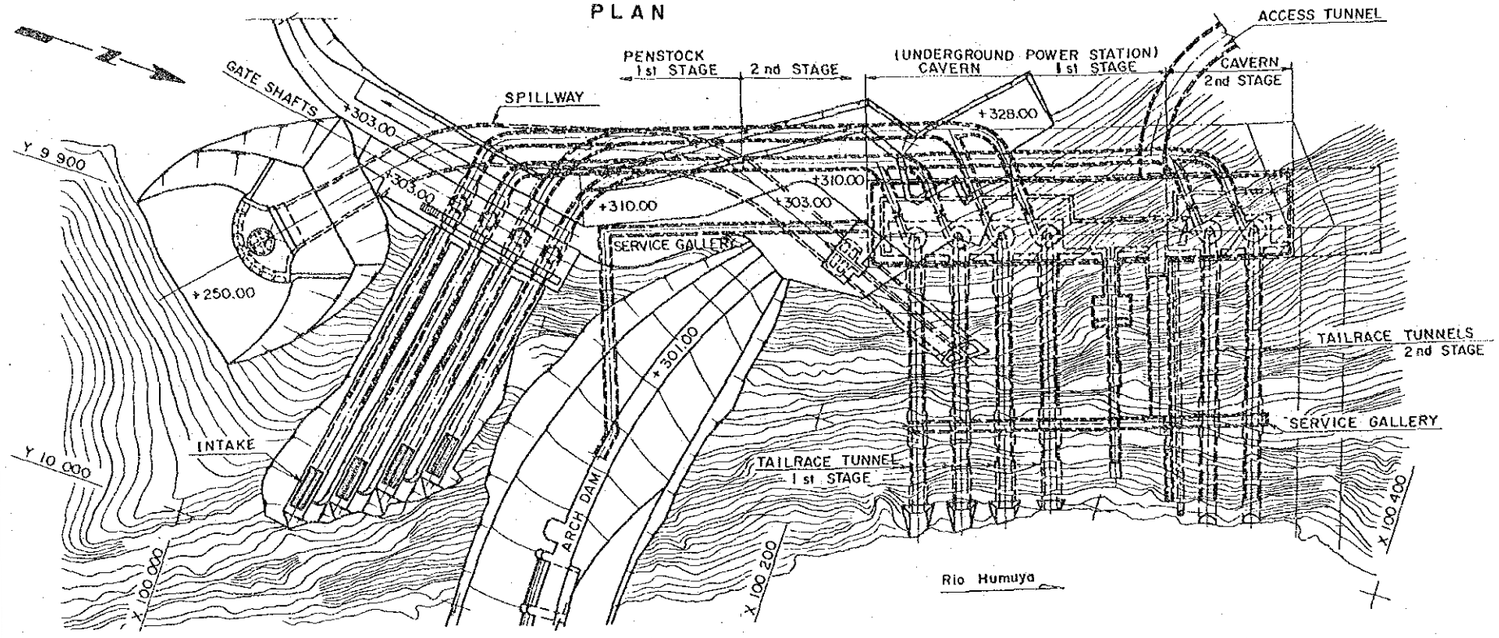
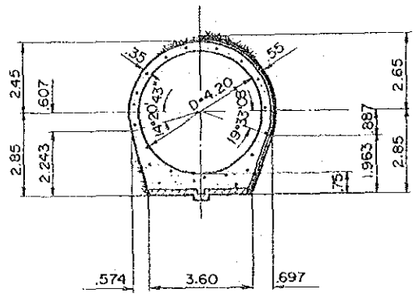
PLAN



