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GOVERNMENT OF THE REPUBLIC OF ECUADOR

CENTRO DE REHABILITACION DE MANABI (CRM)

FEASIBILITY STUDY
ON
THE WATER RESOURCES DEVELOPMENT
FOR CHONE-PORTOVIEJO RIVER BASINS

FINAL REPORT
VOLUME III
(ANNEXES)

DECEMBER 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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1. INTRODUCTION

For the purpose of planning a transbasin, it is necessary to evaluate a guaranteed water quantity to be diverted from Daule-Peripa to La Esperanza and from La Esperanza to Poza Honda, through an integrated operation study of these three reservoirs.

In the Study area and its vicinity, there are two dams in operation, Poza Honda (1973) and Daule-Peripa (1987) with an effective reservoir capacity of 85 MCM and 4,000 MCM, respectively; one dam at the construction stage, La Esperanza with an effective capacity of 391 MCM, and one more dam under study, Chirijos with an effective capacity of 59 MCM.

These dams will be studied in detail. The location of these dams are shown in Fig. F.1.

2. ACTUAL OPERATION OF POZA HONDA RESERVOIR

There exists no specific reservoir operation rule for the Poza Honda dam nor for the Santa Ana intake weir. These facilities have been operated to fulfill the minimum requirements conceived in the design and the reservoir water level of Poza Honda has never been below the emergency water level of EL.93.5 m since its completion in 1973 as shown in Fig. F.2. The recorded minimum water level was EL.94.97 m with the water volume in the reservoir of 28.42 MCM. Annual maximum and minimum water levels of Poza Honda are shown in Table F.1. Fluctuations of reservoir water levels from 1979 to 1990 are shown in Fig. F.3. The above mentioned data and information suggest that the reservoir has been operated in the following manner.

- Reservoir water level is not allowed to be lower than the emergency level, EL.93.5 m

- Priority of water release from the dam is;

  (1) Obliged river maintenance flow of 0.25 m^3/s (7.9 MCM/year).
  (2) Domestic water supply
  (3) Irrigation water supply

- The river maintenance flow and the domestic water supply should be assured at practically 100% of guarantee, while irrigation water supply depends on water availability.

3. RESERVOIR OPERATION OF LA ESPERANZA

INTECSA-GEOSISA executed in 1984 a reservoir operation study of La Esperanza with and without transbasin from Daule-Peripa. A simulation study was made for the case without transbasin based on two series of synthetic flows and the results are shown in Table F.2. Another study with transbasin was made for diversion discharges of 1, 2 and 8 m^3/s to evaluate the available water quantity after regulation by a limited reservoir capacity of La Esperanza. The study, however, was not detailed.

In 1988, the Ecuadorian-Brazilian consortium made a study on transbasin from Daule-Peripa to La Esperanza at the request of CRM, to evaluate a technical feasibility to make the transbasin level lower from EL.69 m to EL.66 m for transbasin capacities of 6 m^3/s and 12 m^3/s to meet the water demand for irrigation of 20,500 ha. The study concluded that the lower level transbasin would increase the diverted water volume by only 2.5%, but the decision to make the diversion level lower than the originally proposed level of EL.69 m was actually made by CRM mainly to provide more safety with the transbasin plan, when the reservoir operation rule of Daule-Peripa by CEDEGE was unknown. The study results are shown in Table F.3.

In 1989, the same consortium, at the request of CRM, revised the diversion tunnel design from Daule-Peripa to La Esperanza to have a capacity of 18 m^3/s, and the reservoir operation study of La Esperanza was repeated for the transbasin level fixed at EL.66 m. The study results, which is given in Table F.4, showed that even with increased transbasin capacity of 18 m^3/s, irrigation water supply to 20,500 ha could not be guaranteed by 100%.

In order to meet water demands in Chone and Portoviejo river basins, the same consortium executed in 1985 the reservoir operation study of La Esperanza receiving water from Daule-Peripa with a diversion capacity of 18 m^3/s and supplying water to Poza Honda with a diversion capacity of 12 m^3/s. The study results are shown in Table F.5, which indicates that water shortage may take place for 11.25% of the simulation period to meet the demands in the planning year of 2015, due to physical reasons such as the case when water level of Daule-Peripa becomes lower than the

intake level of EL.66 m. The water demands for domestic use and irrigation purpose applied in the study are shown in Table F.5.

On the other hand, CCAI executed in 1989 a reservoir operation study of La Esperanza for a simulation period from 1965 to 1982, to supply irrigation water to 21,500 ha with revised water requirement estimated for the Carrizal-Chone project. The study concluded that for a transbasin capacity of 12 m^3/s the number of months when water shortage would happen was 22 (10.2%) for the diversion level of EL.69 m and 17 (7.8%) for EL.66 m, indicating the lower diversion level increased the guarantee by 2.4%.

4. INTERINSTITUTIONAL AGREEMENT FOR TRANSBASIN FROM DAULE-PERIPA TO LA ESPERANZA

4.1 Declaration of CEDEGE Board of Directors

The Board of Directors of CEDEGE declared in April 1980 that the Manabí province could be one of the beneficiaries of the Jaime Roldós Aguilera Multipurpose Project, Daule-Peripa dam, and be entitled to divert water from the Daule-Peripa dam up to 500 MCM per annum.

4.2 Legislative Law No. 77 of 1981

The Legislative Law No. 77 was published in the Official Register No. 80 on September 15, 1981.

The Law established that water supply to Manabi would be urgent and national priority be given to it including financing. The Law also indicated that the transbasin project to use water of Daule-Peripa should be in accordance with the criteria of CEDEGE and the Municipal Company of Water Supply to Guayaquil (EMAP-G).

4.3 Agreement Among CEDEGE-CRM-INERHI of 1982

An agreement for interinstitutional cooperation was signed on April 30, 1982, among CEDEGE, CRM and INERHI. This document is of much importance from the legal viewpoint in the proposed transbasin scheme being studied by JICA.

In the document, CEDEGE and CRM confirmed the contents of the previous documents, recognized the necessity of utilizing water of the Daule and Peripa rivers, which would be stored by the dam constructed by CEDEGE, through realization of a transbasin project, and expressed an intention to allocate an annual volume of water up to 500 MCM for the use in the Manabí province.

The third clause of the document indicated its objectives and in its subclause (c) each one of the parties was requested to take actions for the realization of studies, designs, construction an operation of the Jaime Roldós A. Project and the transbasin project to Manabí.

In the same subclause, on the other hand, INERHI "concedes the right to use required volume of water in accordance with the Law in this regard".

Finally, the agreement mentioned in its subclause (d) for responsibilities that "the operation of the transbasin system to Manabí should be made in a manner as determined by the feasibility study and the definite design for the Daule-Peripa project, guaranteeing domestic water supply to Guayaquil city and following the priorities established by the Water Law and its relevant regulations. The three institutions should coordinate in their respective water use to this effect".

4.4 Agreement of 1986

A new agreement was signed between CRM and CEDEGE on December 8, 1986, containing more concrete clauses about the studies and possible alternatives for water transbasin and its financing.

It is to be noted that in this agreement "the use of Daule-Peripa reservoir water" is left to be determined in the next agreement, stating "taking into account the regulations and codes in force for use of water".

4.5 Transbasin Studies for Use of 500 MCM

In accordance with subclause (c) of the third clause of the Agreement for interinstitutional cooperation signed on April 30, 1982, CRM conducted, through contract with specialized consultants, a feasibility study and definite design of the water transbasin project from Daule to La Esperanza and Poza Honda, and the study report was submitted to CEDEGE.

During the feasibility study phase, various alternatives were studied and the following two alternatives were selected for further comparison study from the technical and economic points of view.

- Alternative B, consisting of two sequential transbasins, first from Daule-Peripa to La Esperanza through a tunnel of 8.3 km in length to divert water by gravity and second from La Esperanza to Poza Honda by constructing a pumping station at the La Esperanza reservoir side, penstock line from the pumping station to a stand-pipe and conduction of water by gravity through a pipeline and a tunnel.

- Alternative C, consisting of two independent transbasins, one from Daule-Peripa to La Esperanza through a diversion tunnel by gravity flow, and the other from the Daule river to Poza Honda by means of a pumping station on the right bank of the river, penstock line to a stand-pipe and conduction of water by gravity through a pipeline and a tunnel.

Of these two alternatives, the Alternative C was recommended for preparation of a definite design, which contained two independent transbasins, one to La Esperanza with a capacity of 6 m^3/s and the other to Poza Honda with a capacity of 12 m^3/s, within a limit of 500 MCM/year. The definite design was completed in 1987.

In June 1989, CRM, in view of the national priority of the Central Government to construct the La Esperanza dam and the preliminary result of PHIMA, advised CEDEGE that CRM had decided to revise the design of the diversion tunnel to La Esperanza to have a capacity of 18 m^3/s to divert water of maximum 500 MCM/year. Thus, CRM virtually returned to select the Alternative B, consisting of two sequential transbasins.

The revision of the design concluded that the original design of the portal of tunnel was not needed to be modified, and CRM informed it to CEDEGE by the letter Nº 659 of July 12, 1989. CEDEGE constructed the portal of tunnel accordingly through the Spanish contractor AGROMAN in the dry season of 1989.

Based on the above mentioned background, it may be concluded that CEDEGE allows the transbasin of up to 500 MCM from Daule-Peripa to La Esperanza through

the 18 m^3/s diversion tunnel, the portal of which was already constructed by CEDEGE in the Daule-Peripa reservoir.

5. RESERVOIR OPERATION OF DAULE-PERIPA

The Daule-Peripa reservoir will be operated to meet the demands for power (minimum reservoir water level for power generation, EL.65 m), domestic water, irrigation and dilution for irrigation return flow, transbasin to La Esperanza (minimum level of the transbasin, EL.66.6 m) and transbasin to the Santa Elena Peninsula. The design water levels of the Daule-Peripa reservoir are shown in Fig. F.5 and summarized as follows.

Normal High Water Level	EL. 85 m
Low Water Level	EL. 60 m
Flood Water Level	EL. 88 m

At the request of the JICA Study Team, CEDEGE conducted a reservoir operation study, generating synthetic flows as inflows to the reservoir, 30 series of 30 years each. In Fig. F.6, the results of the reservoir operation study are shown for series No. 1, 12 and 18).

5.1 Reservoir Operation Study

A transbasin discharge rating curve is prepared from Daule-Peripa to La Esperanza through the 18 m^3/s diversion tunnel, which is dependent on the reservoir water level of Daule-Peripa, as shown in Table F.6 and in Fig. F.7. The transbasin discharge is 0 m^3/s at the reservoir level EL. 66.6 m and is more than 18 m^3/s for reservoir level higher than EL. 74.5 m. The reservoir operation study was executed to meet all the demands established by CEDEGE and for three levels of dilution water requirements; 1.2, 1.6 and 2.0 times of irrigation return flow volume to dilute saline return flow to an acceptable level. In the present study, a dilution level of 1.6 is applied. In Table F.7, numbers of months when water shortage takes place are shown out of 360 months (30 years) for one series as well as the percentage of water shortage months. Water shortage will happen minimum 0.08% for domestic water supply and maximum 9.85% for transbasin to Manabí. The highest probability of water shortage for Manabí transbasin is due to physical limit of inlet level at EL. 66.6 m rather than the shortage of reservoir capacity of Daule-Peripa.

5.2 Water Volume of Transbasin to La Esperanza

Divertable water volumes to La Esperanza are computed as shown in Figs. F.8 - F.10 for one year, two consecutive years and 3 consecutive years, respectively, as well as the exceeding probabilities. The results are summarized as follows.

(MCM)

Exceeding probability	Divertable water volume		
(%)	One year	Two years	Three years
Maximum volume	568	1,135	1,703
50	568	1,135	1,703
80	555	1,087	1,612
89	500	1,000	1,485
Minimum volume	0	16	407

From the above table, it is understood that water of 537 MCM/year (1,612/3) could be diverted to La Esperanza at 80% guarantee (4 years assured out of 5 years), corresponding as basic years for design to the series 24, year 706, 707 and 708 with the respective divertable water volume of 488, 556 and 568. Technically divertable flows for each month are shown in Table F.8, which indicates that during 5 months, from December to April, the divertable flow is less than 18 m^3/s. Since the agreement between CEDEGE and CRM limits the diversion water volume only up to 500 MCM/year and the diversion flow up to 18 m^3/s, it is necessary to reduce the diversion water volume from the calculated 537 MCM to 500 MCM intentionally to the best interest of the Manab_ province. It is proposed to reduce the diversion flow to La Esperanza in 3 months from January to March when rainfalls are maximum and water demands are minimum. The proposed monthly transbasin pattern is shown in Table F.8.

6. INTEGRATED RESERVOIR OPERATION OF LA ESPERANZA AND POZA HONDA

Based on the transbasin discharges and volumes as determined in Table F.8, an integrated reservoir operation study is conducted to evaluate:

- Discharges and volume of transbasin from La Esperanza to Poza Honda

- Reservoir water levels of these two dams as well as the optimum levels for operation

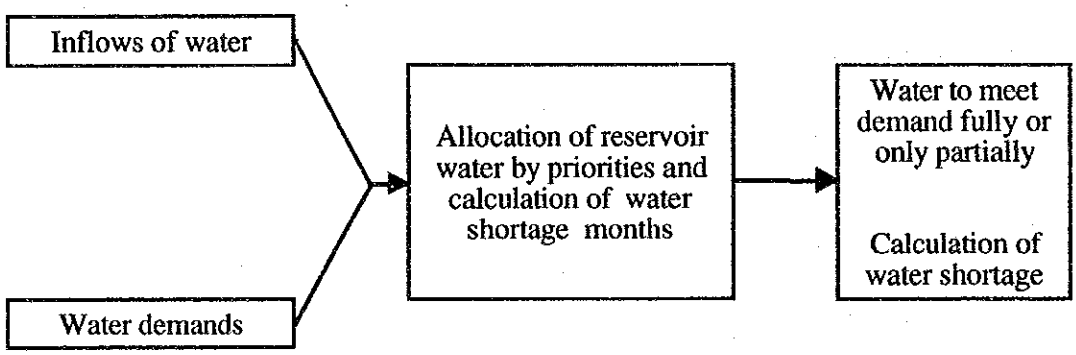
- Minimum, maximum and average pumping head from La Esperanza to Poza Honda

- Guaranteed volume of transbasin from La Esperanza to Poza Honda

- Level of guarantee to meet all the demands by the two reservoirs.

6.1 Mathematical Model

The same mathematical model as used by CEDEGE for the Daule-Peripa reservoir operation study is used with some simplifications and modifications to best fit for an integrated operation of two reservoirs. The flow diagram of the used program OPERAM-30 is shown as follows.

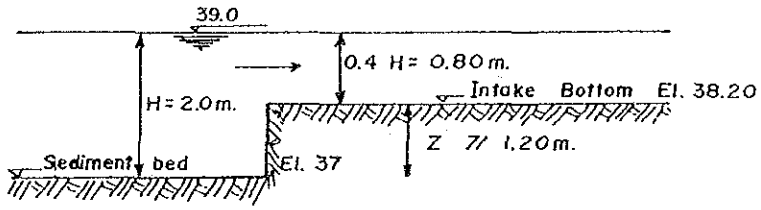


6.2 Results

For transbasin alternatives 5, 5b and 5a, which schemes are shown in Figures F.11 and F.12, reservoir operation for different transbasins were developed, as well as their related costs, in order to select the optimal schemes; summary on them are shown in Table F.9. Summary on the selected scheme for each transbasin alternative are in Tables F.10, F.11 and F.12. Concluding that on the viewpoint of reservoir operation, all demands are satisfied in any of the three(3) Alternatives, but in any case under 10% allowable.

6.2.1 Pumping levels

In the next Table it is shown the different levels reached in each reservoir operation scheme and defined as minimum (LWL), and average (AWL) (50%). Based upon minimum level, it is recommended fix the base elevation of the intake structure at El. 38.20 m in order to avoid sediment get into the suction sump, as indicated in the next figure.



Transbasin Scheme	Minimum Water Level (LWL)		Average Water Level (AWL)	
	Esperanza	Poza Honda	Esperanza	Poza Honda
5	37.00	37.00	56.13	99.08
5b	37.00	90.25	52.44	97.75
5a	37.00	90.25	53.05	97.11

6.2.2 Reservoir operation optimum level

In order to define which is the optimum level of reservoir operation not only for Esperanza dam but also for Poza Honda Dam, three reasons have taken into account as follow:

- Keep La Esperanza reservoir as high as possible to reduce pumping head
- Keep Poza Honda reservoir as low as possible to receive water from La Esperanza with minimum pumping head
- Spillover from the spillway should be limited and low as much as possible
- Keep deficit below 10%

In order to satisfy above requirements OPERAM-33 mathema-tical model was run several times and the results are shown on Tables F.10, F.11 and F.12, and main conclusions are:

- For Alternative 5, when 10 m^3/s are pumped up from La Esperanza to Poza Honda reservoir,the optimum operation levels are EL 60 and EL 106.5, respectively.

- For Alternative 5b and 5a, when 13 and 16 m^3/s are pumped up, the optimum operation levels will be EL 66 and EL 102.5, respectively.

On Figures F.13 and F.14 for Alternative 5a case, are shown the reservoir operation curves for the whole simulated 20 years period.

7. TRANSBASIN PLAN FROM DAULE-PERIPA TO CHONE-PORTOVIEJO RIVER BASINS

7.1 Water Balance

On Figures F.15, F.16 and F.17 the water balances for each one of the Alternatives are shown. Through these water balances the volume of water to be derivated are calculated, in this annual manner for alternative 5a from the 500 mcm derivated from Daule-Peripa to La Esperanza, 360 mcm will be derivated again to Poza Honda reservoir and 140 mcm remain in La Esperanza reservoir in order to satisfy its own water demands.

7.2 Transbasin Schemes

On figures F.11, and F.12 the transbasin schemes that have been studied during this stage are shown, having been selected the Alternative 5a.

7.3 Poza Honda Reservoir as Flood Control

When operating the Poza Honda reservoir at EL 102.50, there will be a surplus volume of 35 mcm to handle the inflow run-off up to a return period of 500 years, diminishing, this way, the floods downstream of the dam. Even though the reservoir operation occurs at EL 102.5 and 107.0, the dumping effect on the floods, is the same.

