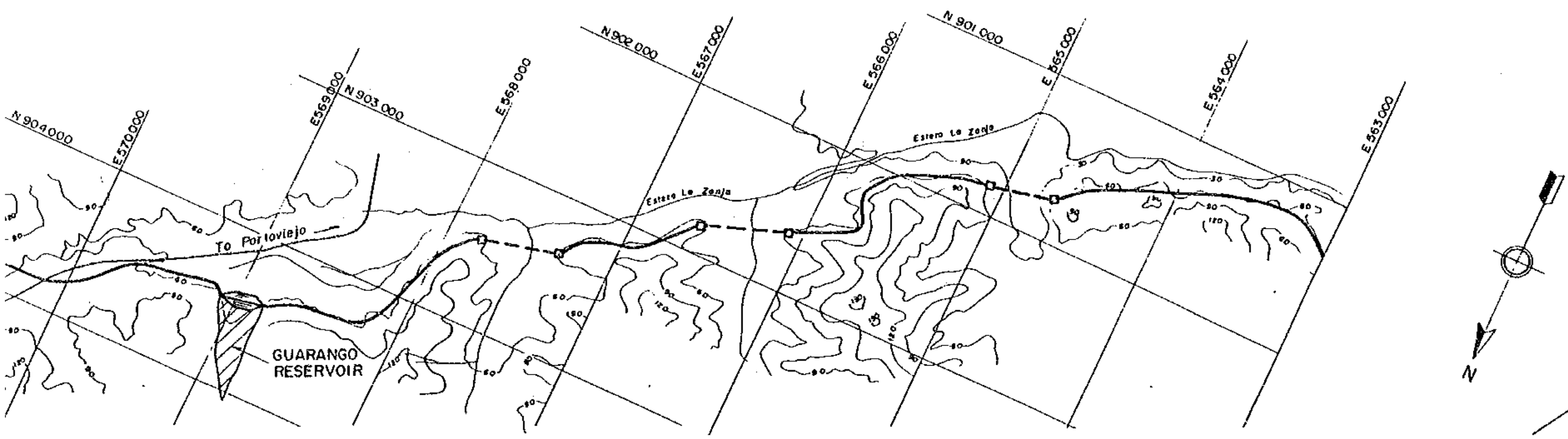
PLAN SCALE A

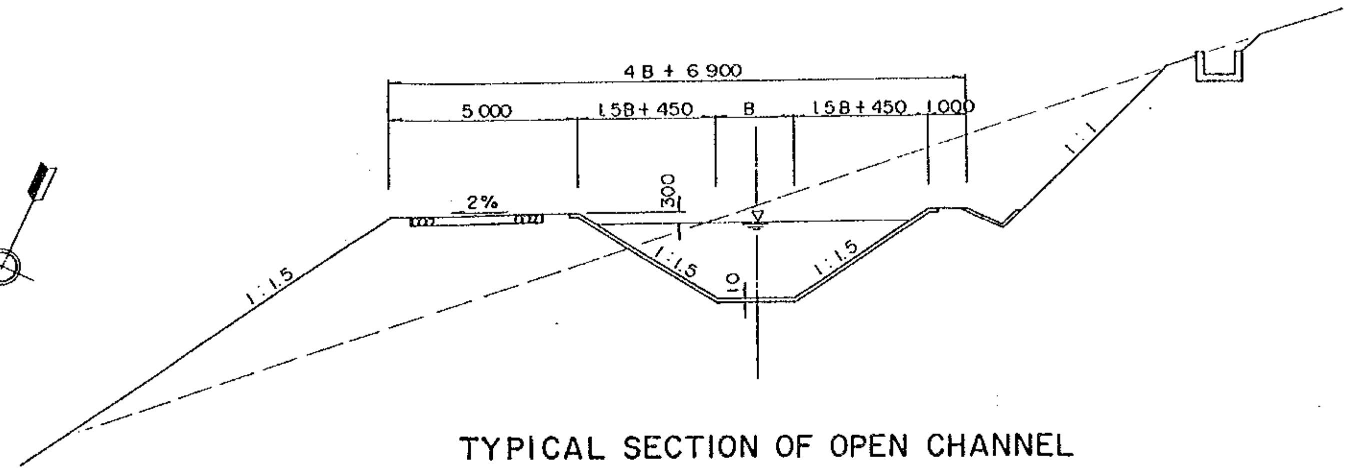


/3,000 | TUNNEL L = 6,600m I = 1/3,000 D = 2.5m Q = 5.3m³/s | OPEN CHANNEL L = 1,800m I = 1/3,000 B=H=2.0m CONCRETE CLOSE PROFIU L=60m | GUARANGO DAM | OPEN CHANNEL Q = 6.75m³/s I = 1/3,000 B=H = 2.1m | SYPHON Q=6.5m³/s ø 2,000 | OPEN CHANNEL Q = 6.25m³/s B=H = 2.1m | SYPHON Q=6.0m³/s ø 2,000 | OPEN CHANNEL Q = 5.75m³/s B=H = 2.05m | CHANNEL Q=55m³/s B=H=2.0m | SYPHON ø 2,000 | OPEN CHANNEL Q = 5.25m³/s B=H = 2.0m | OPEN CHANNEL Q = 5.0m³/s B=H = 1.95m