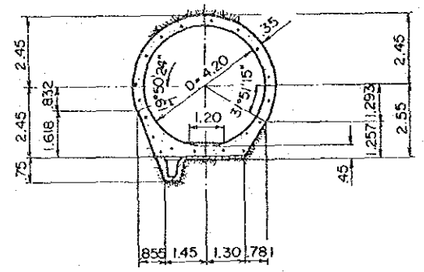
TYPICAL SECTION OF PENSTOCK

TYPE I TYPE II

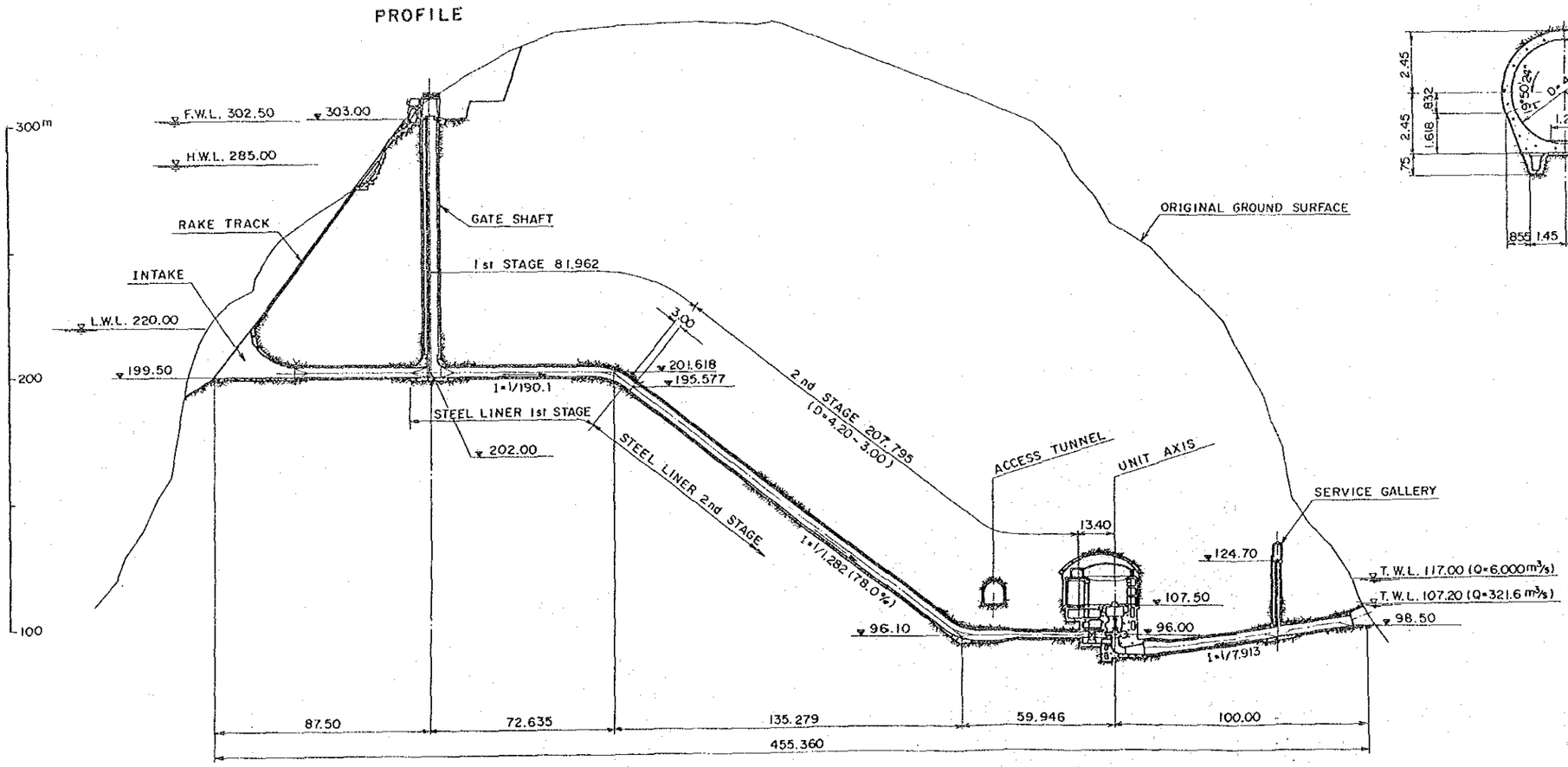


TYPICAL SECTION OF TAILRACE TUNNEL

TYPE II



PROFILE



0 100 m
(PLAN, PROFILE)

0 10 m
(SECTIONS)