In the next table, there is a summary on the flood volume that can be retained in the reservoir at an optimum operation level of 102.50 m.

Return period (year)	Inflow volume (mcm)	Free reservoir volume (mcm)	Retained volume (mcm)	Spilled over volume (mcm)	Percentage (%)	
					Retained	Spilled over
5	2.73	35.00	2.73	-	100.0	-
10	3.69	35.00	3.69	-	100.0	-
25	4.93	35.00	4.93	-	100.0	-
50	6.28	35.00	6.28	-	100.0	-
100	7.36	35.00	7.36	-	100.0	-
500	9.44	35.00	9.44	-	100.0	-
1000	57.24	35.00	35.00	22.24	61.0	39.00

TABLES

Table F.1 Maximum and Minimum elevation and volumes during Poza Honda reservoir operation, 1979-1990 (*)

Year	Maximum Elevation (m)	Volume (MCM)	Minimum Elevation (m)	Volume (MCM)
1979	106.57	86.50	95.12	29.00
1980	105.05	78.38	94.97	28.42
1981	109.24	101.32	95.76	32.04
1982	104.85	77.36	98.23	44.15
1983	109.24	101.32	103.78	71.90
1984	109.23	101.27	103.94	72.70
1985	108.82	99.10	98.95	47.75
1986	109.26	101.43	98.95	47.75
1987	109.28	101.54	98.51	45.55
1988	109.12	100.60	98.65	46.25
1989	109.12	100.60	98.38	44.90
1990	107.69	92.55	97.21	39.05

(*) The values from which table was made were gotten from CRM - Poza Honda Operation Department.

Table F.2 Services Guarantee. La Esperanza Reservoir Operation

BASIC DATA:

- Reservoir useful volume	=	364.0	hm^3	
- Domestic water demand	=	19.9	"	
- Irrigation demand	=	276.0	"	
- Ecology	=	31.5	"	(1 m^3/s)
- Evaporation loss	=	11.1	"	

DEMAND DISCHARGES AND DEFICITS:

- Annual average demand (potable water + irrigation)	=	9.38	m^3/s
- Demand satisfied	=	7.52	"
- Deficit	=	1.86	"
- Ecology	=	1.00	"
- Demand satisfied	=	0.80	"
- Deficit	=	0.20	"

SERVICES GUARANTEE:

- No. of months failure:	69
- No. of months with failures larger than 10% of demand:	66
- Guarantee for the second case:	81.7%

Table F.3 Results of Water Balance Simulation(*)
Irrigation Area: 20,500 ha

A. Maximum discharge diverted: 6 m^3/s

Inlet Elevation (m)	Deficit of Volume (%)			Time Deficit (%)		
	Design case	Dilution case of 1.4	Dilution case of 1.8	Design case	Dilution case of 1.4	Dilution case of 1.8
69	10.6	8.5	9.9	13.3	12.0	13.7
67	9.5	7.4	9.6	12.5	10.8	13.3
66	8.9	6.8	9.0	11.7	10.8	13.3

B. Maximum discharge diverted: 12 m^3/s

Inlet Elevation (m)	Deficit of Volume (%)			Time Deficit (%)		
	Design case	Dilution case of 1.4	Dilution case of 1.8	Design case	Dilution case of 1.4	Dilution case of 1.8
69	5.2	2.5	3.9	7.9	3.8	5.8
67	3.3	0.1	3.9	5.0	0.8	5.8
66	2.6	0.0	3.3	4.2	0.0	5.0

(*) Taken from Consortium Ecuatoriano-Brasileño (1988)

Table F.4 La Esperanza Reservoir Operation. Historic Total Simulation (1963-1982) (*)

- Reservoir average volume	%	84.00
- Reservoir average volume	mcm	330.02
- Discharge in the reservoir	mcm	6,891.00
- Diverted discharge	mcm	5,411.00
- Reservoir loss	mcm	- 293.00
- Domestic water demand	mcm	205.00
- Irrigation water demand	mcm	8,676.00
- Reservoir overflow	mcm	3,755.00
- Irrigation deficit	mcm	- 28.00
- Deficit/Irrigation water demand	%	0.32
- Deficits in percentage	%	0.83

(*) Volumes and Demands in million of cubic meters are accumulated during 1963-1982

Table F.5 Summary of Results obtained for La Esperanza Dam Water Balance. Diverted discharge, 18 m^3/s (*)

Year	Municipal Water Demand (m^3/s)		Area to be irrigated (ha)		Deficit in Volume (%)	Deficit (%)
	Carrizal Valley	Portoviejo Valley	Carrizal Valley	Portoviejo Valley		
1992	0.14	1.28	10,300	12,700	0.00	0.00
1993	0.15	1.45	17,600	16,300	0.30	0.83
1995	0.18	1.84	20,500	17,000	3.40	3.75
1996	0.19	1.91	20,500	17,000	7.09	7.02
2005	0.25	2.80	20,500	17,000	7.88	9.17
2006	0.26	2.92	20,500	17,000	9.16	9.58
2010	0.29	3.46	20,500	17,000	9.91	10.42
2015	0.33	4.29	20,500	17,000	10.11	11.25

(*) Taken from Consortium Ecuatoriano-Brasileño (1988).

Table F.6 Discharge curve of intake works Transbasin from Daule-Peripa dam to La Esperanza dam

Elevation (masl)	Discharge (m^3/s)
66.60	0.00
67.50	2.50
68.50	11.61
69.50	12.98
70.50	14.22
71.50	15.36
72.50	16.42
73.50	17.42
74.50	18.36
75.50	19.25
76.50	20.11
77.50	20.93
78.50	21.72
79.50	22.48
80.50	23.22
81.50	23.94
82.50	24.63
83.50	25.31
84.20	25.77

Table F.7 Summary of deficit Daule-Peripa reservoir for each trace

Trace No.	DEFICIT											
	Energy		Potable Water		Irrigation		Manabi Transbasin		Macul Transbasin		S. Elena Transbasin	
	No. month	%	No. month	%	No. month	%	No. month	%	No. month	%	No. month	%
1	0.00	0.00	0.00	0.00	0.00	0.00	4.00	1.11	0.00	0.00	0.00	0.00
2	9.00	2.50	0.00	0.00	0.00	0.00	45.00	12.50	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	9.00	2.50	0.00	0.00	0.00	0.00
4	7.00	1.94	0.00	0.00	1.00	0.28	27.00	7.50	1.00	0.28	1.00	0.28
5	0.00	0.00	0.00	0.00	0.00	0.00	22.00	6.11	0.00	0.00	0.00	0.00
6	9.00	2.50	0.00	0.00	1.00	0.28	48.00	13.33	1.00	0.28	1.00	0.28
7	5.00	1.39	0.00	0.00	0.00	0.00	39.00	10.83	0.00	0.00	0.00	0.00
8	4.00	1.11	0.00	0.00	0.00	0.00	41.00	11.39	0.00	0.00	0.00	0.00
9	22.00	6.11	3.00	0.83	6.00	1.67	45.00	12.50	6.00	1.67	6.00	1.67
10	4.00	1.11	0.00	0.00	0.00	0.00	30.00	8.33	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	14.00	3.89	0.00	0.00	0.00	0.00
12	4.00	1.11	0.00	0.00	0.00	0.00	64.00	17.78	0.00	0.00	0.00	0.00
13	10.00	2.78	0.00	0.00	0.00	0.00	44.00	12.22	0.00	0.00	0.00	0.00
14	13.00	3.61	0.00	0.00	0.00	0.00	47.00	13.06	0.00	0.00	0.00	0.00
15	5.00	1.39	0.00	0.00	0.00	0.00	44.00	12.22	0.00	0.00	0.00	0.00
16	5.00	1.39	0.00	0.00	0.00	0.00	29.00	8.06	0.00	0.00	0.00	0.00
17	11.00	3.06	0.00	0.00	0.00	0.00	57.00	15.83	0.00	0.00	0.00	0.00
18	2.00	0.56	0.00	0.00	0.00	0.00	34.00	9.44	0.00	0.00	0.00	0.00
19	7.00	1.94	0.00	0.00	0.00	0.00	41.00	11.39	0.00	0.00	0.00	0.00
20	5.00	1.39	0.00	0.00	0.00	0.00	33.00	9.17	0.00	0.00	0.00	0.00
21	4.00	1.11	0.00	0.00	0.00	0.00	52.00	14.44	0.00	0.00	0.00	0.00
22	3.00	0.83	0.00	0.00	0.00	0.00	30.00	8.33	0.00	0.00	0.00	0.00
23	7.00	1.94	0.00	0.00	0.00	0.00	45.00	12.50	0.00	0.00	0.00	0.00
24	3.00	0.83	0.00	0.00	0.00	0.00	32.00	8.89	0.00	0.00	0.00	0.00
25	22.00	6.11	4.00	1.11	5.00	1.39	45.00	12.50	7.00	1.94	7.00	1.94
26	0.00	0.00	0.00	0.00	0.00	0.00	10.00	2.78	0.00	0.00	0.00	0.00
27	14.00	3.89	2.00	0.56	3.00	0.83	42.00	11.67	4.00	1.11	4.00	1.11
28	0.00	0.00	0.00	0.00	0.00	0.00	17.00	4.72	0.00	0.00	0.00	0.00
29	2.00	0.56	0.00	0.00	0.00	0.00	40.00	11.11	0.00	0.00	0.00	0.00
30	8.00	2.22	0.00	0.00	0.00	0.00	34.00	9.44	0.00	0.00	0.00	0.00
Average	6.17	1.71	0.30	0.08	0.53	0.15	35.47	9.85	0.63	0.18	0.63	0.18

Table F.8 Derivated Flow

	Flow m^3/s				Average Volume to be derivated (mmc)	Adjusted Average Volume (mmc)	Derivated flow (m^3/s)
	Year 706	Year 707	Year 708	Average			
January	13.80	15.10	18.00	15.63	41.9	29.4	11.0
February	12.60	16.40	18.00	15.67	37.9	25.5	10.5
March	7.90	18.00	18.00	14.63	39.2	26.7	10.0
April	9.00	18.00	18.00	15.00	38.9	38.9	15.0
May	18.00	18.00	18.00	18.00	48.2	48.2	18.0
June	18.00	18.00	18.00	18.00	46.6	46.6	18.0
July	18.00	18.00	18.00	18.00	48.2	48.2	18.0
August	18.00	18.00	18.00	18.00	48.2	48.2	18.0
September	18.00	18.00	18.00	18.00	46.6	46.6	18.0
October	18.00	18.00	18.00	18.00	48.2	48.2	18.0
November	18.00	18.00	18.00	18.00	46.6	46.6	18.0
December	16.60	18.00	18.00	17.53	46.9	46.9	18.0
Total					537.4	500.0	

Table F.9 Summary of reservoirs operation and associated costs

Alter-natives	Maximum Transbasin Capacity (m3/s)	Irrigation Annual Water Demand								Irrigation Water Demand 1/5 year							
		Operation factor	Hmax (m)	Have (m)	Power Cost (US.$x10^6)	Transbasin Cost (US.$x10^6)	Total Cost (US.$x10^6)	Maximum Deficit (%) Poza Honda	La Esperanza	Operation factor	Hmax (m)	Have (m)	Power Cost (US.$x10^6)	Transbasin Cost (US.$x10^6)	Total Cost (US.$x10^6)	Maximum Deficit (%) Poza Honda	La Esperanza
5	(*) 10	0.62	72.60	57.90	3.02	48.50	51.52	9.17	0.42								
	11	0.56	74.10	58.04	3.00	51.40	54.40	6.67	0.42								
	12	0.52	74.20	58.80	3.14	53.90	57.04	4.58	0.83	0.66	74.20	62.02	4.13	53.90	58.03	3.33	10.83
5b	13									0.61	74.00	62.70	4.18	56.60	60.78	2.08	11.25
	(*) 13									0.61	74.10	61.50	4.10	56.60	60.70	5.00	10.83
5a	14	0.69	71.94	57.75	4.69	59.20	63.89	8.75	0.00								
	15	0.64	72.80	58.19	4.70	61.20	65.90	7.08	0.42								
	16	0.60	73.53	58.27	4.70	63.00	67.70	3.75	0.83	0.71	74.53	60.95	5.82	63.00	68.82	2.92	9.17
	17									0.67	74.00	61.30	5.87	64.80	70.67	0.00	10.42
	(**)16 (*)									0.71	74.53	60.95	5.82	63.00	68.82	7.50	9.17
	(**)17									0.67	74.99	61.30	5.87	64.80	70.67	3.33	10.42

(*) Selected capacity for the given alternative

(**) Row water for El Ceibal treatment plant is supplied through Poza Honda-Mancha Grande transbasin

Table F.10 SUMMARY OF RESULT OF RESERVOIR OPERATION WITH AVERAGE IRRIGATION WATER DEMAND
SCHEME 5 (PEAK DISCHARGE = 10 m3/s)

RESUMEN DE LOS RESULTADOS DE LA OPERACION DE EMBALSE CON DEMANDA PROMEDIO DE AGUA PARA RIEGO
ESQUEMA 5 CON UN CAUDAL PICO DE 10 m3/s

Transbasin from Daule-Peripa Dam to La Esperanza Dam	No.	Optimum Levels of Operation ESP/P. HON	Transbasin from La Esperanza Dam to Poza Honda Dam	Transbasin from P.Honda Dam to Chirijos Dam	La Esperanza Dam											Poza Honda Dam										
					# of Month with Deficit Ecology	%	# of Month with Deficit in Transbasin	%	# of Month with Deficit Water Supply	%	# of Month with Deficit Irrigation	%	# of Month with Deficit Shrimp	%	Overflow Million m3	# of Month with Deficit Ecology	%	# of Month with Deficit in Transbasin	%	# of Month with Deficit Water Supply	%	# of Month with Deficit Irrigation	%	# of Month with Deficit Shrimp	%	Overflow Million m3
JAN = 11.0	1	66/108.5	JAN = 2.0	JAN = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,350.00	0.00	0.00	0.00	0.00	4.00	1.67	16.00	6.67	12.00	5.00	230.37
	2	66/106.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,350.00	0.00	0.00	0.00	0.00	4.00	1.67	22.00	9.17	17.00	7.08	71.80
FEB = 10.5	3	66/104.5	FEB = 2.0	FEB = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,350.00	0.00	0.00	0.00	0.00	4.00	1.67	28.00	11.67	21.00	8.75	59.71
	4	66/102.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,350.00	0.00	0.00	0.00	0.00	10.00	4.17	43.00	17.92	33.00	13.75	48.40
MAR = 10.0	5	66/100.5	MAR = 4.0	MAR = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,350.00	0.00	0.00	0.00	0.00	12.00	5.00	63.00	26.25	46.00	19.17	37.90
APR = 15.0	6	64/108.5	APR = 8.0	APR = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	841.70	0.00	0.00	0.00	0.00	4.00	1.67	16.00	6.67	12.00	5.00	230.37
	7	64/106.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	841.70	0.00	0.00	0.00	0.00	4.00	1.67	22.00	9.17	17.00	7.08	71.80
MAY = 18.0	8	64/104.5	MAY = 9.0	MAY = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	841.70	0.00	0.00	0.00	0.00	4.00	1.67	28.00	11.67	21.00	8.75	59.71
	9	64/102.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	841.70	0.00	0.00	0.00	0.00	10.00	4.17	43.00	17.92	33.00	13.75	48.40
JUN = 18.0	10	64/100.5	JUN = 7.0	JUN = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	841.70	0.00	0.00	0.00	0.00	12.00	5.00	63.00	26.25	46.00	19.17	37.90
JUL = 18.0	11	62/108.5	JUL = 8.0	JUL = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	535.26	0.00	0.00	0.00	0.00	4.00	1.67	16.00	6.67	12.00	5.00	230.37
	12	62/106.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	535.26	0.00	0.00	0.00	0.00	4.00	1.67	22.00	9.17	17.00	7.08	71.80
AUG = 18.0	13	62/104.5	AUG = 10.0	AUG = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	535.26	0.00	0.00	0.00	0.00	4.00	1.67	28.00	11.67	21.00	8.75	59.71
	14	62/102.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	535.26	0.00	0.00	0.00	0.00	10.00	4.17	43.00	17.92	33.00	13.75	48.40
SEP = 18.0	15	62/100.5	SEP = 10.0	SEP = 2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	535.26	0.00	0.00	0.00	0.00	12.00	5.00	63.00	26.25	46.00	19.17	37.90
OCT = 18.0	16	60/108.5	OCT = 10.0	OCT = 2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.42	453.13	0.00	0.00	0.00	0.00	4.00	1.67	16.00	6.67	12.00	5.00	230.37
	17	60/106.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.42	453.13	0.00	0.00	0.00	0.00	4.00	1.67	22.00	9.17	17.00	7.08	71.80
NOV = 18.0	18	60/104.5	NOV = 10.0	NOV = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.42	453.13	0.00	0.00	0.00	0.00	4.00	1.67	28.00	11.67	21.00	8.75	59.71
	19	60/102.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.42	453.13	0.00	0.00	0.00	0.00	10.00	4.17	43.00	17.92	33.00	13.75	48.40
DEC = 18.0	20	60/100.5	DEC = 7.0	DEC = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.42	453.13	0.00	0.00	0.00	0.00	12.00	5.00	63.00	26.25	46.00	19.17	37.90

Table F.11 SUMMARY OF RESULT OF RESERVOIR OPERATION WITH IRRIGATION WATER DEMAND OF 1 IN 5 YEAR.
SCHEME 5-B (PEAK DISCHARGE = 13 m3/s)

RESUMEN DE LOS RESULTADOS DE LA OPERACION DE EMBALSE CON DEMANDA DE AGUA PARA RIEGO DE 1 EN 5 AÑOS.
ESQUEMA 5-B CON UN CAUDAL PICO 13 m3/s