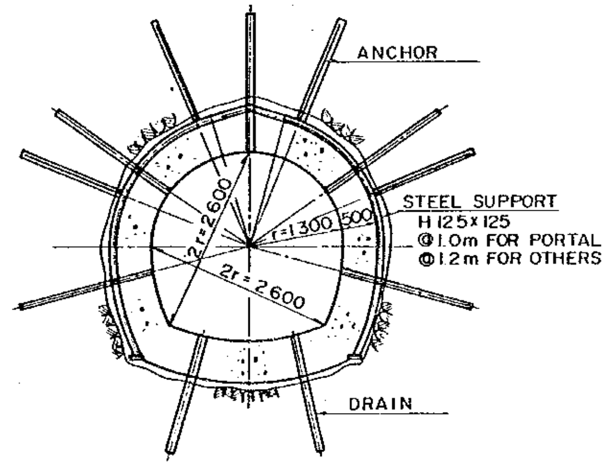
64.41	70.00	5730	1000	5+730
64.33 / 64.21	72.00	5950	220	5+950
63.88	120.00	6950	1000	6+950
63.54	108.00	7950	1000	7+950
63.21	126.00	8950	1000	8+950
62.88	170.00	9950	1000	9+950
62.54	110.00	10950	1000	10+950
62.21	114.00	11950	1000	11+950
62.00	72.00	12550	600	12+550
61.79 / 61.77	59.50 / 59.50	13170 / 13230	620 / 60	13+170 / 13+230
61.40	61.40	14350	1800	14+350
56.80	56.80	14650	300	14+650
56.27	56.00	16200	1550	16+200
55.08	56.00	16700	500	16+700
54.75	56.50	17700	1000	17+700
53.69	56.00	18240	540	18+240
53.37	56.00	19200	960	19+200
53.09	54.00	19700	500	19+700
52.53	54.00	20130	430	20+130
52.19	60.00	21140	1010	21+140
51.85	55.00	22150	1010	22+150

PROFILE H : SCALE A V : SCALE B

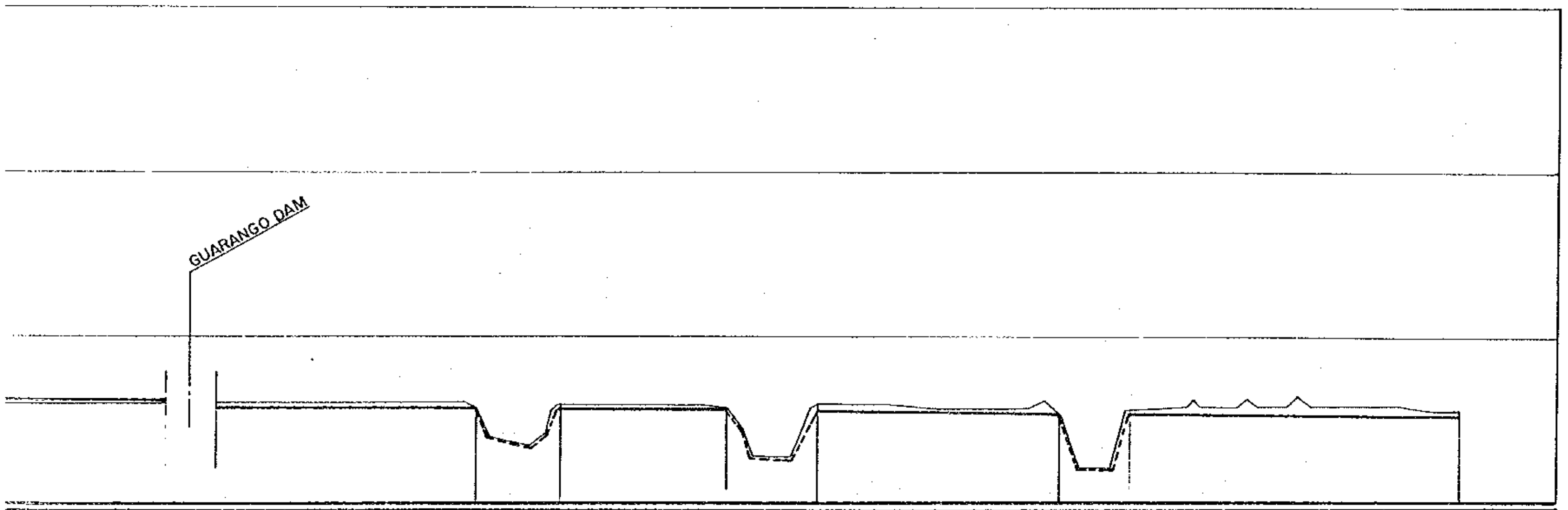




TYPICAL SECTION OF OPEN CHANNEL



TUNNEL SECTION SCALE C



ANNEL | GUARANGO DAM | OPEN CHANNEL | SYPHON | OPEN CHANNEL | SYPHON | OPEN CHANNEL | CHANNEL | SYPHON | OPEN CHANNEL | OPEN CHANNEL

/3,000 B=H=2.0m; SE PROFIU L=60m | Q=6.75m³/s I=1/3,000 B=H=2.1m | Q=6.5m³/s ø 2,000 | Q=6.25m³/s B=H=2.1m | Q=6.0m³/s ø 2,000 | Q=5.75m³/s B=H=2.05m | Q=5.5m³/s B=H=2.0m | ø 2,000 | Q=5.25m³/s B=H=2.0m | Q=5.0m³/s B=H=1.95m

61.40	56.80	56.27	55.08	54.75	53.69	53.37	53.09	52.53	52.19	51.85
61.40	56.80	56.00	56.00	56.50	56.00	56.00	54.00	54.00	60.00	55.00
14350	14650	16200	16700	17700	18240	19200	19700	20130	21140	22150
1800	300	1550	500	1000	540	960	500	430	1010	1010
14+350	14+650	16+200	16+700	17+700	18+240	19+200	19+700	20+130	21+140	22+150

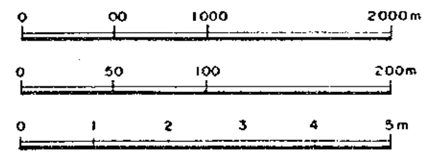


Fig. I.14 Preliminary Design of Water Transbasin Scheme "Amarillos - Guarango"