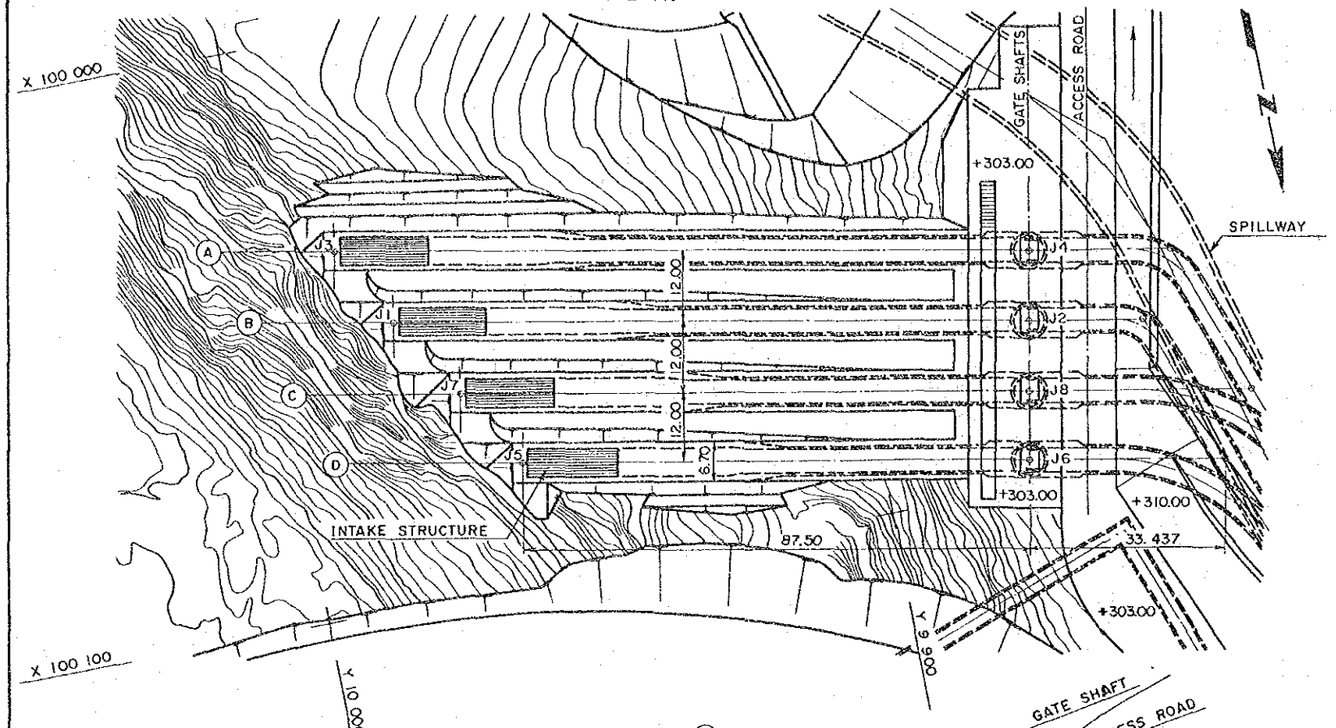
REPUBLIC OF HONDURAS

AMPLIFICATION PROJECT OF
EL CAJON HYDROELECTRIC POWER PLANT

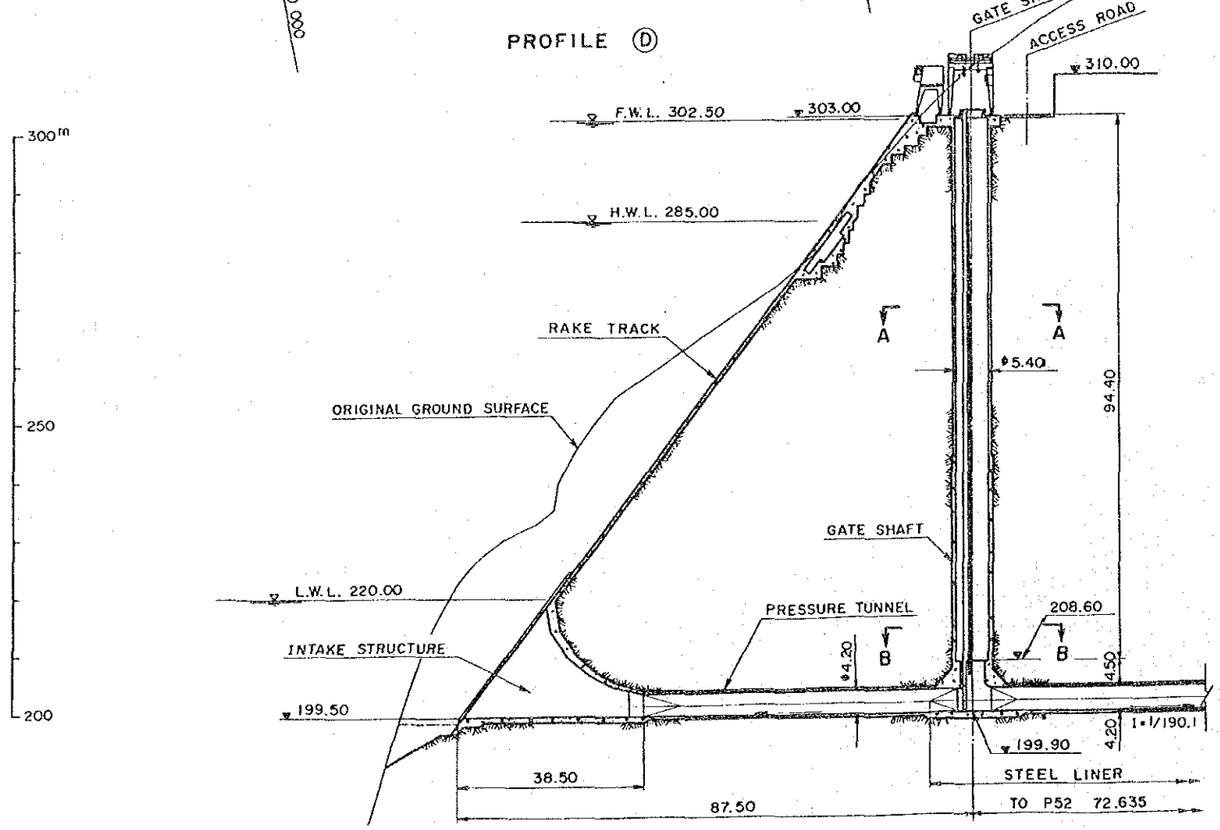
WATER WAY