Transbasin from Daule-Peripa Dam to La Esperanza Dam	No.	Optimum Levels of Operation ESP/P. HON	Transbasin from La Esperanza Dam to Poza Honda Dam	Transbasin from P.Honda Dam to Chirijos Dam	La Esperanza Dam											Poza Honda Dam										
					# of Month with Deficit Ecology	%	# of Month with Deficit in Transbasin	%	# of Month with Deficit Water Supply	%	# of Month with Deficit Irrigation	%	# of Month with Deficit Shrimp	%	Overflow Million m3	# of Month with Deficit Ecology	%	# of Month with Deficit in Transbasin	%	# of Month with Deficit Water Supply	%	# of Month with Deficit Irrigation	%	# of Month with Deficit Shrimp	%	Overflow Million m3
JAN = 11.0	1	66/108.5	JAN = 5.0	JAN = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	23.00	9.58	26.00	10.83	278.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	215.78
	2	66/106.5			0.00	0.00	0.00	0.00	0.00	0.00	23.00	9.58	26.00	10.83	278.11	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.83	0.00	0.00	115.94
FEB = 10.5	3	66/104.5	FEB = 6.0	FEB = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	23.00	9.58	26.00	10.83	278.11	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.83	0.00	0.00	69.86
	4	66/102.5			0.00	0.00	0.00	0.00	0.00	0.00	23.00	9.58	26.00	10.83	278.11	0.00	0.00	0.00	0.00	0.00	0.00	12.00	5.00	5.00	2.08	33.75
MAR = 10.0	5	66/100.5	MAR = 8.0	MAR = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	23.00	9.58	26.00	10.83	278.11	0.00	0.00	0.00	0.00	0.00	0.00	22.00	9.17	14.00	5.83	12.75
APR = 15.0	6	64/108.5	APR = 11.0	APR = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	27.00	11.25	28.00	11.67	141.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	215.78
	7	64/106.5			0.00	0.00	0.00	0.00	0.00	0.00	27.00	11.25	28.00	11.67	141.93	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.83	0.00	0.00	115.94
MAY = 18.0	8	64/104.5	MAY = 11.0	MAY = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	27.00	11.25	28.00	11.67	141.93	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.83	0.00	0.00	69.86
	9	64/102.5			0.00	0.00	0.00	0.00	0.00	0.00	27.00	11.25	28.00	11.67	141.93	0.00	0.00	0.00	0.00	0.00	0.00	12.00	5.00	5.00	2.08	33.75
JUN = 18.0	10	64/100.5	JUN = 8.0	JUN = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	27.00	11.25	28.00	11.67	141.93	0.00	0.00	0.00	0.00	0.00	0.00	22.00	9.17	14.00	5.83	12.75
JUL = 18.0	11	62/108.5	JUL = 9.0	JUL = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	30.00	12.50	33.00	13.75	94.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	215.78
	12	62/106.5			0.00	0.00	0.00	0.00	0.00	0.00	30.00	12.50	33.00	13.75	94.63	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.83	0.00	0.00	115.94
AUG = 18.0	13	62/104.5	AUG = 11.0	AUG = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	30.00	12.50	33.00	13.75	94.63	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.83	0.00	0.00	69.86
	14	62/102.5			0.00	0.00	0.00	0.00	0.00	0.00	30.00	12.50	33.00	13.75	94.63	0.00	0.00	0.00	0.00	0.00	0.00	12.00	5.00	5.00	2.08	33.75
SEP = 18.0	15	62/100.5	SEP = 13.0	SEP = 2.0	0.00	0.00	0.00	0.00	0.00	0.00	30.00	12.50	33.00	13.75	94.63	0.00	0.00	0.00	0.00	0.00	0.00	22.00	9.17	14.00	5.83	12.75
OCT = 18.0	16	60/108.5	OCT = 13.0	OCT = 2.0	0.00	0.00	0.00	0.00	0.00	0.00	32.00	13.33	38.00	15.83	94.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	215.78
	17	60/106.5			0.00	0.00	0.00	0.00	0.00	0.00	32.00	13.33	38.00	15.83	94.63	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.83	0.00	0.00	115.94
NOV = 18.0	18	60/104.5	NOV = 11.0	NOV = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	32.00	13.33	38.00	15.83	94.63	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.83	0.00	0.00	69.86
	19	60/102.5			0.00	0.00	0.00	0.00	0.00	0.00	32.00	13.33	38.00	15.83	94.63	0.00	0.00	0.00	0.00	0.00	0.00	12.00	5.00	5.00	2.08	33.75
DEC = 18.0	20	60/100.5	DEC = 8.0	DEC = 1.0	0.00	0.00	0.00	0.00	0.00	0.00	32.00	13.33	38.00	15.83	94.63	0.00	0.00	0.00	0.00	0.00	0.00	22.00	9.17	14.00	5.83	12.75

Table F.12 SUMMARY OF RESULT OF RESERVOIR OPERATION WITH IRRIGATION WATER DEMAND OF 1 IN 5 YEARS.
SCHEME 5-A (PEAK DISCHARGE = 16 m3/s)

RESUMEN DE LOS RESULTADOS DE LA OPERACION DE EMBALSE CON DEMANDA DE AGUA PARA RIEGO DE 1 EN 5 AÑOS.
ESQUEMA 5-A CON UN CAUDAL PICO DE 16 m3/s

Transbasin from Daule-Peripa Dam to La Esperanza Dam	No.	Optimum Levels of Operation ESP/P. HON	Transbasin from La Esperanza Dam to Poza Honda Dam	Transbasin from P.Honda Dam to Chirijos Dam	La Esperanza Dam										Poza Honda Dam									
					# of Month with Deficit Ecology	%	# of Month with Deficit in Transbasin	%	# of Month with Deficit Water Supply	%	# of Month with Deficit Irrigation	%	# of Month with Deficit Shrimp	%	Overflow Million m3	# of Month with Deficit Ecology	%	# of Month with Deficit in Transbasin	%	# of Month with Deficit Water Sopply	%	# of Month with Deficit Irrigation	%	# of Month with Deficit Shrimp	%	Overflow Million m3
JAN = 11.0	1	66/108.5	JAN = 8.0	JAN = 2.0	0.00	0.00	0.00	0.00	1.00	0.42	22.00	9.17	21.00	8.75	326.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	174.79
	2	66/106.5			0.00	0.00	0.00	0.00	1.00	0.42	22.00	9.17	21.00	8.75	326.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.78
FEB = 10.5	3	66/104.5	FEB = 9.0	FEB = 2.0	0.00	0.00	0.00	0.00	1.00	0.42	22.00	9.17	21.00	8.75	326.65	0.00	0.00	0.00	0.00	0.00	0.00	5.00	2.08	5.00	33.12
	4	66/102.5			0.00	0.00	0.00	0.00	1.00	0.42	22.00	9.17	21.00	8.75	326.65	0.00	0.00	0.00	0.00	0.00	0.00	18.00	7.50	14.00	5.83	0.00
MAR = 10.0	5	66/100.5	MAR = 12.0	MAR = 3.0	0.00	0.00	0.00	0.00	1.00	0.42	22.00	9.17	21.00	8.75	326.65	0.00	0.00	0.00	0.00	0.00	0.00	50.00	20.83	45.00	18.75	0.00
APR = 15.0	6	64/108.5	APR = 14.0	APR = 3.0	0.00	0.00	0.00	0.00	1.00	0.42	24.00	10.00	24.00	10.00	153.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	174.79
	7	64/106.5			0.00	0.00	0.00	0.00	1.00	0.42	24.00	10.00	24.00	10.00	153.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.78
MAY = 18.0	8	64/104.5	MAY = 15.0	MAY = 3.0	0.00	0.00	0.00	0.00	1.00	0.42	24.00	10.00	24.00	10.00	153.55	0.00	0.00	0.00	0.00	0.00	0.00	5.00	2.08	5.00	2.08	33.12
	9	64/102.5			0.00	0.00	0.00	0.00	1.00	0.42	24.00	10.00	24.00	10.00	153.55	0.00	0.00	0.00	0.00	0.00	0.00	18.00	7.50	14.00	5.83	0.00
JUN = 18.0	10	64/100.5	JUN = 11.0	JUN = 3.0	0.00	0.00	0.00	0.00	1.00	0.42	24.00	10.00	24.00	10.00	153.55	0.00	0.00	0.00	0.00	0.00	0.00	50.00	20.83	45.00	18.75	0.00
JUL = 18.0	11	62/108.5	JUL = 13.0	JUL = 3.0	0.00	0.00	0.00	0.00	2.00	0.83	27.00	11.25	27.00	11.25	98.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	174.79
	12	62/106.5			0.00	0.00	0.00	0.00	2.00	0.83	27.00	11.25	27.00	11.25	98.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.78
AUG = 18.0	13	62/104.5	AUG = 15.0	AUG = 3.0	0.00	0.00	0.00	0.00	2.00	0.83	27.00	11.25	27.00	11.25	98.12	0.00	0.00	0.00	0.00	0.00	0.00	5.00	2.08	5.00	2.08	33.12
	14	62/102.5			0.00	0.00	0.00	0.00	2.00	0.83	27.00	11.25	27.00	11.25	98.12	0.00	0.00	0.00	0.00	0.00	0.00	18.00	7.50	14.00	5.83	0.00
SEP = 18.0	15	62/100.5	SEP = 16.0	SEP = 4.0	0.00	0.00	0.00	0.00	2.00	0.83	27.00	11.25	27.00	11.25	98.12	0.00	0.00	0.00	0.00	0.00	0.00	50.00	20.83	45.00	18.75	0.00
OCT = 18.0	16	60/108.5	OCT = 16.0	OCT = 4.0	0.00	0.00	0.00	0.00	2.00	0.83	29.00	12.08	31.00	12.92	98.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	174.79
	17	60/106.5			0.00	0.00	0.00	0.00	2.00	0.83	29.00	12.08	31.00	12.92	98.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.78
NOV = 18.0	18	60/104.5	NOV = 14.0	NOV = 3.0	0.00	0.00	0.00	0.00	2.00	0.83	29.00	12.08	31.00	12.92	98.12	0.00	0.00	0.00	0.00	0.00	0.00	5.00	2.08	5.00	2.08	33.12
	19	60/102.5			0.00	0.00	0.00	0.00	2.00	0.83	29.00	12.08	31.00	12.92	98.12	0.00	0.00	0.00	0.00	0.00	0.00	18.00	7.50	14.00	5.83	0.00
DEC = 18.0	20	60/100.5	DEC = 11.0	DEC = 3.0	0.00	0.00	0.00	0.00	2.00	0.83	29.00	12.08	31.00	12.92	98.12	0.00	0.00	0.00	0.00	0.00	0.00	50.00	20.83	45.00	18.75	0.00

FIGURES

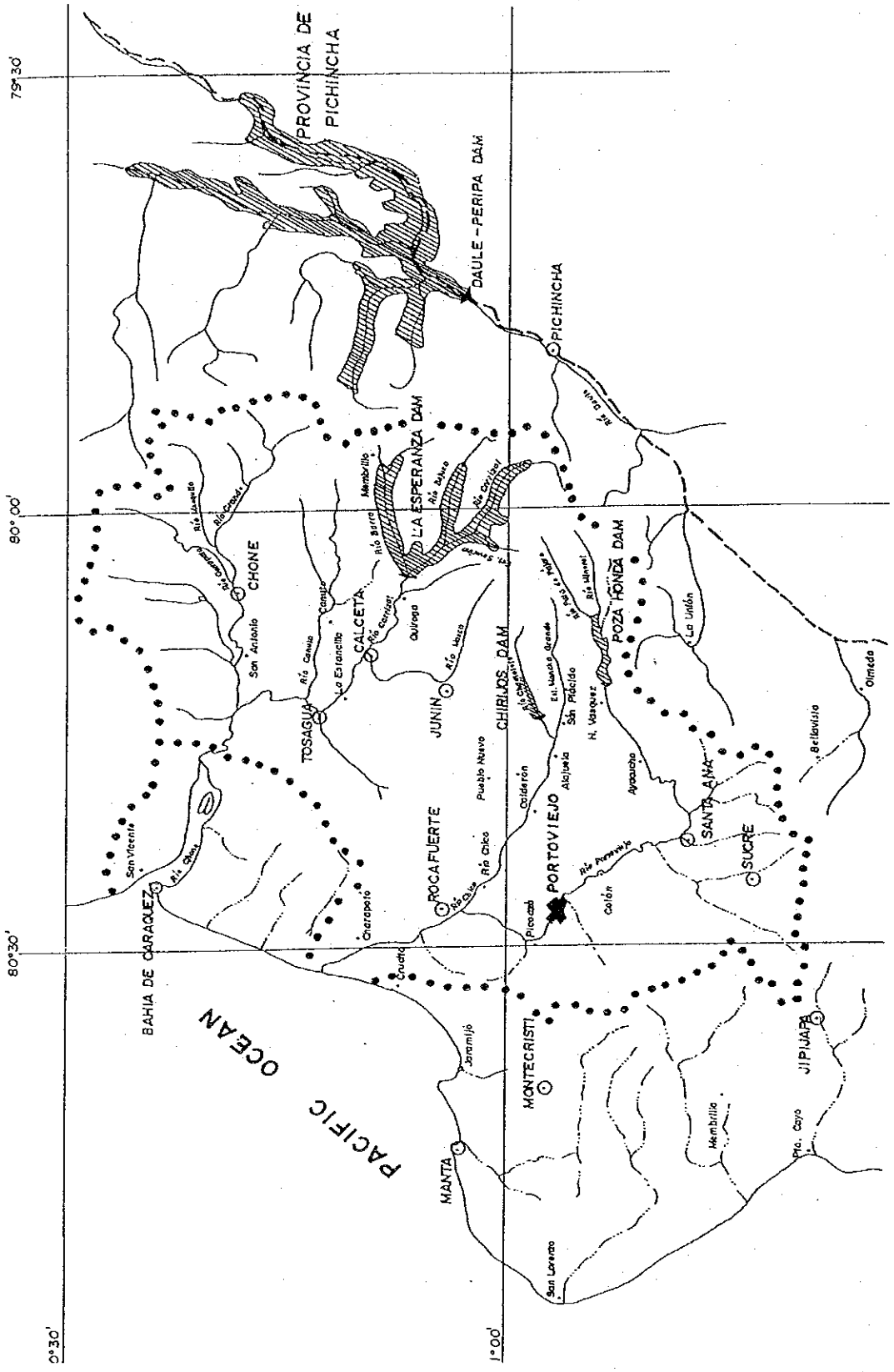


Fig. F.1 Reservoirs Location

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

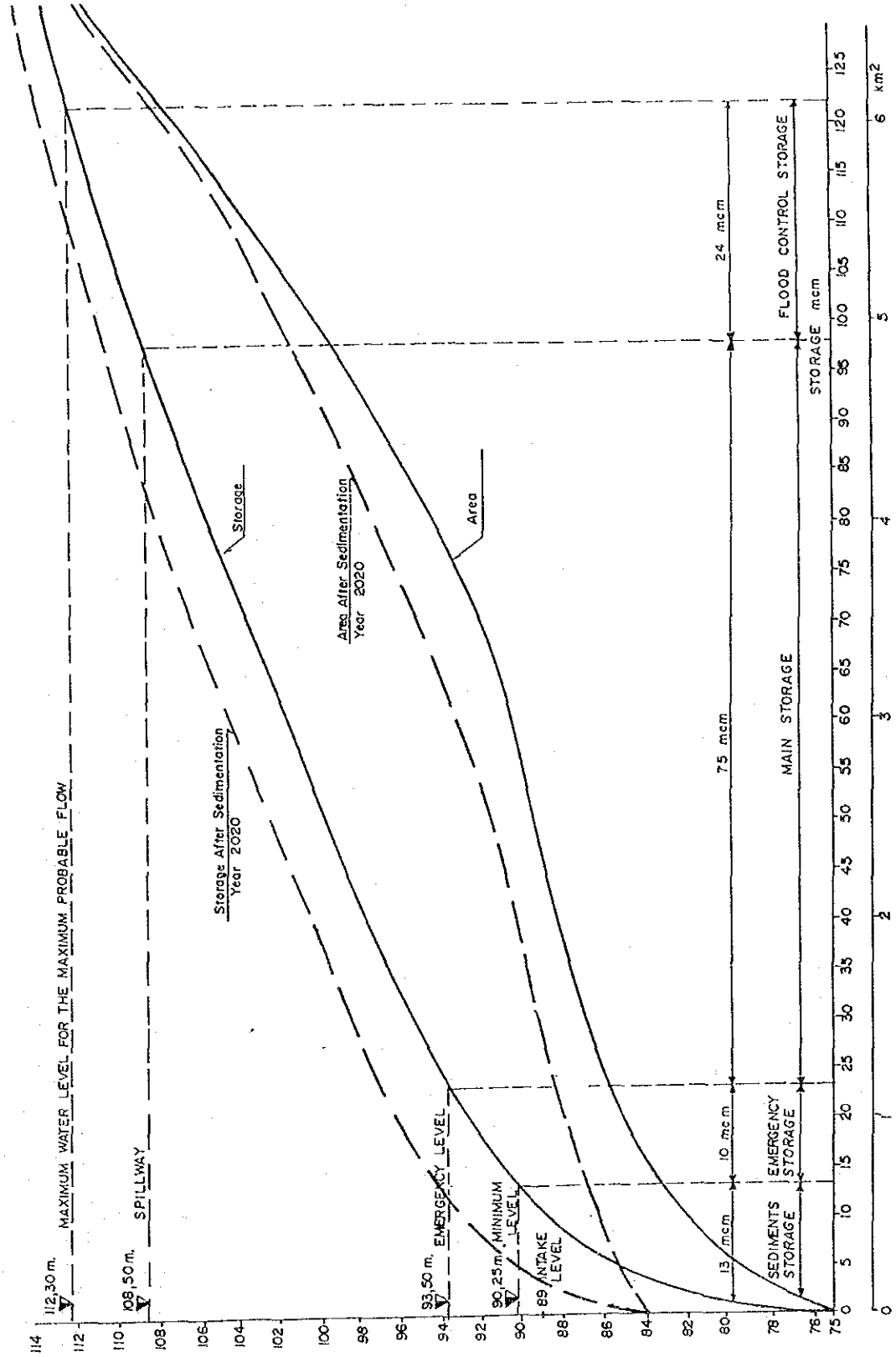


Fig. F.2 Poza Honda Dam, Area-Storage Capacity Curves

GOVERNMENT OF THE REPUBLIC OF ECUADOR
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THE FEASIBILITY STUDY ON THE WATER RESOURCES DEVELOPMENT FOR CHONE-PORTOVIEJO RIVER BASINS
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RESERVOIR OPERATION CURVE