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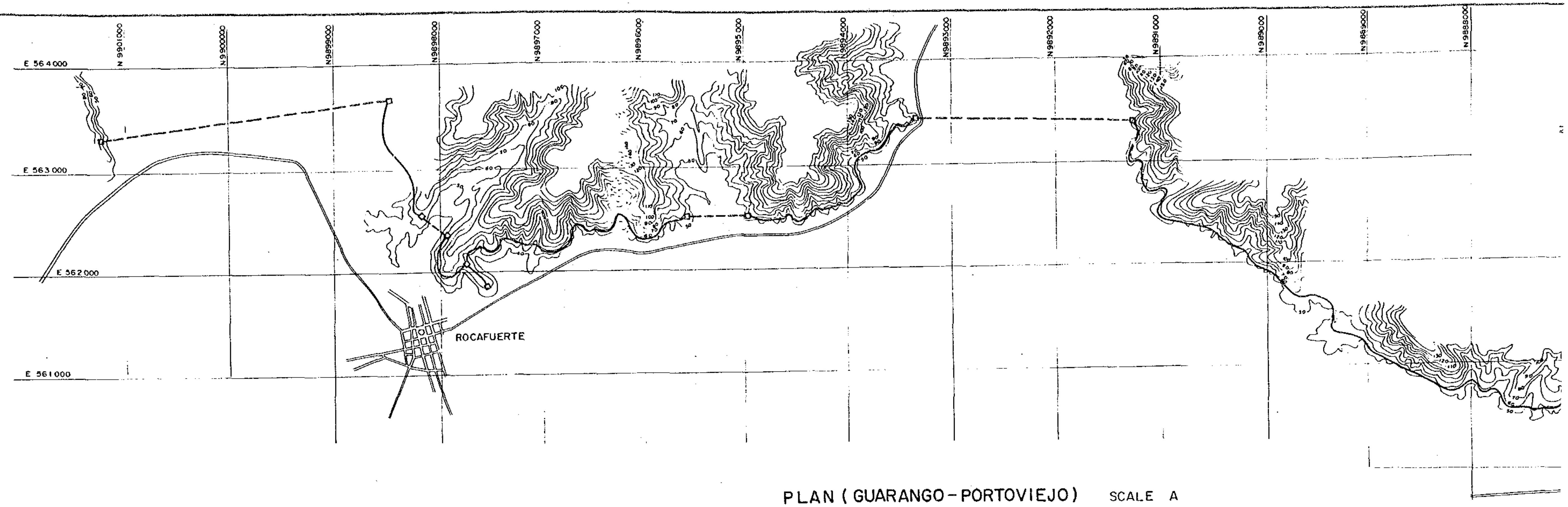
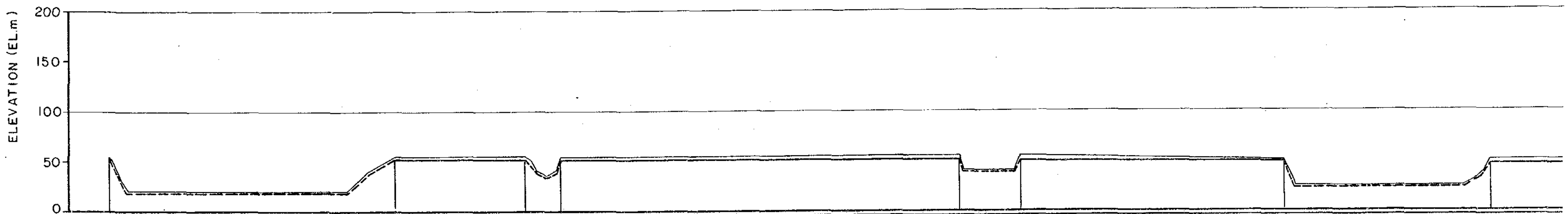
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN (GUARANGO–PORTOVIEJO) SCALE A

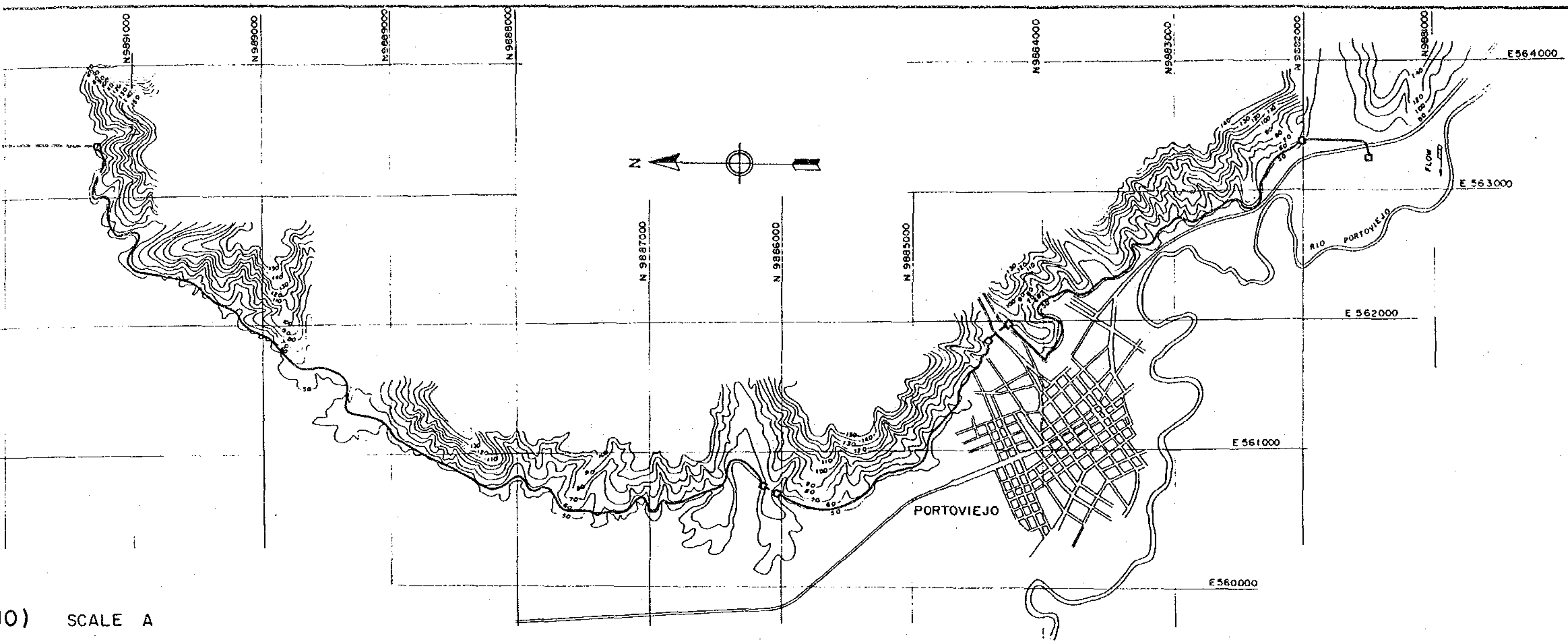


TYPE OF STRUCTURE:

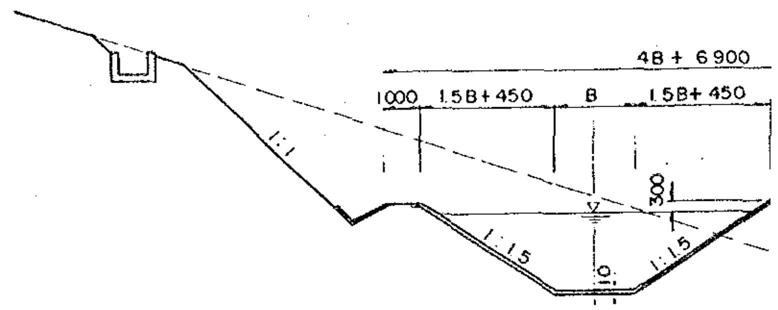
- 0+000 – 2+800: SYPHON, Q = 9.9 m³/s ø 2,900
- 2+800 – 4+070: OPEN CHANNEL, B = 2.0, H = 2.3, I = 1/5,000
- 4+070 – 4+410: SYPHON, ø 2,900
- 4+410 – 5+200: OPEN CHANNEL, B = 2.0, H = 2.3
- 5+200 – 8+380: OPEN CHANNEL, Q = 5.6 m³/s, B = 1.6, H = 1.9, I = 1/5,000
- 8+380 – 8+980: SYPHON, ø 2,000
- 8+980 – 11+530: OPEN CHANNEL, B = 1.6, H = 1.9, I = 1/5,000
- 11+530 – 13+610: SYPHON, Q = 5.2 m³/s, ø 2,000

STATION	0+000	2+800	4+070	4+410	5+200	8+380	8+980	11+530	13+610
ELEVATION OF FORMATION (EL.m)	53.00	51.15	50.90	50.55	50.73	50.09	49.03	48.52	45.85
ELEVATION OF GROUND (EL.m)	55.00	55.00	55.00	55.00	55.00	55.00	55.00		50.00
ACCUMULATED DISTANCE (m)	0	2 800	4 070	4 410	5 200	8 380	8 980	11 530	13 610
DISTANCE (m)	0	2 800	1 270	340	790	3 180	600	2 550	2 080