PLAN, PROFILE AND SECTIONS

Figure 11-3

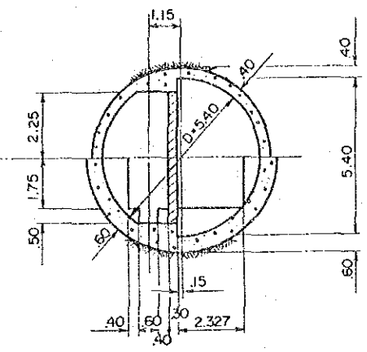
PLAN



PROFILE Ⓓ

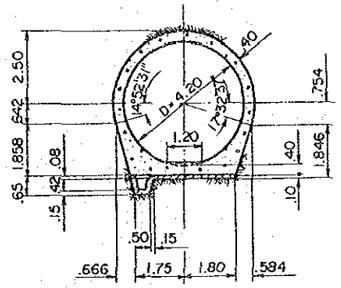


GATE SHAFT

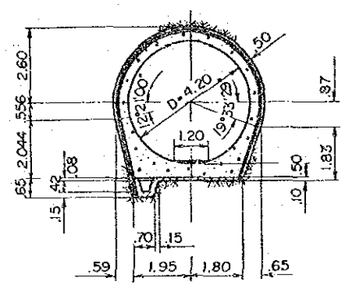