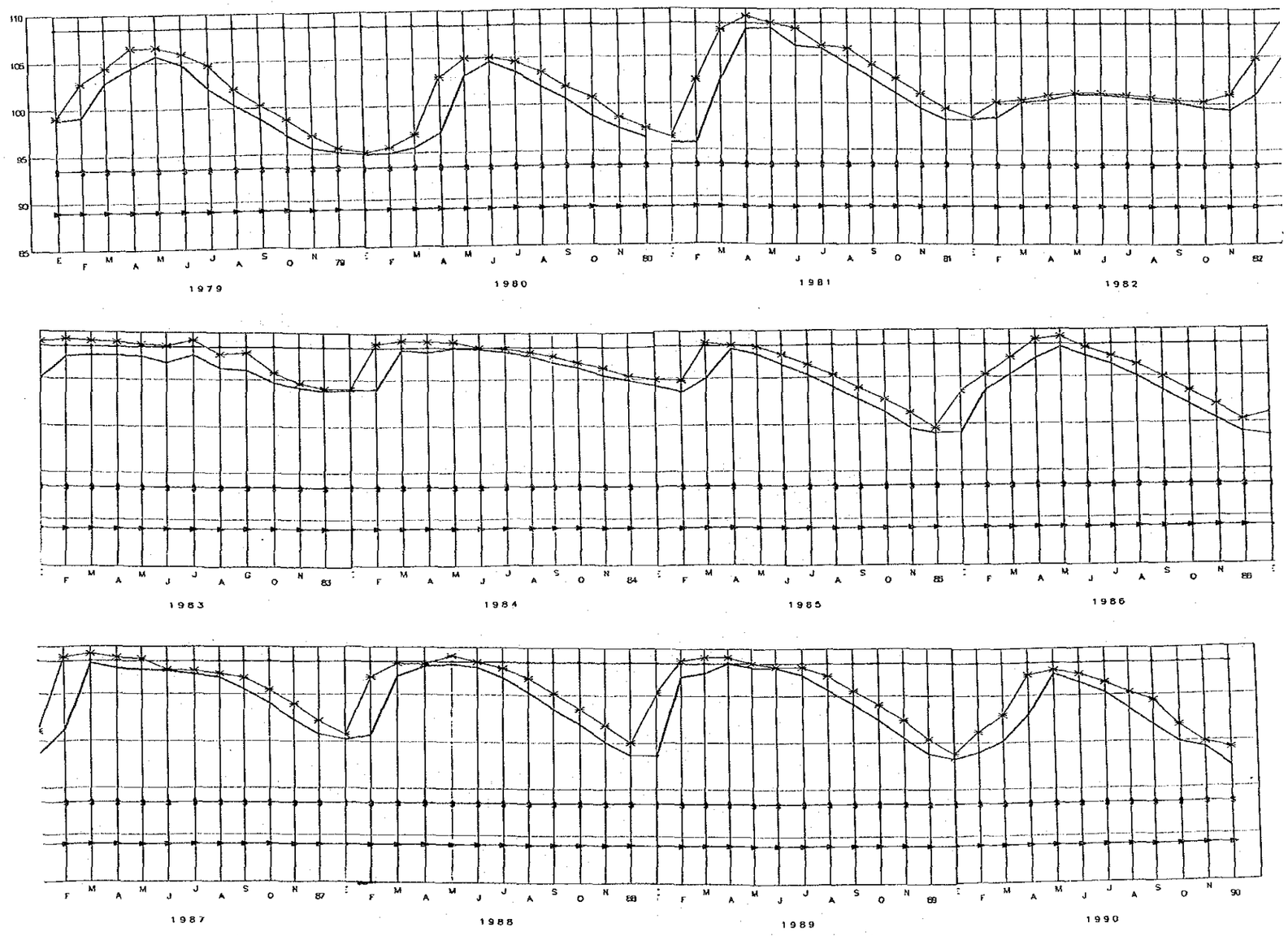
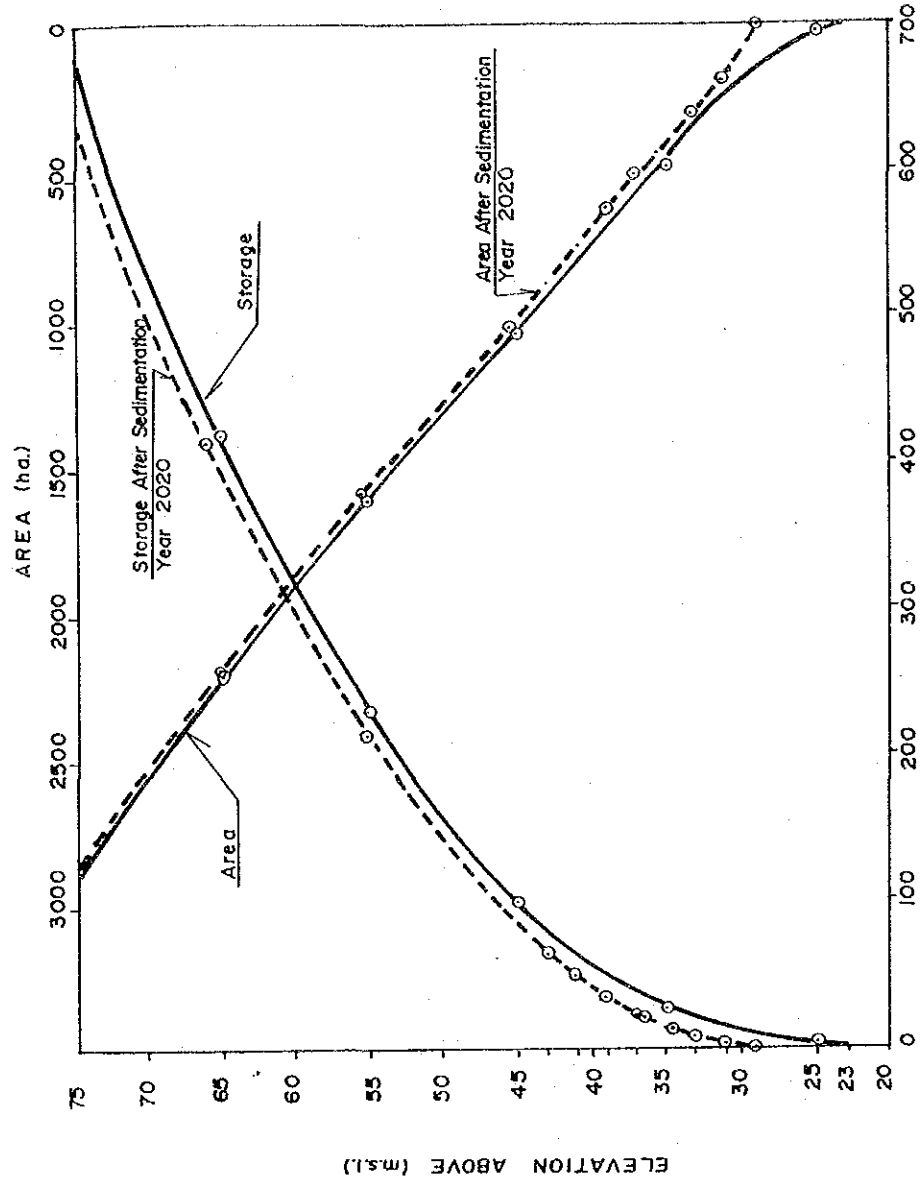


Fig. F.3

Present Operation of Poza Honda Reservoir (1979-1990)

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



ELEVATION (m.s.l.)	23	25	35	45	55	65	75
AREA (ha.)	0	30.83	482.30	1037.80	1605.42	2210.90	2887.15
ACCUMULATED VOLUME (m.c.m.)	0	0.309	25.966	101.97	234.13	424.95	679.85

Fig. F.4 Area-Storage Capacity Curves (La Esperanza Dam)

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

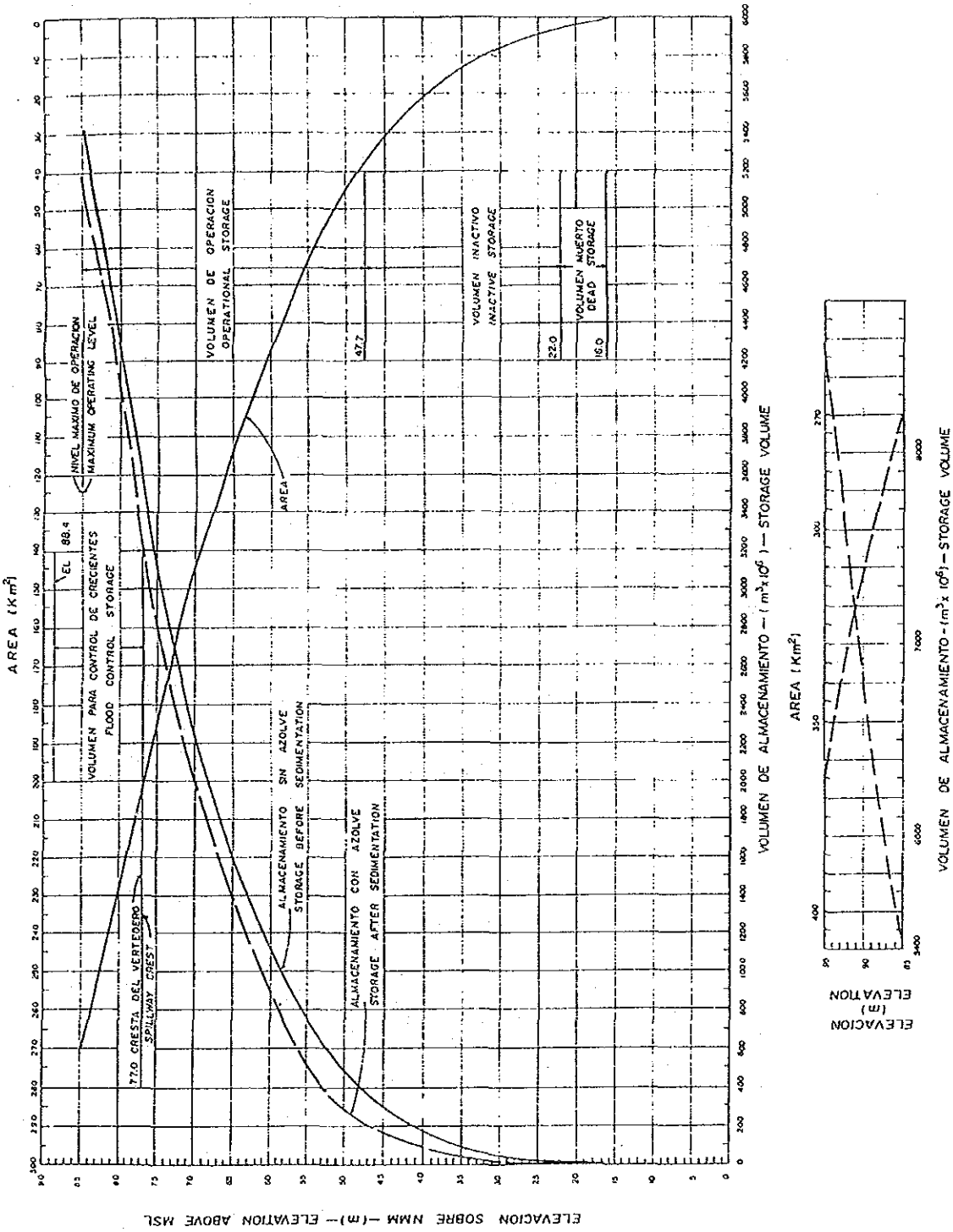

Fig. F.5 Area-Storage Capacity Curves (Daule-Peripa Reservoir)

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
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LEVELS FLUCTUATION OF DAULE - PERIPA RESERVOIR FOR DILUTION OF 1.6

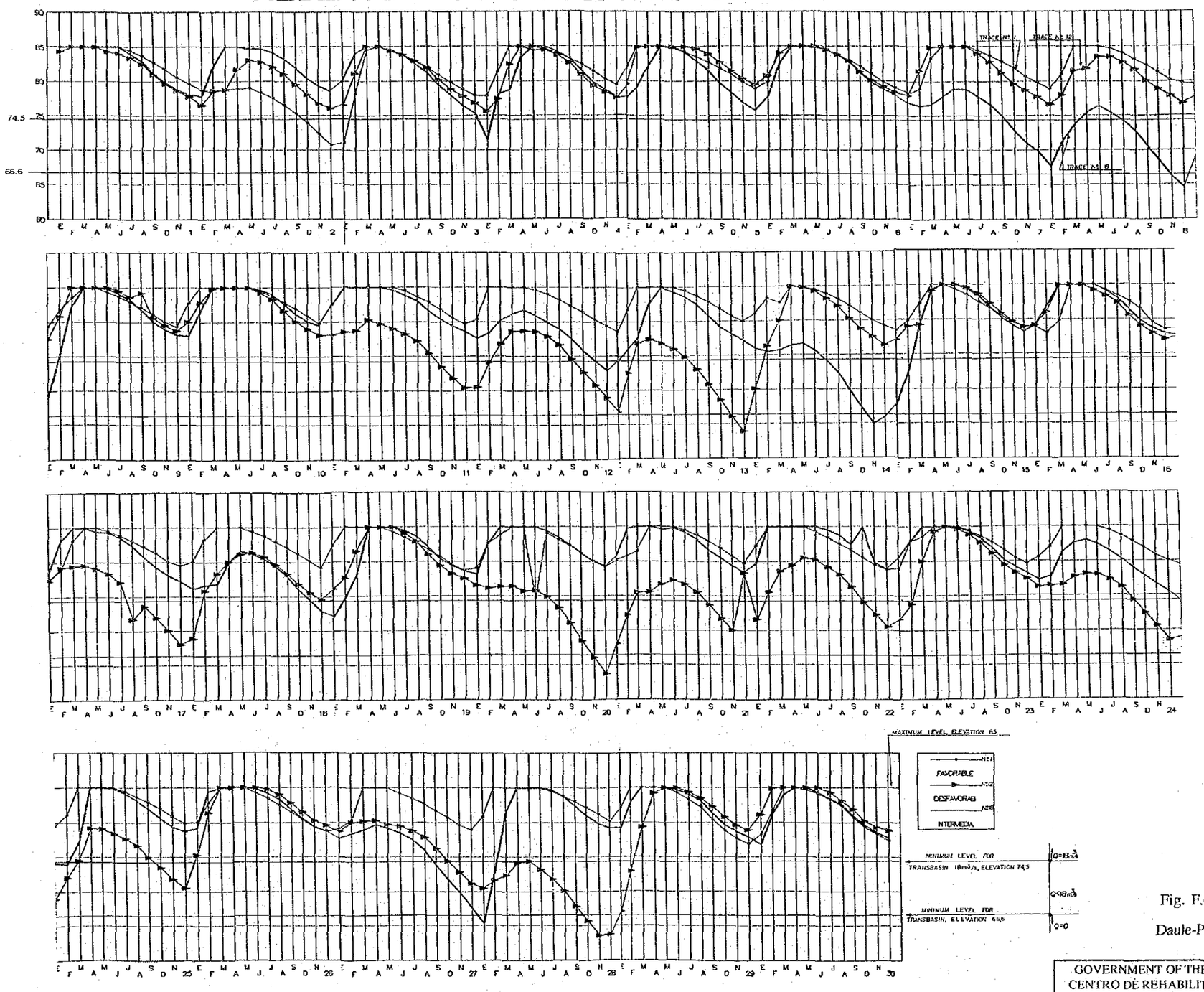

Fig. F.6

Daule-Peripa Reservoir Operation

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

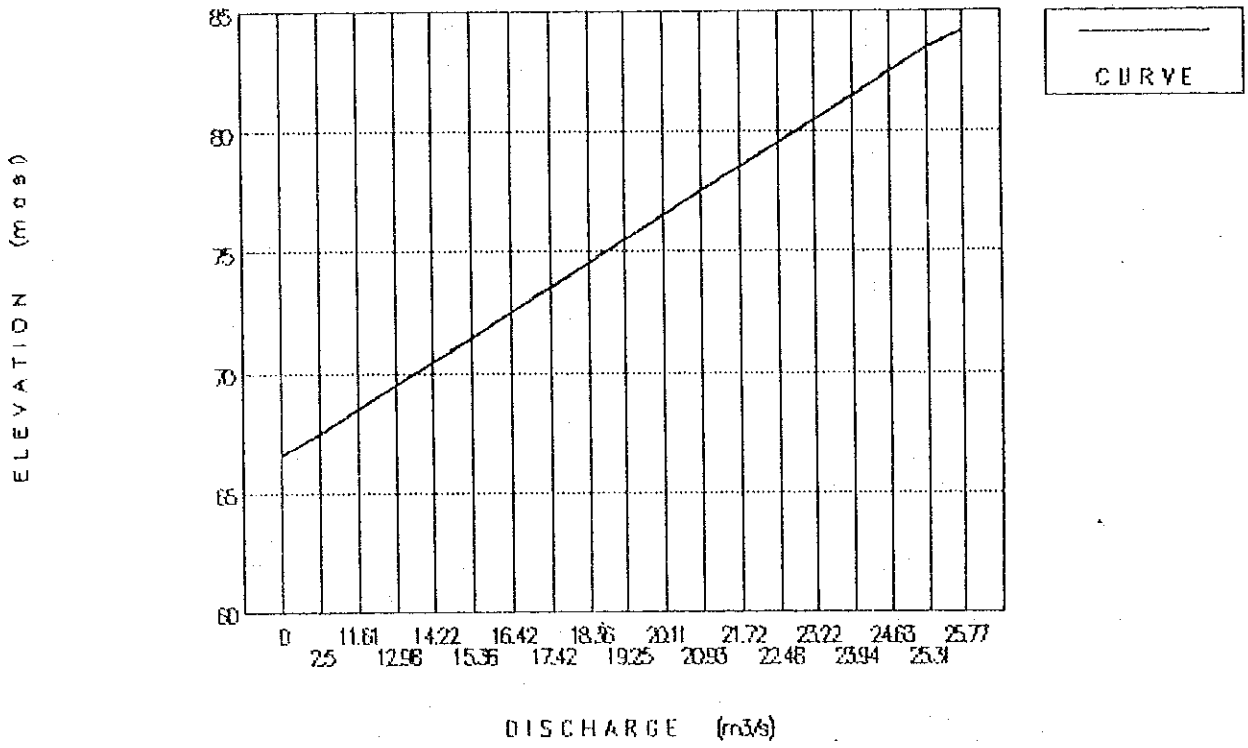

Fig. F.7 Discharge Curve of Intake Works Transbasin from Daule-Peripa Dam to La Esperanza Dam