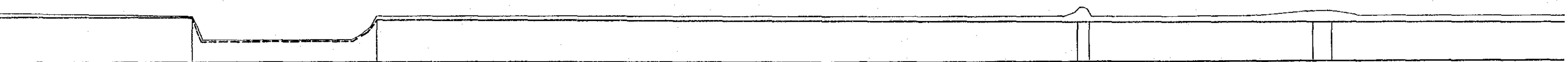
PROFILE H : SCALE A V : SCALE B



…0) SCALE A

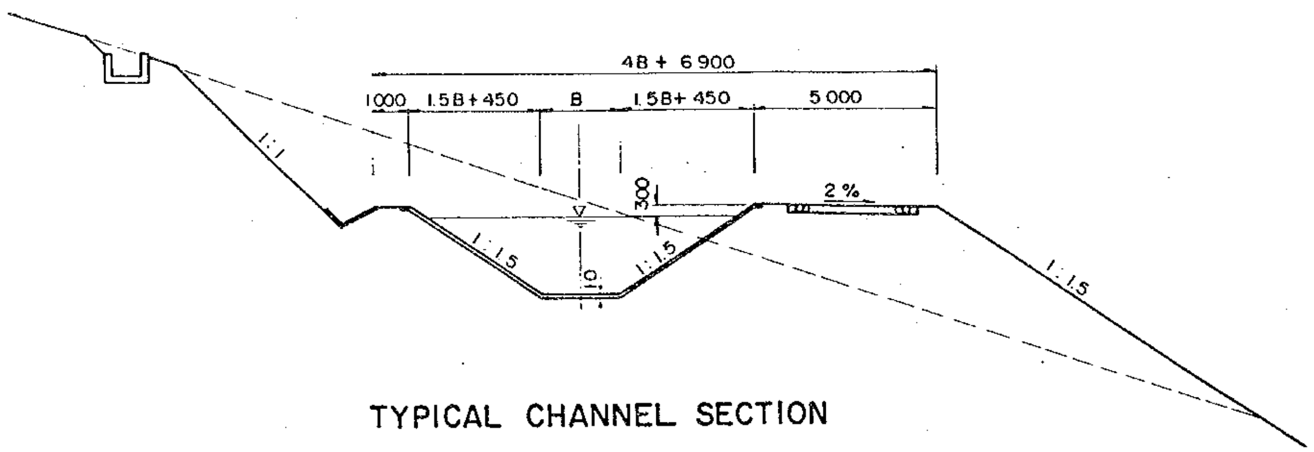


TYPICAL CHANNEL SEC…

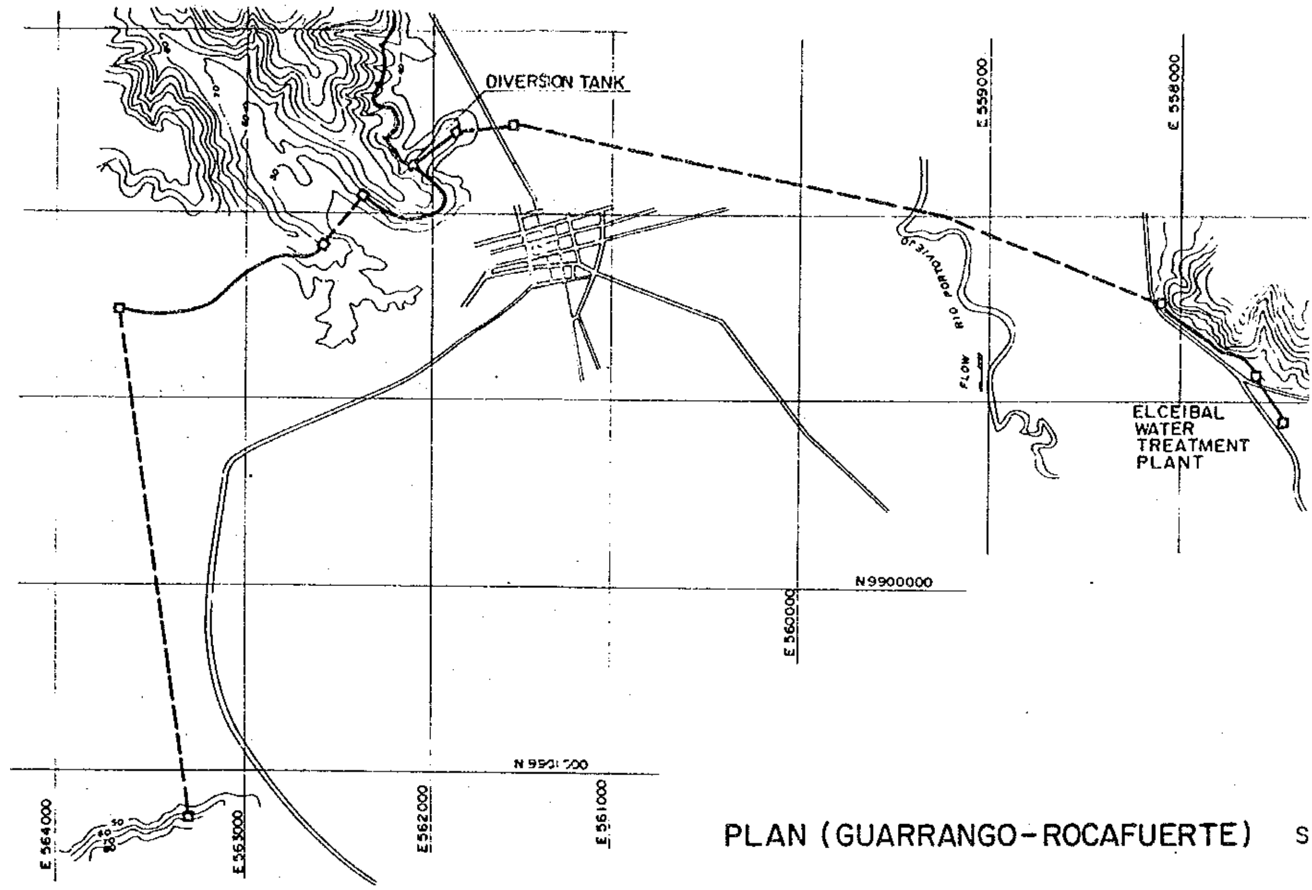


OPEN CHANNEL B=1.6 H=1.9 I=1/5,000	SYPHON Q=5.2m³/s, ø2,000		OPEN CHANNEL B=1.5 H=1.8 Q=5.2m³/s I=1/5,000							CULVERT B=2.5 H=2.1		OPEN CHANNEL Q=3.3m³/s, B=1.3 H=1.6	CULVERT B=2.5 H=2.1	OPEN CHANNEL B=1.3 H=1.6 I=1/5,…
	48.52	45.85								44.34	44.51	44.03	43.99	
		5000							5000	5600	5000	5600	5600	
	11530	13610	14610	15610	16610	17610	18610	19610	20610	21200	21330	23730	23930	
	2550	2080	1000	1000	1000	1000	1000	1000	1000	590	130	2400	200	
	11+530	13+610	14+610	15+610	16+610	17+610	18+610	19+610	20+610	21+200	21+330	23+730	23+930	