TYPICAL SECTIONS OF PRESSURE TUNNEL

TYPE A



TYPE B

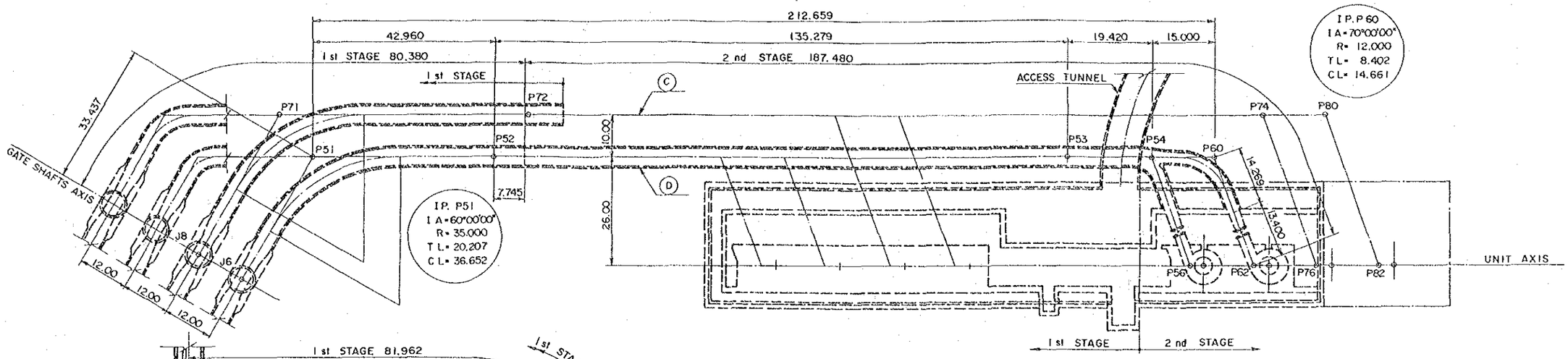


0 50m (PLAN, PROFILE)

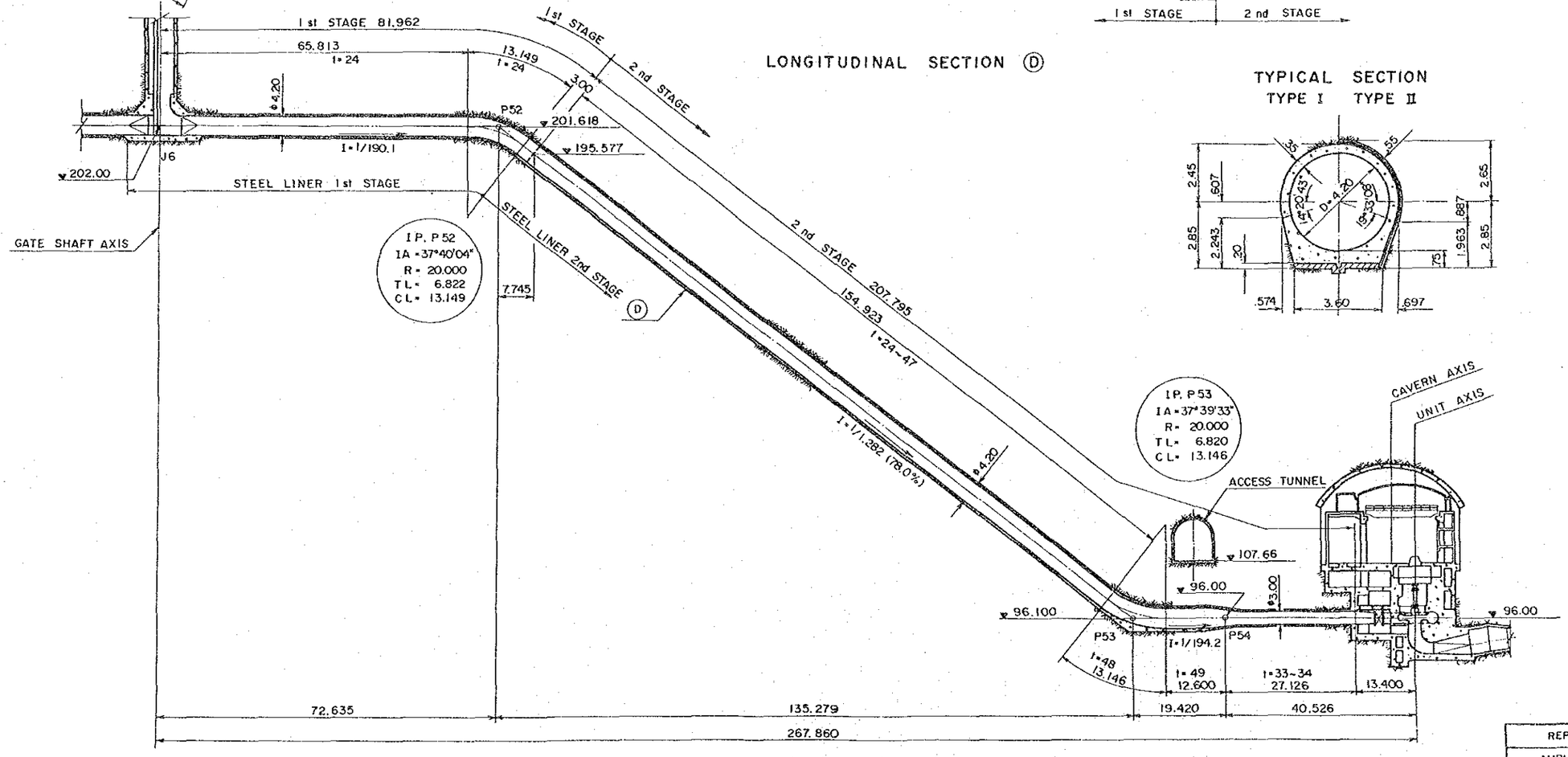
0 10m (SECTIONS)