GOVERNMENT OF THE REPUBLIC OF ECUADOR
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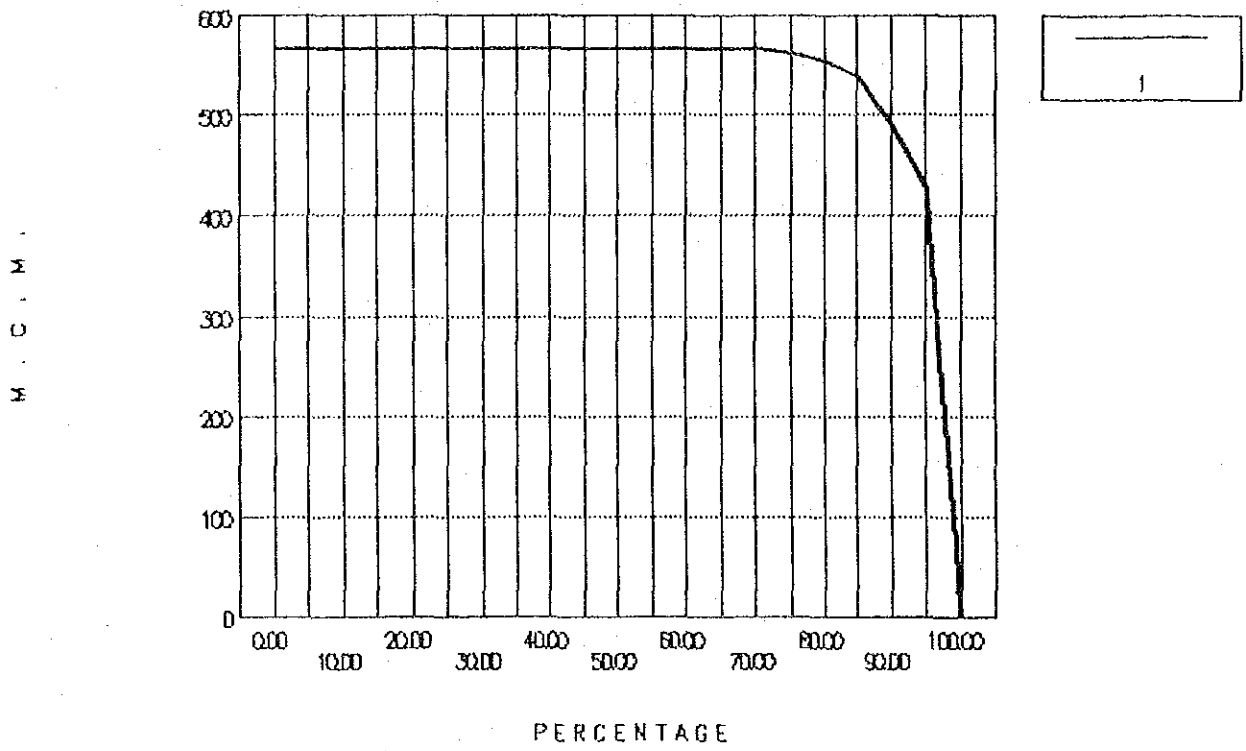

Fig. F.8 Total Annual Water Volume Transbased from Daule-Peripa to La Esperanza

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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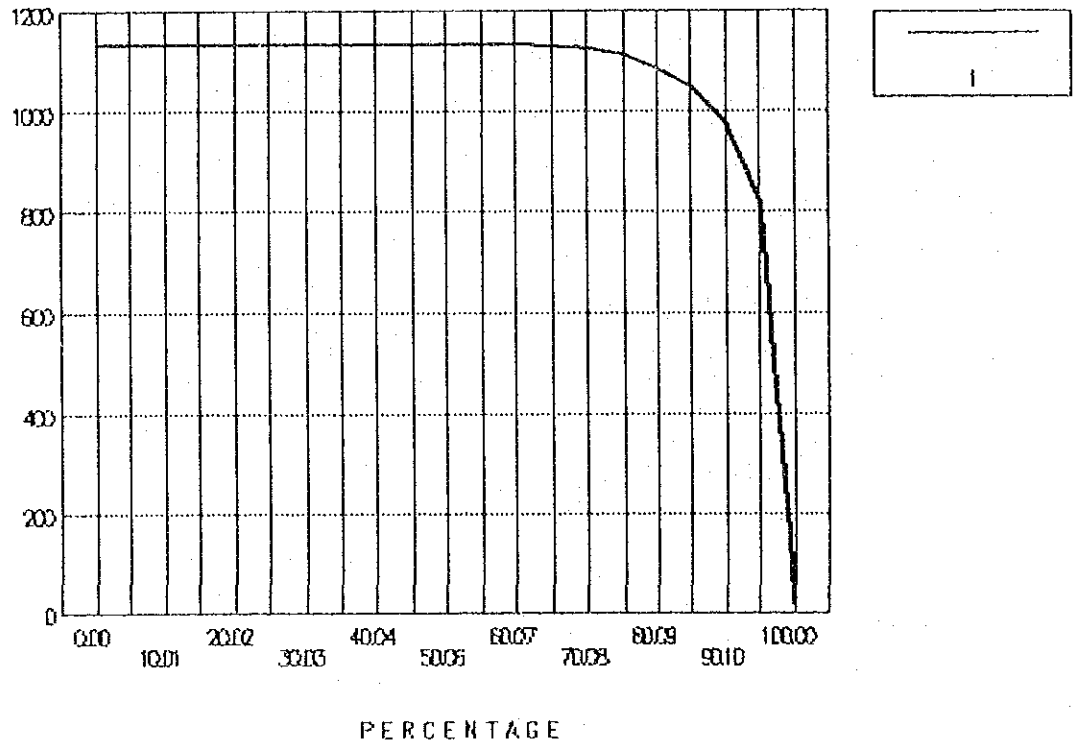

Fig. F.9 Total Bi-Annual Water Volume Transbased from Daule-Peripa to La Esperanza

GOVERNMENT OF THE REPUBLIC OF ECUADOR
CENTRO DE REHABILITACION DE MANABI (CRM)
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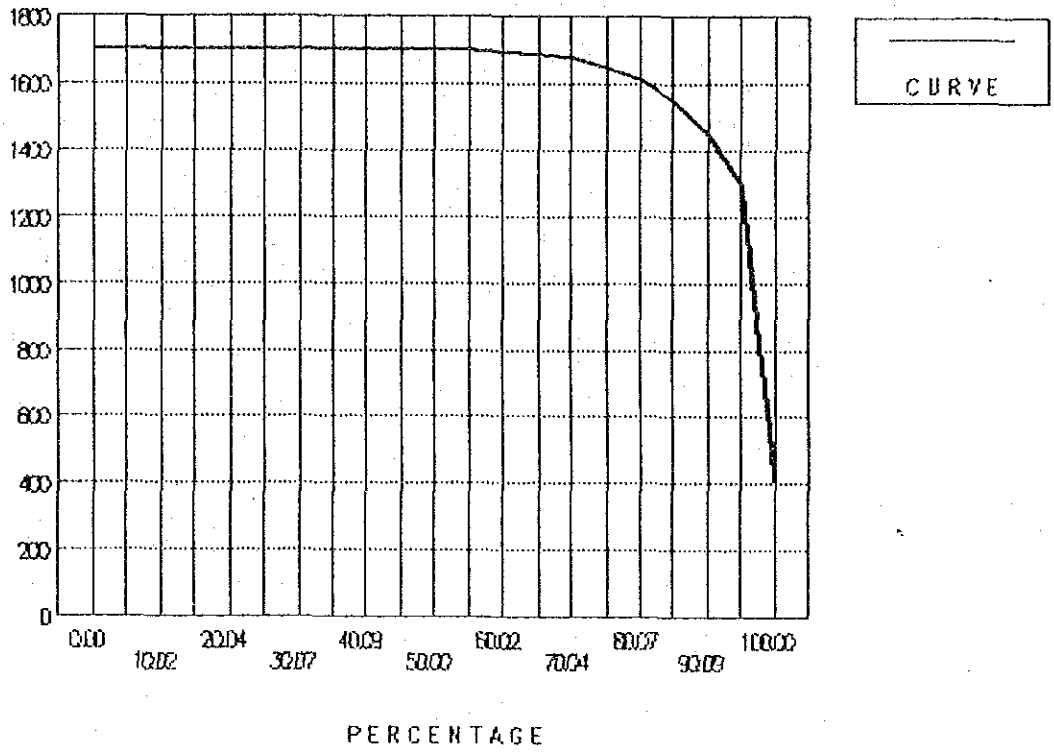

Fig. F.10 Total Tri-Annual Water Volume Transbased from Daule-Peripa to La Esperanza

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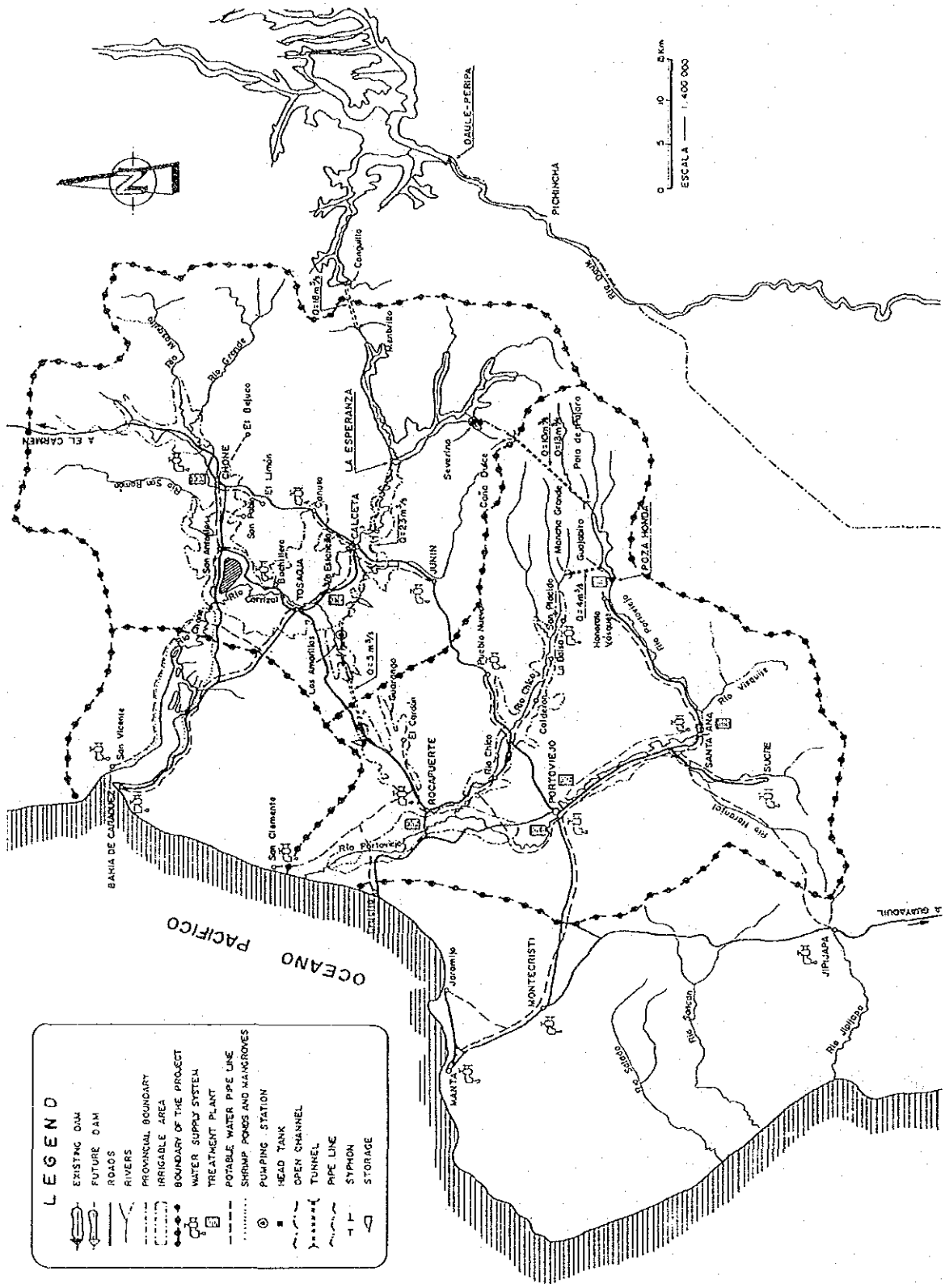

Fig. F.11 Transbasin Schemes, Alternatives 5, 5b

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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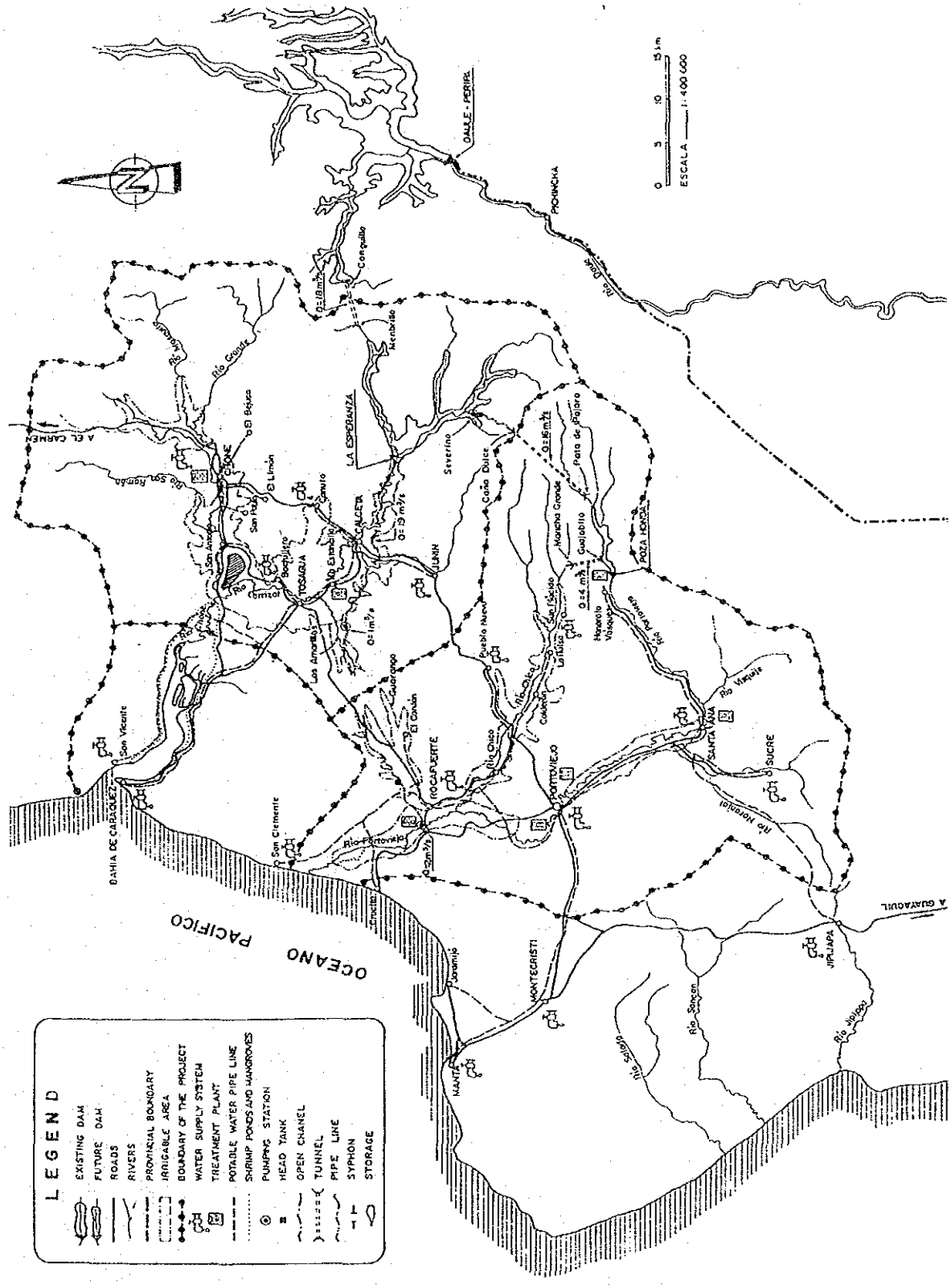


Fig. F.12 Transbasin Scheme, Alternative 5a

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

SUMMARY OF RESERVOIR OPERATION

LA ESPERANZA DAM (peak flow = 16 m3/s)