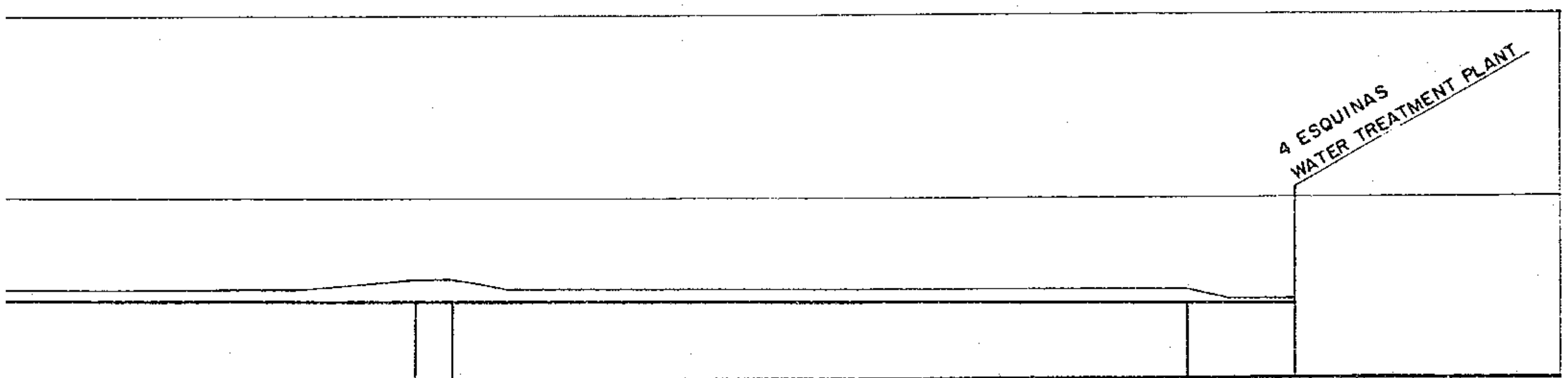
PROFILE H: SCALE A V: SCALE B



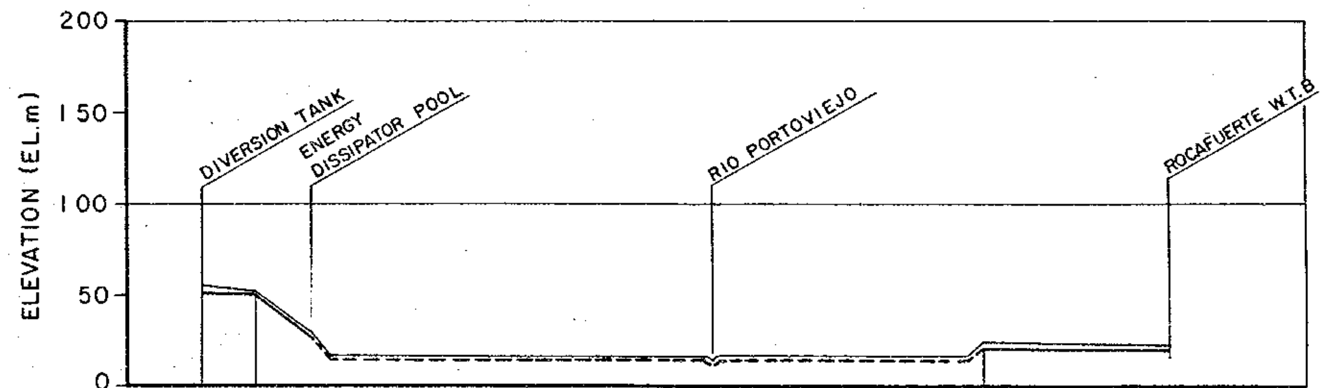
TYPICAL CHANNEL SECTION



PLAN (GUARRANGO-ROCAFUERTE) S

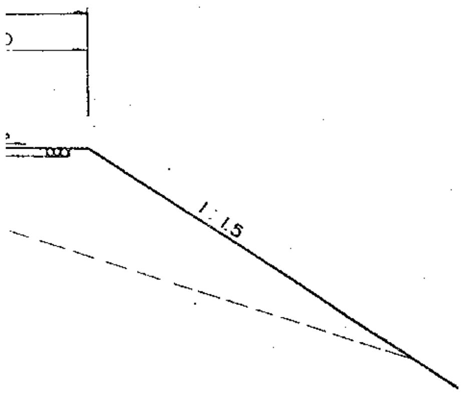


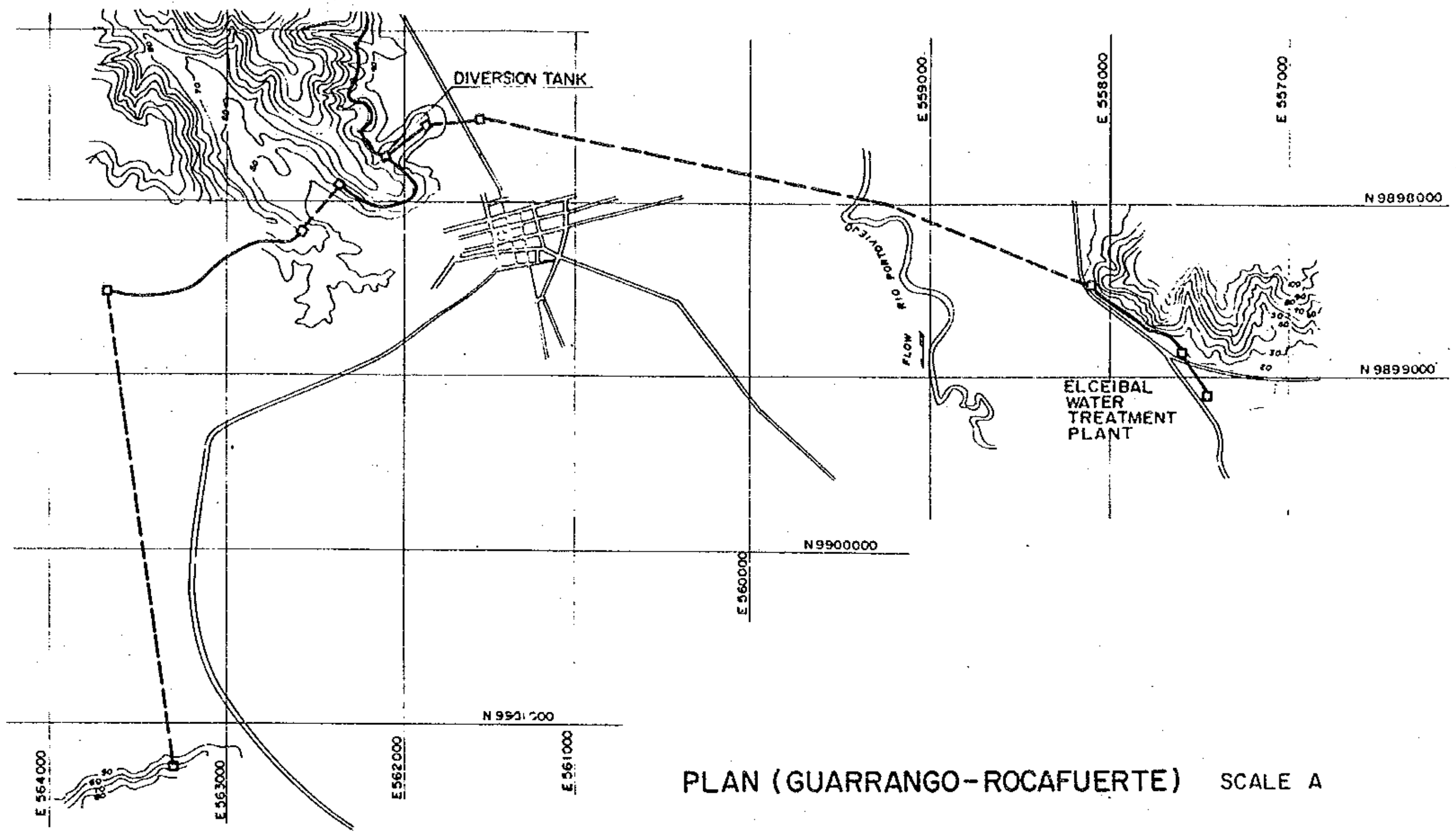
OPEN CHANNEL Q=3.3m³/s, B=1.3 H=1.6	CULVERT B=2.5 H=2.1		OPEN CHANNEL B=1.3 H=1.6 I=1/5,000	OPEN CHANNEL B=1.3 H=1.6
	44.03	43.99	43.13	42.30
	56.00	56.00	50.00	43.00
	23 730	23 930	27 960	28 560
	2 400	200	4 030	600
	23+730	23+930	27+960	28+560