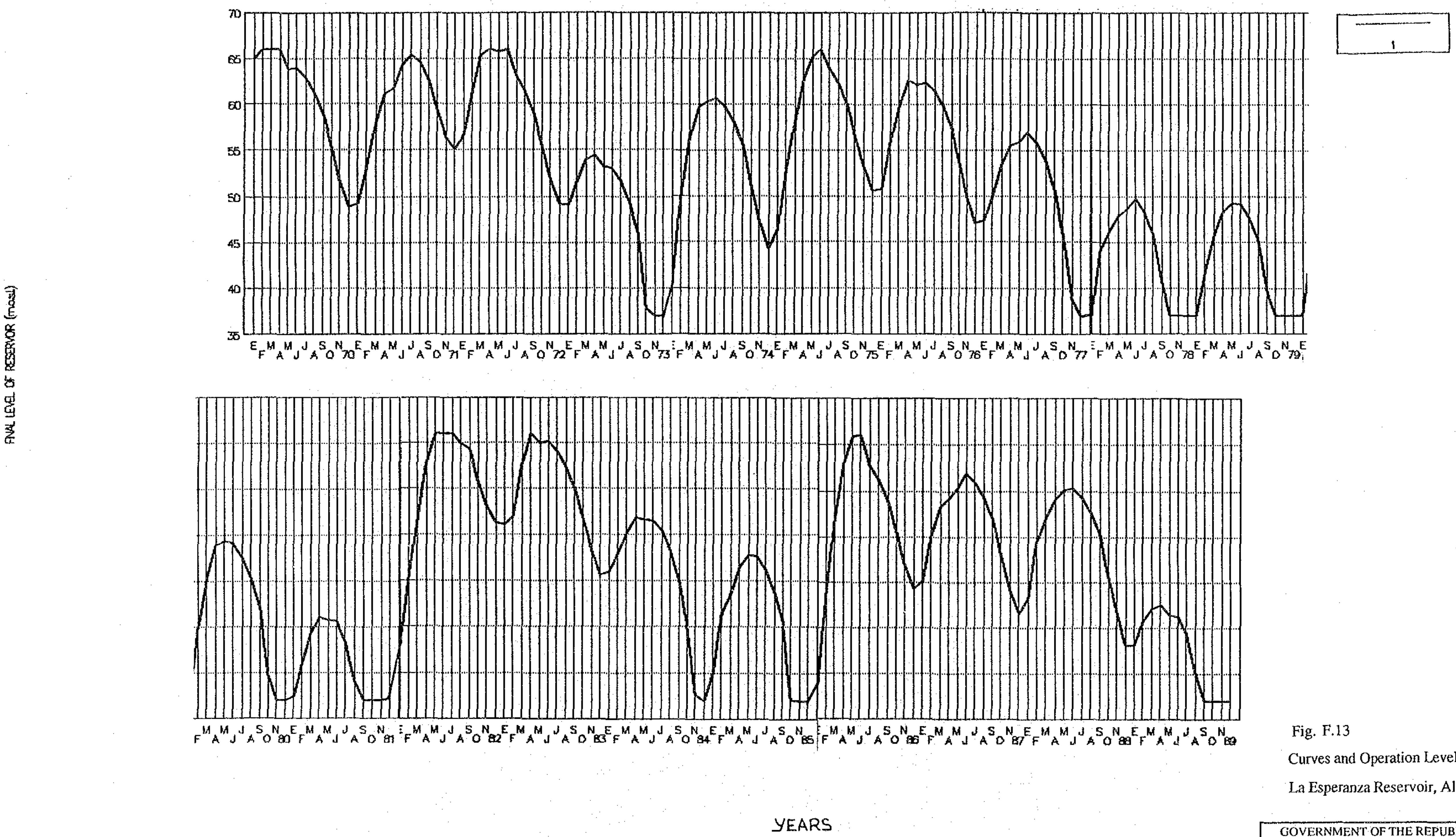


Fig. F.13

Curves and Operation Levels of

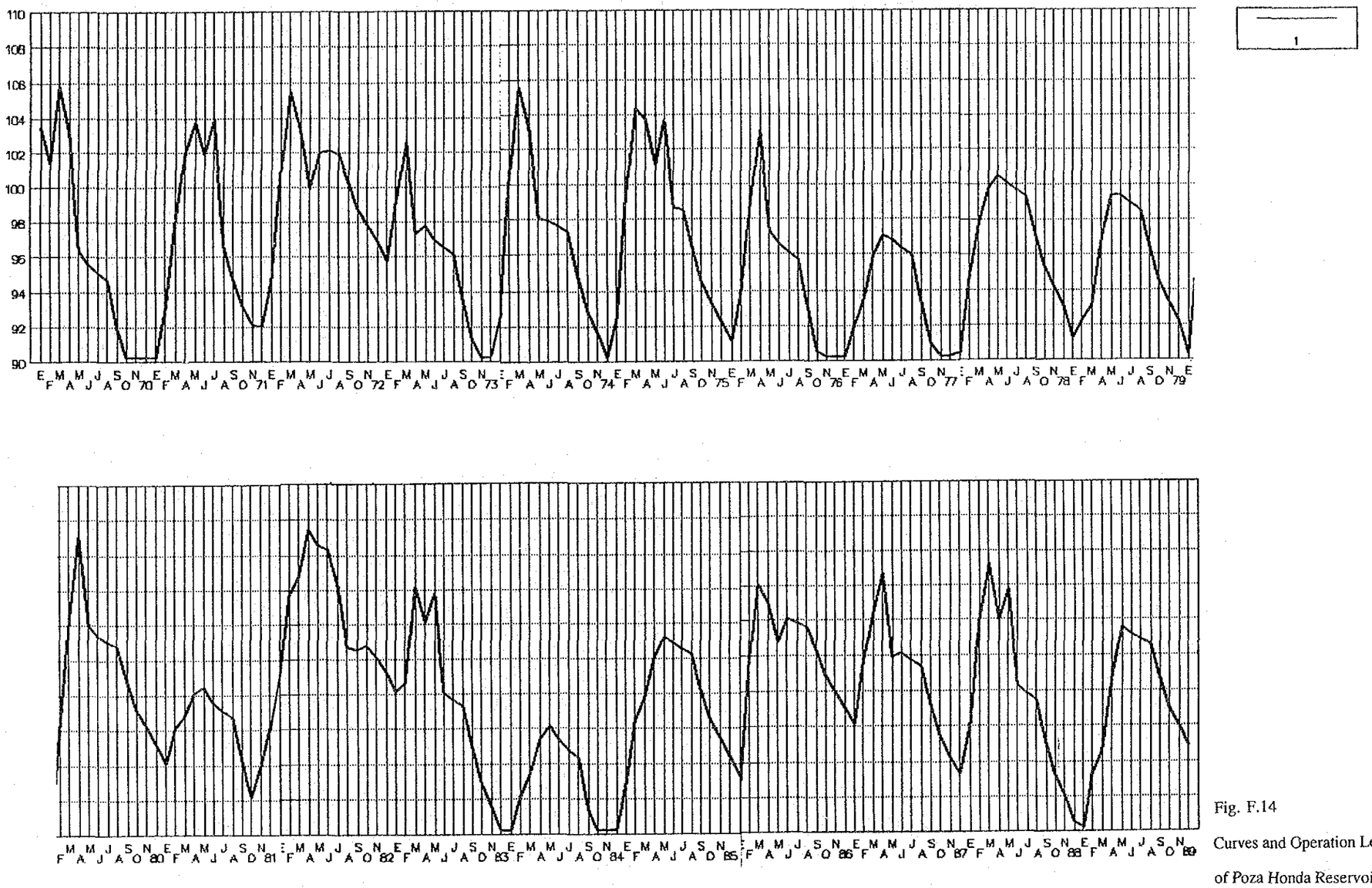
La Esperanza Reservoir, Alternative 5a

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

SUMMARY OF RESERVOIR OPERATION

POZA HONDA DAM (peak flow=16 m3/s)



FINAL LEVEL OF RESERVOIR (masl)

Fig. F.14

Curves and Operation Levels

of Poza Honda Reservoir, Alternative 5a

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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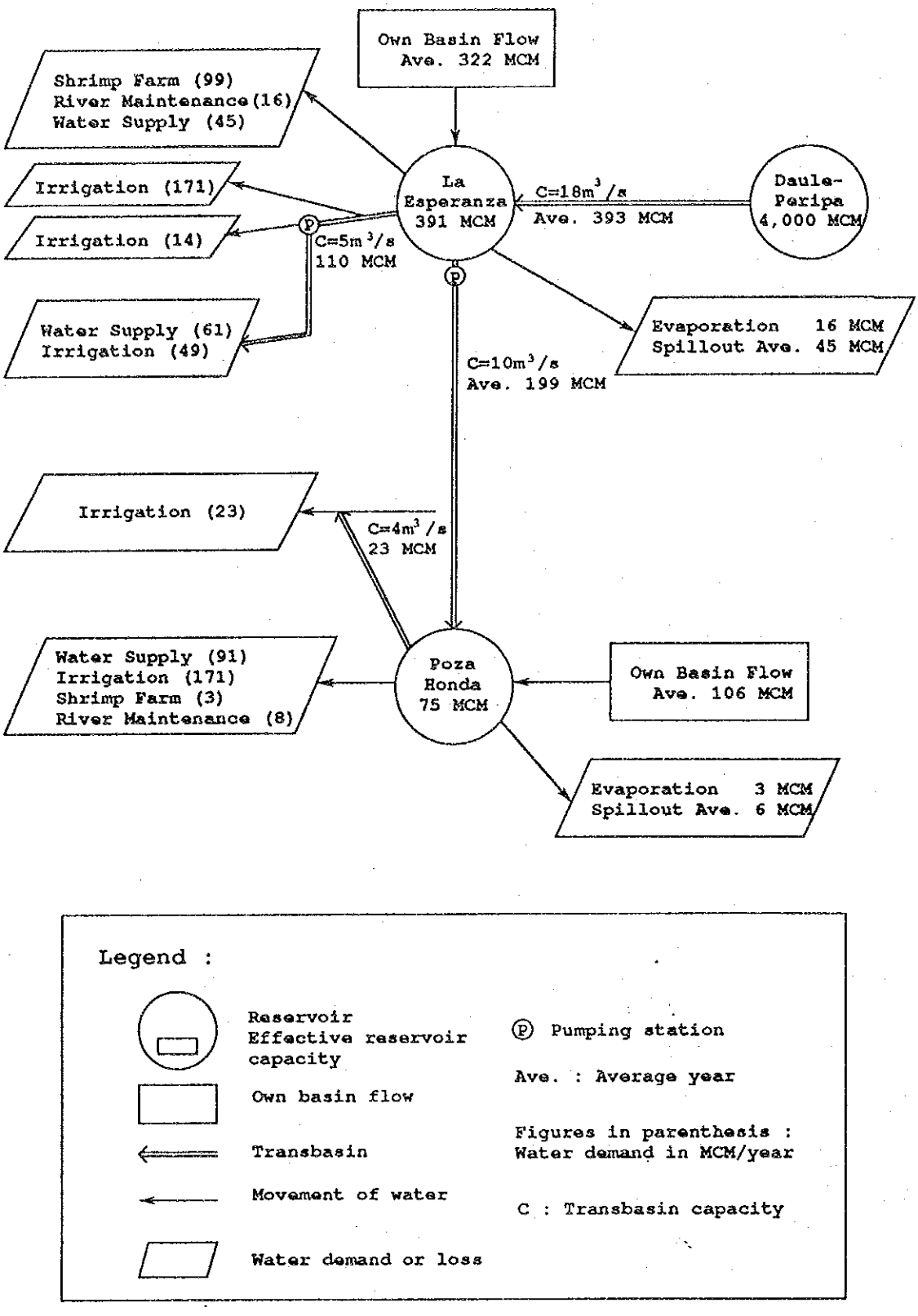

Fig. F.15 Hydraulic Balance, Alternative 5

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

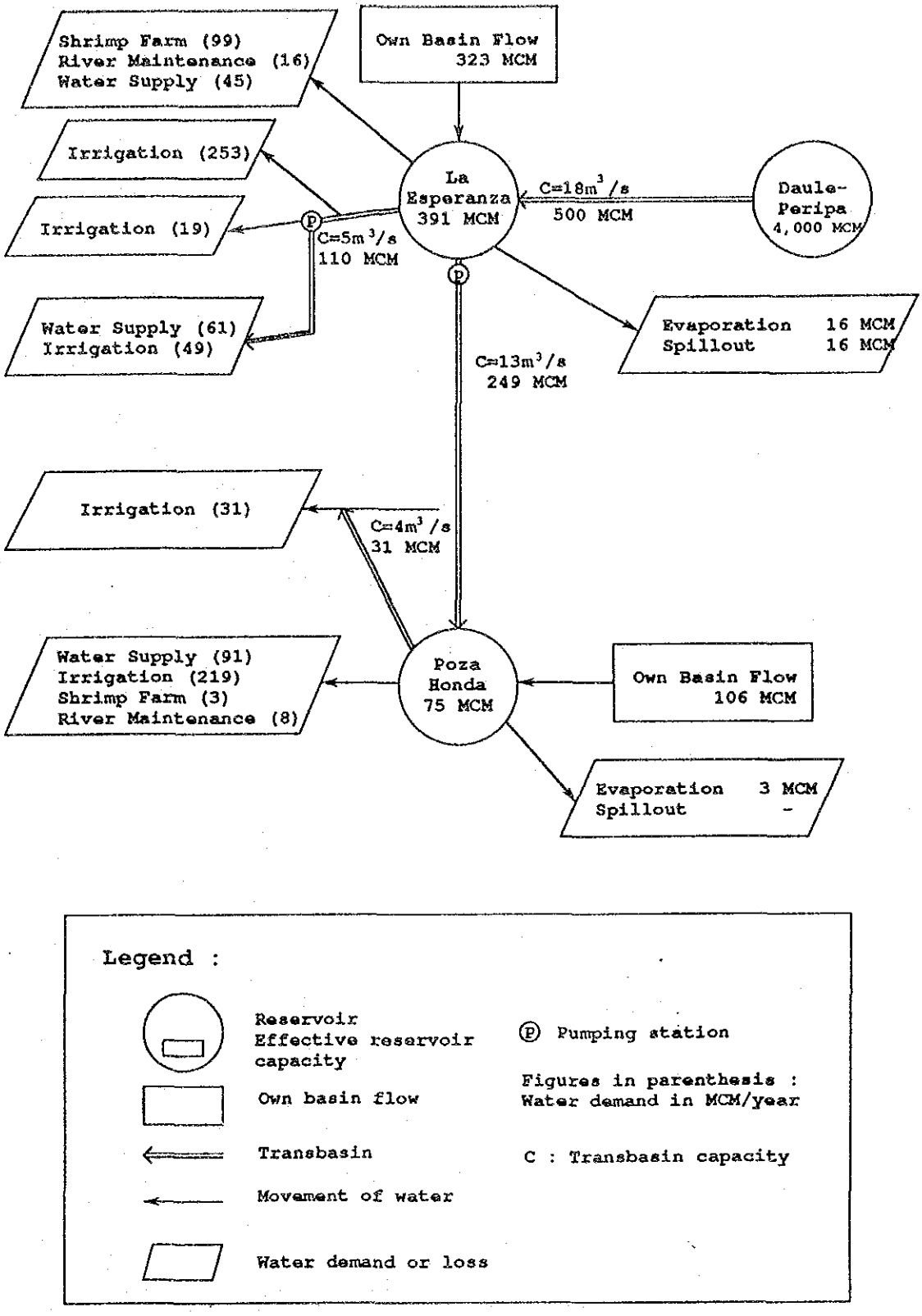

Fig. F.16 Hydraulic Balance, Alternative 5b

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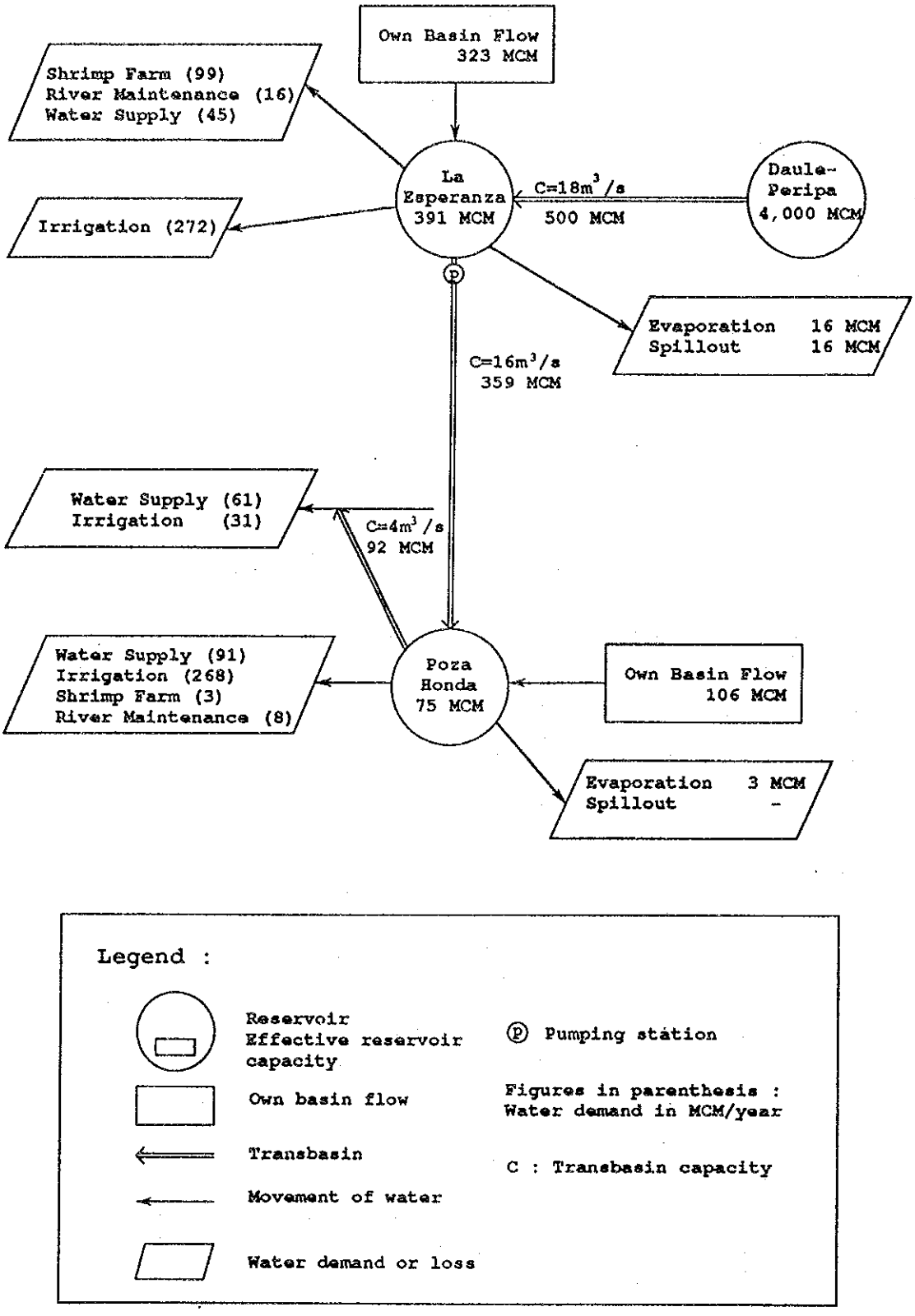

Fig. F.17 Hydraulic Balance, Alternative 5a

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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Annex G

TOPOGRAPHIC SURVEY

ANNEX G TOPOGRAPHIC SURVEY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This survey work was executed in cooperation with the CRM counterparts from the beginning of june 1991 to the end of november 1991.

Performance of survey work was also carried out in teams of supervision of JICA study team, and of contractors by Instituto Geografico Militar (herein after IGM), AEROMAPA, CARTOTECNIA, and Glenn Flores Mora.

Respective survey work is the following contents:

- Photogrammetric Mapping along the Transbasin Routes.
- Aerial photography covering the Chone-Portoviejo River Basins.
- Topographic Mapping at the Chirijos Dam Sites and three (3) Pumping Stations (Maravillas Site, Altamira Site, Severino Site).
- Leveling for the Seismic Survey.
- Polygonal Survey and Leveling at the Poza Honda Dam.

Mapping area of the structure sites including the transbasin routes are as shown in Fig. G.2 and Fig. G.4.

Quantity of the survey work was as follows:

	Work Item		Quantity
(1)	Photogrammetric Mapping along the Transbasin Routes		
	a. Aerial Photography (Scale of 1:20,000)		70 km^2
	b. Control Survey:	- Horizontal Control Points	23 points
		- Vertical Control Points	8 points
		- Bench Marks	26 points
	c. Field Classification		70 km^2
	d. Aerial Triangulation		54 Models
	e. Restitution (Scale of 1:5,000)		70 km^2
(2)	Aerial photography Covering the Chone-Portoviejo River Basins (Scale of 1:20,000):		4,400 km^2

	Work Item		Quantity
(3)	Topographic Mapping of the Structure Sites.		
	a. Polygonal Survey:	- 1st. Polygonal - 2nd. Polygonal	33.7 km 7.78 km
	b. Detail Survey		100 ha
	c. Plotting and drawing (Scale of 1:1,000)		100 ha
(4)	Leveling for Seismic Survey:		51.5 km

2. CORRECTION OF EXISTING DATA

2.1 Topographic Maps

Necessary existing topographic maps were collected from IGM and CRM. Collected Maps from IGM are national base map such as scale of 1:50,000. From CRM were obtained large scale topographic maps that other related projects had prepared until now.

List of these maps are as shown in Table G.1 and Fig. G.1.

2.2 Aerial Photographs

Aerial photographs of covering necessary study area were also obtained from IGM.

List of these aerial photographs are as shown in Table G.3.

2.3 Data of Existing Control Points

Results of coordinates, elevation and description of points were obtained from IGM.

List of these data is as shown in Table G.2.

3. PHOTOGRAMMETRIC MAPPING ALONG THE TRANSBASIN ROUTES

3.1 Aerial Photography

Aerial photography for the mapping area was shot four (4) lines in terms of aircraft owned by IGM at september 16, 1991.

At planning of the first stage, aerial photography has been expected as for shooting until end of july. But by virtue of the wicked weather conditions, aerial photography couldn't carried out until midle of september.

As a result, concerning quality of aerial photographs has satisfied our technical specification.

List of these aerial photographs is as shown in Table G.4.

The following aircraft, equipments and materials were used for aerial photography:

(1)	Aircraft	:	Beech craft KING A200
(2)	Aerial camera	:	ZEISS RMK-1015 (Wide angle lens, F = 152.35 mm)
(3)	Aerial Film	:	Kodak (Panchromatic Film)

Results of photographs were as follows:

(1)	Scale of photographs	:	1:20,000
(2)	Flying altitude	:	Approx. 3,200 m
(3)	Quantity of photographs	:	58 pcs
(4)	Size of photographs	:	23 cm x 23 cm
(5)	Flight lines	:	4 lines

3.2 Control Survey

Control survey was carried out useful method of the Global Positioning System (herein after GPS), in order to adjustments of aerial photographs using the photogrammetric mapping after established control points with air photo signals.

3.2.1 Horizontal control survey

Horizontal control survey was observed by the differential positioning using two (2) GPS receivers. Observation of GPS was carried out by method of traversing and triangulation which was measured with adjoining control points, and radio wave was received two (2) hours from more four (4) GPS satellites.

Time zone on the observation was beforhand determined by the Navigation Message which had always received ephemeris information from GPS satellites.

Analytical method of GPS or namely coordination was carried out calculation using the ellipsoid of WGS-84 (World Geodetic System 84), and then was transfered to the ellipsoid of PSAD-56 to be adopted in Ecuador.

Grade of horizontal control survey was provided that 3rd order of IGMs specifications.

The following geographical datum of control survey are:

(1)	Horizontal	:	PSAD-56 (La Canoa - Venezuela)
(2)	Vertical	:	De La Libertad, Provincia del Guayas (Mean sea level).
(3)	Ellipsoid	:	Hayford-International (a=6,378,388 m, 1/f = 297.00)
(4)	Projection	:	Universal Transverse Mercator (UTM, Zone 17)
(5)	Scale Factor:	:	0.9996 on the longitude West 81 degree

The following precision of GPS observation was obtained:

Routes	Difference of Coordinates (m)		Restriction (m)
	Lat.	Long.	
CP02-CP01	0.380	0.511	1.3
CP05-CP04	0.651	0.746	2.4
CP06-CP05	0.419	0.534	1.6
CP07-CP06	0.585	0.679	2.2
CP08-CP07	0.367	0.496	1.4
MINA-CP08	0.607	0.685	2.2
TABL-CP01	0.558	0.652	2.0
MINA-CP09	0.495	0.601	1.8
CP02-CP03	0.962	0.921	2.3
CP04-CP03	0.409	0.526	1.5
CP10-CP11	0.424	0.549	1.5
CP12-CP11	0.410	0.537	1.5
CP13-CP12	0.914	0.856	2.7
CP13-CP13	0.402	0.530	1.4
CHON-CP14	0.680	0.763	2.2
CHON-CP15	0.408	0.527	1.5
CP16-CP15	0.394	0.153	1.5
CP17-CP16	0.417	0.533	1.6
CP18-CP17	0.375	0.502	1.4
CP19-CP18	0.344	0.481	1.2
TABL-CP20	0.096	0.112	3.4
MINA-CP20	0.096	0.112	3.1
CP10-CP21	0.200	0.250	1.6
CP18-CP22	0.390	0.420	1.6

The following instruments of GPS observation and computation were used:

(1) GPS Receiver : ASHTECH XII
(2) Computer : ALR386BGA
(3) Software : GPPS

Results of these control points by GPS are as shown in Table G.5.

Location map of control points is as shown in Fig. G.2.

3.2.2 Vertical control survey

Vertical control survey was observed by the direct leveling from first order national bench marks to be known points. Elevation was connected to the whole control points including horizontal control points.

To the leveling routes were established bench marks approximate two (2) km interval.

The restriction of leveling was carried out 8.4 mm$\sqrt{s}$ (s = km), and they also have satisfied our technical specifications.

The following precision of leveling was obtained:

Routes		Distance	Closure	Restriction
From	To	(km)	(m)	(± m)
VIII-B-8A	BM-T1	3.25	+0.0086	0.0151
BM-T1	BM-T2	1.60	+0.0102	0.0106
BM-T2	BM-T3	1.42	+0.0088	0.0100
BM-T3	BM-T4	1.51	+0.0098	0.0103
BM-T4	BM-T5	1.46	+0.0095	0.0101
BM-T5	CP-04	1.55	+0.0095	0.0105
BM-T1	BM-T6	1.62	+0.0103	0.0107
BM-T6	CP-01	1.63	+0.0056	0.0107
BM-T6	BM-T7	3.32	+0.0074	0.0153
BM-T7	CP-02	1.42	-0.0004	0.0100
CP-04	BM-T8	1.77	+0.0011	0.0112
BM-T8	BM-79	0.97	-0.0065	0.0083
BM-T9	CP-03	2.20	-0.0024	0.0125
VIII-B-8-A	BM-T10	4.18	+0.0050	0.0172
BM-T10	PV-2	3.20	-0.0090	0.0150
PV-2	IT	6.02	-0.0070	0.0206

Routes		Distance	Closure	Restriction
From	To	(km)	(m)	(± m)
PTO.PASO 1T	PV1	2.60	-0.0030	0.0135
BM-T8	2T	4.20	0.0000	0.0172
PTO.PASO 2T	PV-3	3.45	+0.0080	0.0156
BM-T8 (BM-T9)	CP-03	3.17	-0.0089	0.0150
BM-T1 (BM-T6;T7)	CP-02	6.36	-0.0181	0.0212
BM-T6	CP-01	1.63	-0.0066	0.0107
VIII-B-8A (BM-T-10; PTO. PASO 1-T)	PV-1	16.00	-0.0140	0.0336
C-J-8 (BM-1M;2M;3M;4M; CPO6;5M;6M)	CP-05	13.15	+0.0056	0.0305
MQ-45	CP-10	0.08	-0.0002	0.0024
MQ-58-AJ	PV-7	1.02	-0.0013	.0085
XIII-B-15 (BM-8M;CP18)	CP-17	10.00	+0.0056	0.0266
BM-8M	PC-19	3.20	+0.0029	0.0150
PD-26	CP-20	3.90	-0.0036	0.0166
BM-3-CH	BM-3-CH-A	0.01	+0.0007	0.0008
BM-4-CH	BM-4-CH-A	0.01	0.0000	0.0008
MQ-67	PV-4	2.06	+0.0040	0.0120
MQ-58-AJ (PV-8;MQ-59-AJ)	MQ-58-AJ	12.05	-0.0265	0.0292
MQ-62-AJ	CP-13	2.73	+0.0057	0.0139
MQ-62-AJ	CP-14	2.34	-0.0108	0.0128
BM-6-CH	PV-5	1.82	+0.0025	0.0113
C-J-8 (BM-1M;2M;3M;BM;3CH; 4CH;5CH;6CH;PV-6;CP-07;CP-08; CP-09;7CH;8CH;PJ-15;PJ-16)	C-J-8	39.72	+0.0320	0.0529
MQ-48 (BM-1-CH;2CH;2CH-A)	CP-12	3.14	+0.0012	0.0149
III-B-13	CP-22	2.62	+0.0052	0.0136
BM-1CH (BM-1CH-A;7M;7M-A; CP11)	CP-21	4.62	-0.0118	0.0180
XIII-B17 (PTO.PASO 2D;3D)	*CP-16	8.08	+0.0800	0.2800
CP16	*CP-15	4.10	-0.1100	0.2000

* Points gotten with RDS (Reduction distance system)

The following instruments of leveling were used

(1)	Level	:	Wild NAK2
(2)	Staff	:	Invar Staff

Results of these vertical control points and bench marks are shown in Table G.6.

Location of vertical control points and bench marks are shown in Fig. G.3.

3.2.3 Monumentation and air photo signal

Monumentation of control points was permanently established using the concrete.

Air photo signals were also established which their signals were clearly reflected in the aerial photographs. Dimension of the monumentation and the air photo signals were as follows.

CONTROL POINT

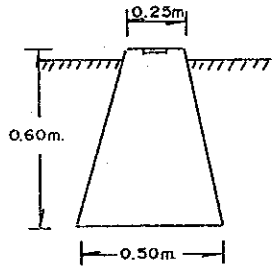
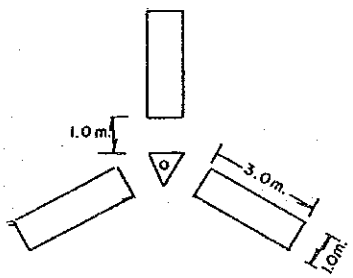


PHOTO SIGNAL



Whole control points and bench marks description were prepared such as attached Appendix A.

3.3 Field Classification

Field classification was investigated using the aerial photographs. In the contents of the investigation were collected geographic name, geographic feature, and other necessities for the restitution in accordance with their map symbols and/or legend. Map symbols are as shown in Fig. G.3.

3.4 Aerial Triangulation

Aerial triangulation was carried out by the analytical method based on the results of the control points.

The following precision of aerial triangulation was obtained:

Precision	Altamira-Poza Honda Area	Severino-Poza Honda Area
(1) Summary Statistics for Camera Stations (RMS for Standard Deviations)	x=1.8433 OMEGA=0°2'24".8644 y=2.3832 PHI =0°1'42".6669 z=1.3428 KAPPA=0°0'39".5735	x=1.2014 OMEGA=0°1'09".2668 y=1.2484 PHI =0°1'04".9131 z=0.6579 KAPPA=0°0'25".1398
(2) Summary Statistics for Control Points (RMS for Standard Deviations)	x=0.8039 y=0.6980 z=1.7022	x=0.5528 y=0.5337 z=0.9799
(3) Residual at Control Points (RMS)	x=0.393 y=0.343 z=0.175	x=0.007 y=0.012 z=0.006

The following equipments of aerial triangulation were used:

(1)	Point Transfer Device	:	WILD PUG IV
(2)	Stereo Comparator	:	ZEISS PSK-2/WILD BC-2
(3)	Electronic Computer	:	VAX-8250
(4)	Software	:	PREPRO, GIANT (Defence Mapping Agency in USA).

Work process from aerial photography until aerial triangulation were executed by virtue of IGM.

3.5 Mapping

Based on the results of the aerial triangulation and field classification, the restitution was plotted and drawn in accordance with the following specifications:

(1) Mapping Scale : 1 : 5,000

(2) Contour Interval : 5.0 m (Supplementary contour = 2.5 m)

(3) Projection : UTM

(4) Sheet Size : A-1

(5) Precision of Topographic Maps:
- Planimetry : 1.0 mm on the map
- Spot Height : 2/3 of the contour interval
- Contour : 1/1 of the contour interval

The following instruments of restitution were used:

Plotting Instruments : KERN PG2-A.T.

Restitution was executed by virtue of following the two (2) subcontractors:

- AEROMAPA S/A
- CARTOTECNIA S/A

4. AERIAL PHOTOGRAPHY COVERING THE CHONE-PORTOVIEJO RIVER BASINS.

4.1 Aerial Photography

This aerial photography was shot by IGM above mentioned the whole study area. Actual aerial photography couldn't be shot as aerial photography of mapping area for the wicked weather conditions. As results aerial Photography of the whole study area still not yet shooting.

List of former aerial photographs is as shown in Table G.4.

5. TOPOGRAPHIC MAPPING OF THE STRUCTURE SITES

5.1 Polygonal Survey and Leveling

As for the nearby polygonal points at the structure sites were established concrete pegs by same standardization with the IGMs control points.

List of precision of first polygonal survey is as shown in Table G.7.

Location of first polygonal points is as shown in Fig. G.4.

Leveling was observed from nearby IGMs control points or bench marks at each structure sites, and were connected to polygonal points.

List of precision results of leveling is as shown in Table G.9.

List of IGMs bench marks used of leveling is as shown in Table G.11.

The following instruments were used:

(1)	Theodolite (Tachimeter)	:	Sokkisha SET3, SET4
(2)	Optical Distance Meter	:	ditto
(3)	Level	:	Sokkisha B2D10316/Topcon AT-S7#01085

5.2 Detail Survey

Detail survey was carried out based on the polygonal points.

The density of the detail points was observed minimum of fifty (50) points per hectare, and observed the position of houses, roads, rivers, fences and others.

Survey method was observed using the total stations which could directly obtained horizontal distance, relative height and others.

Survey instruments were used to the above mentioned it.

5.3 Plotting and Drawing

Obtained data by detail survey were input to computer, then coordinates and elevation of each detail points were calculated.

Each detail point and/or topographic maps was out put by static electricity plotter.

Contents of topographic map are as follows:

(1)	Mapping Scale	:	1:1,000
(2)	Contour Interval	:	1.0 m
(3)	Projection	:	UTM
(4)	Sheet Size	:	A-1
(5)	Precision of Topographic Maps:		
	- Planimetry:	:	1.0 m on the map
	- Spot Height:	:	2/3 of the contour interval
	- Countor:	:	1/1 of the contour interval

The following equipments of plotting were used:

(1)	COMPUTER	:	COMPAC 386-16 MH
(2)	Plotter	:	HOUSTON INSTRUMENT DM50
(3)	Software	:	AUTO-CAD-210-U.S.A.
	Survey Program	:	QUICK SURF V-2

Topographic mapping of the structure sites was executed by virtue of Glenn Flores Mora.

6. LEVELING FOR THE SEISMIC SURVEY

6.1 Leveling

Leveling for the seismic survey was carried out by JICA team for the connection of elevation from IGMs control points and/or bench marks to seismic lines.

List of precision results of leveling is as shown in Table G.10.

List of IGMs bench marks used of leveling is as shown in Table G.11.

7. POLYGONAL SURVEY AND LEVELING AT THE POZA HONDA DAM

7.1 Polygonal Survey and Leveling

Control survey and leveling of existing data were executed before Poza Honda Dam have been constracted period of 1 year from 1970 to 1971. Therefore, these

Control survey and leveling of existing data were executed before Poza Honda Dam have been constracted period of 1 year from 1970 to 1971. Therefore, these survey were carried out by JICA team for the review of existing data and/or to be connected with this project area.

List of precision results of polygonal survey and leveling is as shown in Table G.12.

Known points of polygonal survey and leveling are as follows:

(1) Control Points:

- IGM CP18 (N=9,874,650.30 m, E=588,248.98 m, H = 392.25 m)
- IGM CP16 (N=9,877,450.06 m, E=594,380.77 m, H = 130.50 m)

(2) Bench Mark:

- IGM XIII-B-17 (H = 112.108 m)

Comparison list of existing survey data and newly data is as shown in Table G.13. The new data are reliable and can be used for any purpose.

Location of control points and bench marks is as shown in Fig. G.5.

8. CONNECTION BETWEEN ROUTES

In order to check IGMs leveling routes, connection between two of them was executed by JICA team, following a summary is shown.

Connected Routes	IGMs BM Elevation (m)	Elevation by checking (m)	Closure Error (m)	Restriction (mm)	Remarks
MQ 42 (Alajuela)-CP10	73.660(CP10)	73.665	0.005	40	L = 4 km
MQ62AJ(San Miguel)-BM-1PV5	477.225(PV5)	477.570	0.345	62	L = 9.5 km
PV7 - 1-7(0+660) POZA HONDA LEV	105,997(1-7, 0+660)	106,008	0.001	60	L=9.0 km INDIRECT
CP08 - NO.6(CP6)	106.25(CP6)	105.959	0.303	46	L = 5.3 km ndirect lev.