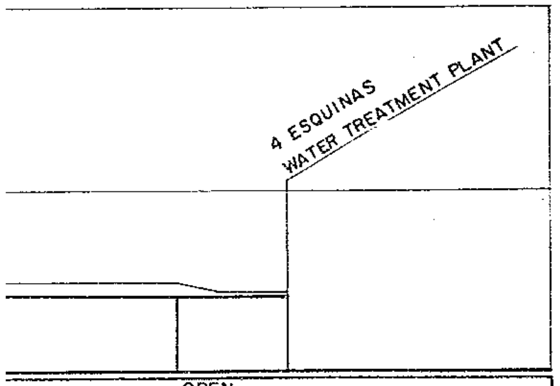
TYPE OF STRUCTURE	OPEN CHANNEL B=1.1 H=1.4		SYPHON Q=3.3m³/s Ø1,500	OPEN CHANNEL B=1.1 H=1.4 I=1/3,000	
ELEVATION OF FORMATION (EL.m)	50.45	50.35	26.80	20.03	20.00
ELEVATION OF GROUND (EL.m)	55.00	51.00	30.00	25.00	22.00
ACCUMULATED DISTANCE (m)	0	300	600	4 250	5 250
DISTANCE (m)	0	300	300	3 650	1 000
STATION	0+000	0+300	0+600	4+250	5+250

PROFILE H : SCALE A V : SCALE B

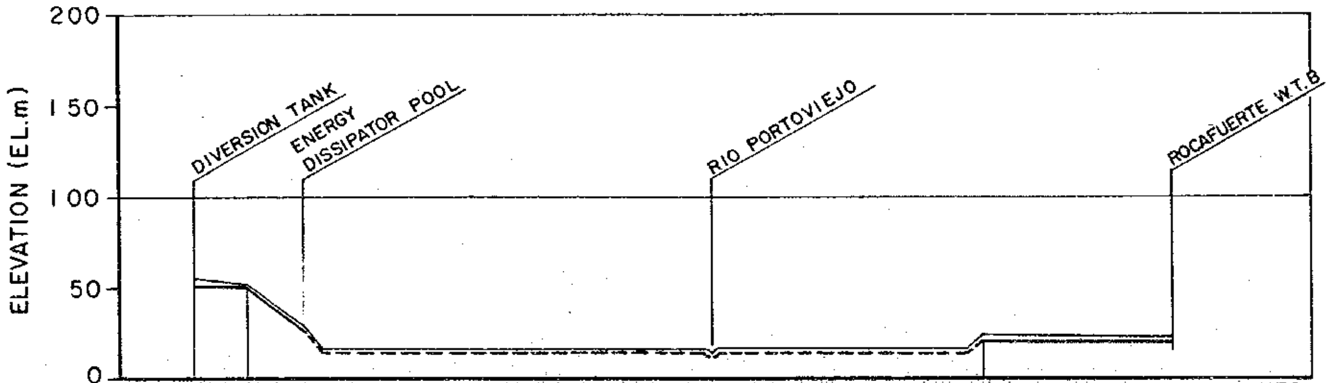




PLAN (GUARRANGO-ROCAFUERTE) SCALE A



	OPEN CHANNEL B=1.3 H=1.6	
	43.13	42.30
	50.00	43.00
	27 960	28 560
	4 030	600
	27+960	28+560



TYPE OF STRUCTURE	OPEN CHANNEL B=1.1 H=1.4		SYPHON Q=3.3m³/s φ1,500	OPEN CHANNEL B=1.1 H=1.4 I=1/3,000	
ELEVATION OF FORMATION (EL.m)	50.45	50.35	26.80	20.03	20.00
ELEVATION OF GROUND (EL.m)	55.00	51.00	30.00	25.00	22.00
ACCUMULATED DISTANCE (m)	0	300	600	4 250	5 250
DISTANCE (m)	0	300	300	3 650	1 000
STATION	0+000	0+300	0+600	4+250	5+250

PROFILE H : SCALE A V : SCALE B

SCALE A 0 500 1000 2000m

SCALE B 0 50 100 200m

Fig. I.15 Preliminary Design of Water Transbasin Scheme "Guarango - Portoviejo"

GOVERNMENT OF THE REPUBLIC OF ECUADOR
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THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
JAPAN INTERNATIONAL COOPERATION AGENCY

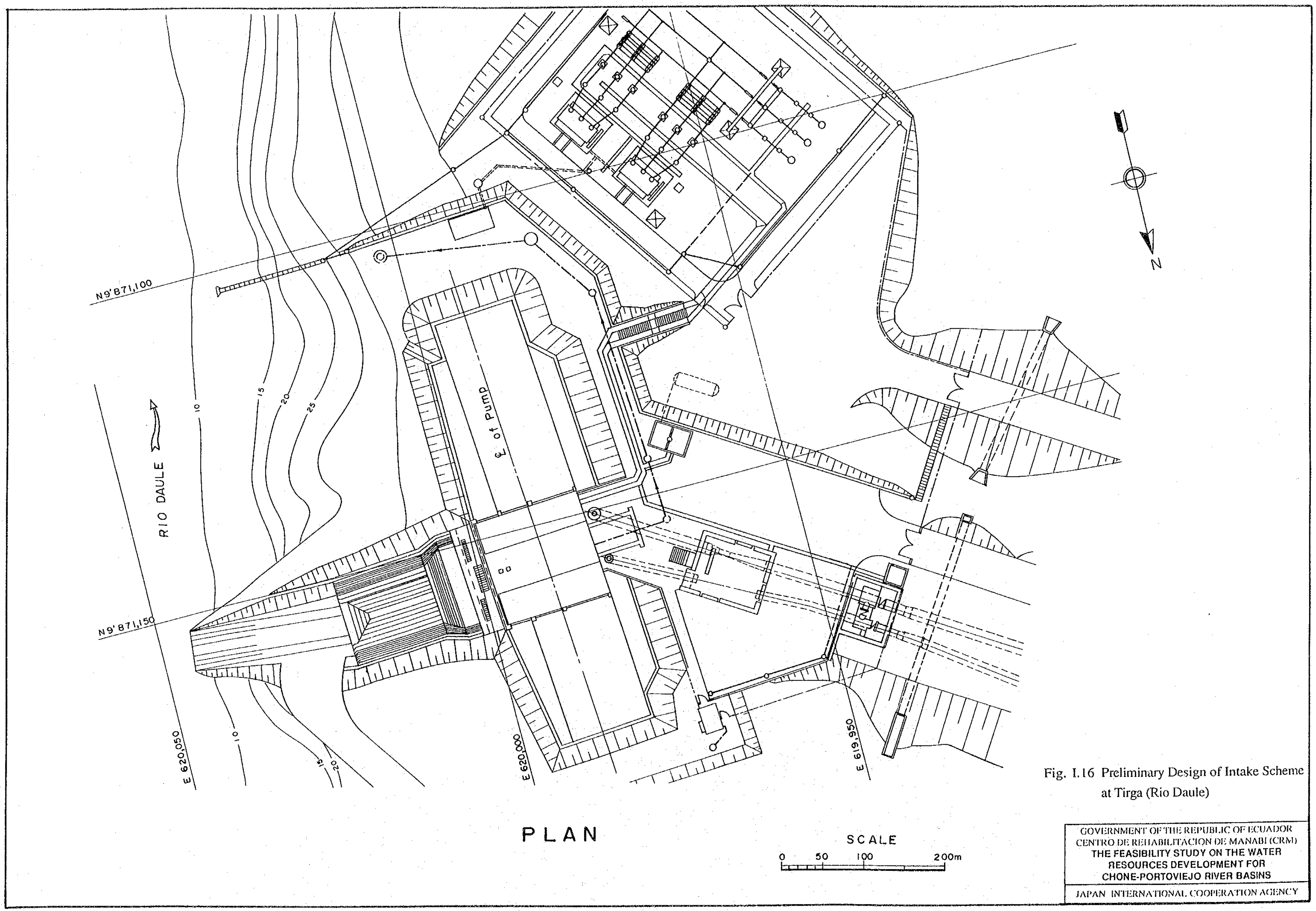

Fig. I.16 Preliminary Design of Intake Scheme at Tirga (Rio Daule)

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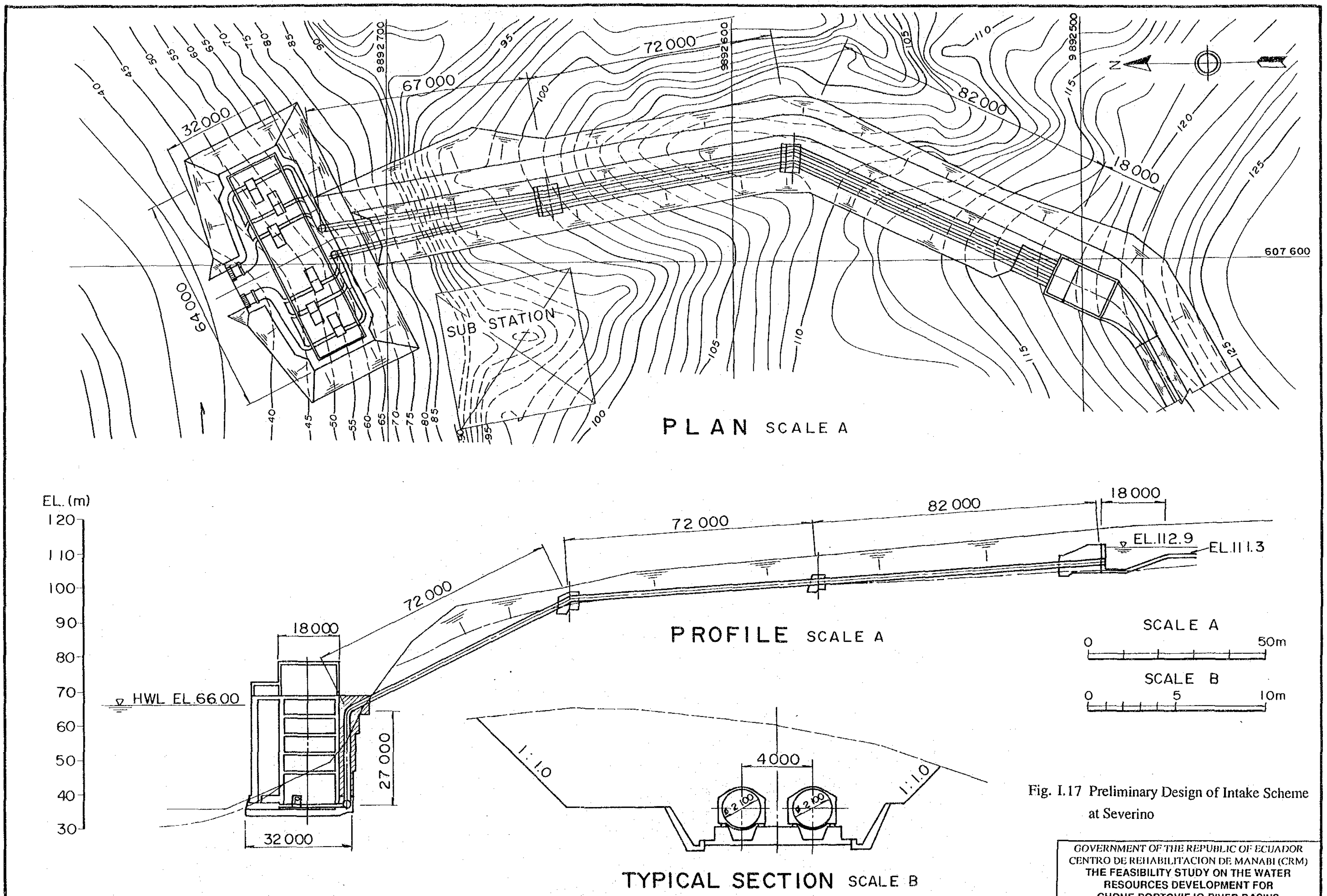

Fig. I.17 Preliminary Design of Intake Scheme at Severino

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