9. FINAL RESULTS

The final results of topographic survey work are as follows:

(a)	Positive film (scale of 1:20,000)		:	1 set
(b)	Contact prints	- Mapping area	:	2 sets
(c)	Flight index photo		:	2 sets
(d)	Topographic map	- Original map	:	1 set
	(Scale of 1:5,000)	- Reprinted map	:	1 set
		- Blue prints	:	3 sets
(e)	Results of control points and bench marks		:	1 set
(f)	Description of points		:	1 set
(g)	Topographic map	- Original map	:	1 set
	(Scale of 1:1,000)	- Reprinted map	:	1 set
(h)	Field note and computation sheet		:	1 set

10. APPENDIX CONTENTS

A. Monograph of control points and Bench Marks

B. Seismic lines sheet calculation

C. Structure Site sheet calculation

D. Connected Routes sheet calculation

E. Maps

1,1A	Location control points	1:50,000
2.	Aerial Photo Routes	1:50,000
3.	Map Simbols	1:5,000
4.	Leveling Routes	1:50,000
5.	Location of control points and bench marks of Poza Honda Dam.	1:1,000

F. Photo

TABLES

TABLE G.1 LIST OF AREAS WITH MAPPING

Project	Scale	Map Name	Map Number	Plant View	Profile
Múltiple Carrizal Chone	1 : 1,000	Levantamiento topgráfico (Perfil R. San Ramón).	1	x	
Múltiple Carrizal Chone	1 : 1,000	Levantamiento topgráfico (Perfil Río Santos).	2	x	
Múltiple Carrizal Chone	1 : 1,000	Trabajos topográficos batimetría Isla de Los Corazones.	4	x	
Múltiple Carrizal Chone	1 : 500	Levantamiento topgráfico de la Presa Simbocal.	10	x	
Múltiple Carrizal Chone	1 : 2,000	Levantamiento topgráfico sector Presa Simbocal Zona Inundable.	1	x	
Múltiple Carrizal Chone	1 : 1,000	Levantamiento topgráfico (Perfil Río Canuto).	1	x	
Múltiple Carrizal Chone	1 : 1,000	Levantamiento topgráfico (Perfil Río Mosca).	1	x	
Riochico - Chirijos	1 : 10,000	Levantamiento aerofotogramétrico.	2	x	
Múltiple Carrizal Chone	1 : 10,000	Trasvase al Valle de Portoviejo (Alternativa trazado posible I y II.			
Múltiple Carrizal Chone	1 : 10,000	Anteproyecto de conducciones principales, margen izquierda.	12	x	x
Múltiple Carrizal Chone	1 : 1,000	Cartografía general	22	x	
Trasvase del Río Daule a los embalses de Poza Honda y La Esperanza.	1 : 250 1 : 100	Estructura de entrada Conguillo. Estructura de salida Membrillo.	2	x	
Trasvase del Río Daule a los embalses de Poza Honda y La Esperanza.	Varias	Estructura general y secciones trasversales	41		
Trasvase del Río Daule a los embalses de Poza Honda y La Esperanza.	Varias	Geotecnia y Geología	15	x	
Ajuste al deseño de la Presa La Esperanza, Proyecto Carrizal-Chone.	Varias	Plano definitivo de licitación.	1		x

TABLE G.2 LIST OF EXISTING CONTROL POINTS AND BENCH MARKS (1/2)

CONTROL POINTS	COORDINATES		ELEVATION	GEOGRAPHIC COORDINATES	
	N (m)	E (m)	(m)	LATITUDE	LONGITUDE
				° ' "	° ' "
*Minaya (1st. order)	9,893,895.44	580,485.76	551.024	S 00 57 35.542	W 80 16 35.587
Tablón (1st. order)	9,907,248.18	599,319.80	353.214	S 00 50 20.553	W 80 06 26.292
Chontilla (3rd. order)	9,878,290.12	600,011.09	407.21	S 01 06 03.592	W 80 06 04.079
Panecillo (3rd. order)	9,882,218.86	560,342.53	231.16	S 01 03 55.951	W 80 27 27.552
Tosagua (2dn. order)	9,912,949.32	584,896.96	69.61	S 00 47 14.984	W 80 14 13.321
PE 15571-X Muyuyo (4th order)	9,904,941.98	572,378.96	175.96	S 00 51 35.834	W 80 20 58.256

Remarks: * These points were utilized for the GPS.

TABLE G.2 LIST OF EXISTING CONTROL POINTS AND BENCH MARKS (2/2)

BENCH MARKS	ELEVATION (m)	REMARKS	
XIII-B-15	80.905	2nd order	Honorato Vásquez
XIII-B-16	83.532	1st order	Honorato Vásquez
C-J 8	46.291	1st order	Junín
PD 26	81.312	1st order	Tosagua
PJ 16	51.252	1st order	Junín
PJ 15	60.852	1st order	Junín
XIII-B-17	112.108	2nd order	Poza Honda Dam
I-D-22	152.504	1st order	Dos Caminos
VIII-B-8-A	26.822	1st order	Quiroga
VIII-C-12	19.533	1st order	Calceta
MQ-42	64.439	1st order	Alajuela
MQ 47-AJ	80.112	1st order	La Cantera
MQ-45	72.384	1st order	San Plácido
MQ-57	424.701	1st order	Palma Junta
MQ 59-AJ	435.009	1st order	Los Colorados
MQ-62-AJ	438.070	1st order	San Miguel
MQ-72-A	462.063	1st order	El Progreso

TABLE G.3
LIST OF EXISTING AERIAL PHOTOGRAPHS

Project	Scale	Date	Roll	Line	No. de Photo
Carta Nacional	1: 60,000	March/77 November/77	30-31	7-14	76
Carta Nacional	1: 60,000	November/77 February/82	26-78-30-31	7-14	36
Carta Nacional	1: 60,000	November/77 June/85	29	15	10
Presa La Esperanza	1: 10,000	December/76 April/77	05-12-19 243-248-249	1-2-3-4-4A B-C-D-E-F-G-S-H	212
Carta Nacional	1: 15,000	November/77	30		7

TABLE G.4
LIST OF NEWLY AERIAL PHOTOGRAPHS

Project	Scale	Date	Roll	Line	No. de Photo
Chone-Portoviejo (JICA)	1: 20,000	September/91	14	28-31	65

TABLE G.5 RESULTS OF CONTROL POINTS BY GPS

CONTROL POINTS	COORDINATES		ELEVATION	GEOGRAPHIC COORDINATES	
	N (m)	E (m)	(m)	LATITUDE	LONGITUDE
				° ' "	° ' "
CP 01	9,903,789.62	604,183.20	72.533	S 00 52 13.146	W 80 03 49.332
CP 02	9,902,114.80	606,496.06	94.038	S 00 53 07.668	W 80 02 34.497
CP 03	9,895,085.00	610,896.95	120.442	S 00 56 56.555	W 80 00 12.064
CP 04	9,896,942.24	607,708.87	34.243	S 00 55 56.104	W 80 01 55.217
CP 05	9,893,966.39	599,371.62	85.154	S 00 57 33.087	W 80 06 24.910
CP 05A	9,893,973.77	599,323.11	84.131	S 00 57 32.847	W 80 06 26.480
CP 06	9,895,155.02	595,563.48	71.442	S 00 56 54.409	W 80 08 28.120
CP 07	9,890,422.24	589,710.55	422.556	S 00 59 28.586	W 80 11 37.437
CP 08	9,890,276.53	586,759.58	455.332	S 00 59 33.354	W 80 13 12.908
CP 09	9,890,486.04	584,102.00	484.166	S 00 59 26.551	W 80 14 38.890
CP 10	9,882,950.10	584,299.16	73.66	S 01 03 31.973	W 80 14 32.454
CP 11	9,885,426.66	587,057.97	422.42	S 01 02 11.296	W 80 13 03.216
CP 12	9,884,187.72	590,243.86	92.62	S 01 02 51.619	W 80 11 20.132
CP 13	9,887,277.77	601,106.11	454.77	S 01 01 10.892	W 80 05 28.738
CP 14	9,885,215.34	603,660.19	446.79	S 01 02 18.032	W 80 04 06.089
CP 15	9,875,663.03	597,370.39	398.74	S 01 07 29.171	W 80 07 29.489
CP 16	9,877,450.06	594,380.77	130.50	S 01 06 31.003	W 80 09 06.230
CP 17	9,874,934.42	591,389.07	398.77	S 01 07 52.956	W 80 10 43.000
CP 18	9,874,650.30	588,248.98	392.25	S 01 08 02.237	W 80 12 24.592
CP 19	9,874,444.46	585,964.91	391.13	S 01 08 08.961	W 80 13 38.489
CP 20	9,908,810.17	581,460.67	92.27	S 00 49 29.804	W 80 16 04.465
CP 21	9,885,168.45	587,638.69	425.44	S 01 02 19.701	W 80 12 44.426
CP 22	9,874,410.14	584,226.80	76.95	S 01 08 10.094	W 80 14 34.725

TABLE G.6 RESULTS OF VERTICAL CONTROL POINTS AND BENCH MARKS

BENCH MARKS	ELEVATION (m)	REMARKS	BENCH MARKS	ELEVATION (m)	REMARKS
PV1	481.734	2nd order	BM 8 CH	140.090	2nd order
PV2	324.993	"	BM 1 M	51.036	"
PV3	346.565	"	BM 2 M	57.178	4th order
PV4	410.809	"	BM 3 M	60.388	"
PV5	477.225	"	BM 4 M	72.635	"
PV6	422.796	"	BM 5 M	80.215	"
PV7	424.491	"	BM 6 M	80.951	"
PV8	408.830	"	BM 7 MA	360.408	"
			BM 8 M	398.746	"
* XIII-B-15	80.905	1st order	BMT 1	30.282	3rd order
* XIII-B-16	83.532	"	BMT 2	31.009	"
* C-J 8	46.291	"	BMT 3	31.111	"
* PD 26	81.312	"	BMT 4	33.599	"
* PJ 16	51.252	"	BMT 5	32.344	"
* PJ 15	60.852	"	BMT 6	29.886	"
BM 1 CH A	83.349	4th order	BMT 7	40.700	"
BM 2 CH A	128.363	"	BMT 8	36.686	"
BM 3 CH A	75.622	2nd order	BMT 9	38.883	"
BM 4 CH A	113.816	"	BMT 10	41.805	"
BM 5 CH	199.328	"			
BM 6 CH	480.445	"			
BM 7 CH	483.276	"			

Remarks: * These points were utilized for known points.

TABLE G.7 LIST OF PRECISION OF FIRST POLYGONAL/SURVEY FOR THE STRUCTURE SITES

AREA	DISTANCE (m)	CLOSURE	AZIMUTH (second)		COORDINATES (m)		REMARKS (Quantity of points)
			Closure	Restriction	Closure	Restriction	
Maravillas	6,493.25	1/9,000	6"	90"	0.716	1.08	9
Altamira	7,620.09	1/185,800	-	-	0.041	1.27	7
Severino	9,031.10	1/46,000	-	-	0.196	1.51	9
Chirijos	9,511.89	1/48,000	-	-	0.197	1.59	10

Remarks: Restriction of Azimuth = 30" x $\sqrt{N}$ (N; quantity of points)
Restrictiion of coordinates = 1/6,000

TABLE G.8 RESULTS OF POLYGONAL POINTS

CONTROL POINTS	COORDINATES (UTM) N (m)	E (m)	ELEVATION (m)	REMARKS
Maravillas Area				
CPS-1	9,908,807.60	581,901.04	81.88	
CPS-2	9,908,883.58	582,170.97	48.86	
HITO 6	9,908,968.34	582,469.36	30.65	
Altamira Area				
CPS	9,899,923.91	603,944.26	88.55	
CPS-1	9,900,055.25	604,001.90	75.06	
CPS-2	9,899,846.42	603,874.51	116.08	
Severino Area				
No. 4 = CPS-1	9,892,445.96	608,243.48	160.26	
No. 5 = CPS-2	9,892,308.59	607,736.02	135.29	
Chirijos Area				
No. 5	9,885.847.67	584,581.10	119.71	
No. 6 = CP6	9,886,286.09	585,267.97	106.25	

Remarks:

TABLE G.9 PRECISION OF LEVELING FOR STRUCTURE SITES

ROUTE	DISTANCE (km)	CLOSURE (mm)	RESTRICTION (mm)	REMARKS
HITO V-D-B-III-CPS1-1-1-VOO-VI.	1.662	0	26	Guarango
1-CP7-PDTA-V-VI-VII-VIII-POT10-IX-CP8-X-XIIV-III-POT5-II-POT4-POT3.	2.499	0	32	Chirijos
CPS2-P-IV-V-VI-VII-VIII-I-II-III.	1.399	0	24	Altamira
CP2-POT-6-7-8-9-V7-V6-POT12-V9-10-11-12-13-14-15-16-V1-VO-POT1-V2-3-POT3-V4-V5-POT5-POT3-V6.	2.220	11	30	Severino

Remarks: Restriction = 20 mm $\sqrt{S}$: S: Distance (km)

TABLE G.10 PRECISION OF LEVELING FOR THE SEISMIC LINES

ROUTE	DISTANCE (km)	CLOSURE (mm)	RESTRICTION (mm)	REMARKS
ALAJUELA				
IGM-BM—BM-1	5.00	3.00	45.00	
BM-1—D-1 (0+750)	0.70	5.00	17.00	
D-1 (0+750)—TBM	2.50	6.00	32.00	
TBM—3-29 (0+200)	2.90	6.00	34.00	
3-29 (0+200)—3-8 (0+287.32)	5.40	3.00	46.00	
LA FLORIDA				
IGM-TBM-6—3-6 (0+590)	0.30	0.00	11.00	
IGM-TBM-6—3-23 (0+000)	2.50	4.00	32.00	
ALTAMIRA				
IGM-TBM-2—3-1 (0+040)	0.20	0.00	9.00	
QUIROGA				
IGM-BM—3-3 (0+470)	4.70	9.00	43.00	
BM-2—3-19 (0+000)	3.30	3.00	36.00	
LA CANTERA				
IGM-BM—3-12 (0+560)	1.80	0.00	27.00	
TBM-16—BM-3	1.70	1.00	26.00	
SAN MIGUEL				
IGM-BM—BM-2 (1-3)	4.00	15.00	40.00	
JULIAN				
IGM-TBM-8—BM-1 (No 1)	4.00	2.00	40.00	
BM-1 (No 1)—1+1 (0+440)	2.00	3.00	28.00	
LOS COLORADOS				
IGM-BM—No 1	0.50	3.00	14.00	
No 1—No3 (1-5, 0+580)	1.00	-	-	By indirect leveling
LOS RANCHOS				
IGM-PV6—BM-1 (3-25)	1.50	2.00	24.00	
POZA HONDA				
IGM-BM—1-7 (0+660)	(8.00)	-	-	By measuring on
IGM-BM—BM-1 (3-15, 3-16)	3.20	2.00	36.00	the water level
IGM-BM—IGM-BM (H.Vásquez)	2.80	17.00	33.00	
IGM-BM—3-31 (0+320)	1.00	1.00	10.00	
MUYUYO				
IGM-BM—4-1 (4+000)	1.50	1.00	24.00	

Remarks: Restriction = 20 mm $\sqrt{S}$ (S; Distance, km)

TABLE G.11 LIST OF IGMs RENCH MARKS USED OF THE TOPOGRAPHIC MAPPING AND THE SEISMIC SURVEY.

BENCH MARKS	ELEVATION (m)	SITE	REMARKS
*MQ-42	64.439	Alajuela	CP10
TBM-6	75.990	La Florida	Temporaty BM of 3rd order liveling.
*BMT2	31.009	Altamira	3rd order
VIII-B-8-A	26.822	Quiroga	1st order
MQ47-AJ	80.112	La Cantera	1st order
MQ-62-AJ	438.070	San Miguel	1st order
*BMT8	36.686	Julián	3rd order
MQ-59-AJ	435.009	Los Colorados	1st order
PV-6	422.796	Los Ranchos	2nd order
XIII-B-17	112.108	Guarumo (Poza Honda)	2nd order
XIII-B-15	80.905	Honorato Vásquez	1st order
PE 15571-X (Control Point)	175.96	Muyuyo	4th order
*CP-20 (Control Point)	92.27	Los Amarillos	3rd order

Note: * Used of topographic survey at the structure sites.

TABLE G.12 LIST OF PRECISION RESULTS OF POLYGONAL SURVEY AND LEVELING (P. HONDA)

Area	Distance (km)	Closure Error	Azimuth (second)		Coordinates (m)		Leveling		Remarks (Quantity of points)
			Closure	Restriction	Closure	Restriction	Closure Error (mm)	Restriction (mm)	
(CP18-BMXIII-B17) CP16	9.449	1/72,000	-	-	0.13	1.57	60 By indirect leveling	62	7
XIII-B-17-N	0.230	-	-	-	-	-	2	10	2
XIII-B-17-A	0.374	-	-	-	-	-	0	12	2
XIII-B-17-D	0.035	-	-	-	-	-	2	4	2
XIII-B-17-M	0.081	-	-	-	-	-	0	6	2

Remarks: Restriction of Azimuth = 30" x $\sqrt{N}$ (N: quantity of points)
Restriction of leveling = 20 mm $\sqrt{S}$ (S: distance (km))
Restriction of coordinates = 1/6,000 m

TABLE G.13 COMPARISON LIST OF EXISTING SURVEY DATA AND NEWLY DATA

Control Point	Existing Data	Newly Data	Remarks
Control Points			
Punto "A"	N = 924,200 m	N =9,877,069.44 m	Punto "A" can't compare for the removal.
	E = 730,632 m	E = 588,683.13 m	
	H = 120.592 m	H = 117,320.00 m	(ditto)
Punto "D"	N = 1,265.811 m	N =9,877,403.11 m	
*BMT8	E = 962,408 m	E = 588,920.83 m	
MQ-59-AJ	H = 130.176 m	H = 128.159 m	Differential height: -2.017 m
Bench Marks			
BM "M"	H = 115.184 m	H = 113.228 m	Differential height: -1.956 m

Remarks: Coordinates of existing data are local coordinates system.