REPUBLIC OF HONDURAS	
AMPLIFICATION PROJECT OF EL CAJON HYDROELECTRIC POWER PLANT	
INTAKE PLAN, PROFILE AND SECTIONS	
Figure 11-4	

PLAN



LONGITUDINAL SECTION Ⓓ



TYPICAL SECTION

TYPE I TYPE II

1; PLATE THICKNESS

0 10 m (TYPICAL SECTION)

0 50 m (PLAN, LONGITUDINAL SECTION)

REPUBLIC OF HONDURAS

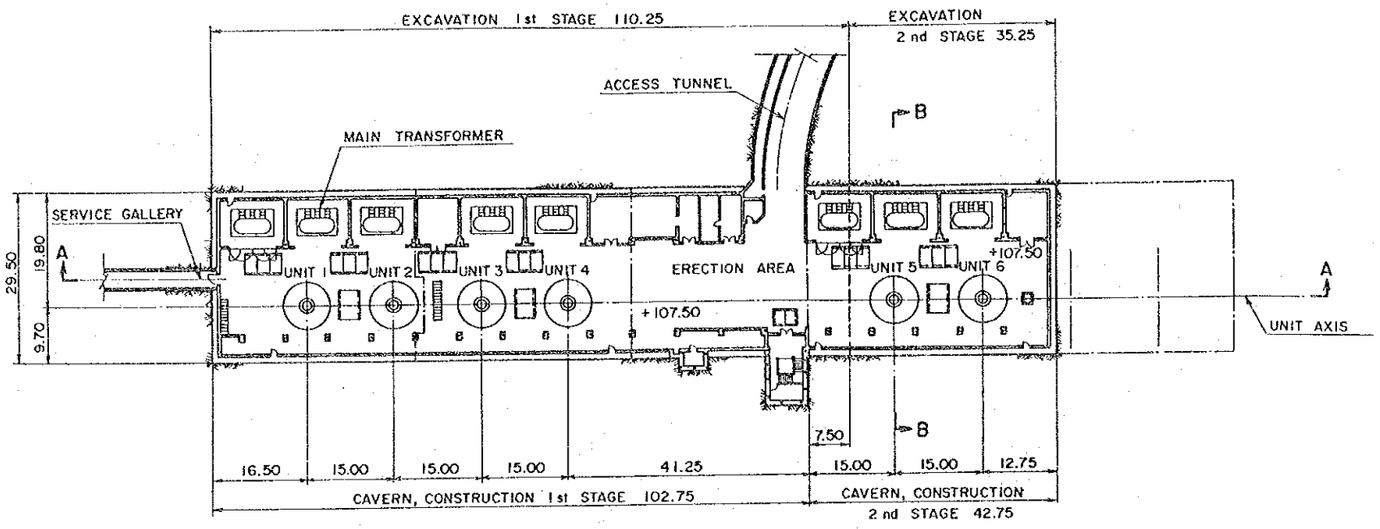
AMPLIFICATION PROJECT OF EL CAJON HYDROELECTRIC POWER PLANT

PENSTOCK

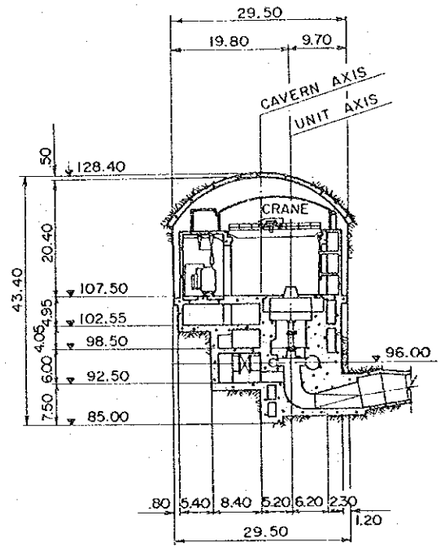
PLAN, PROFILE AND SECTIONS

Figure 11-5

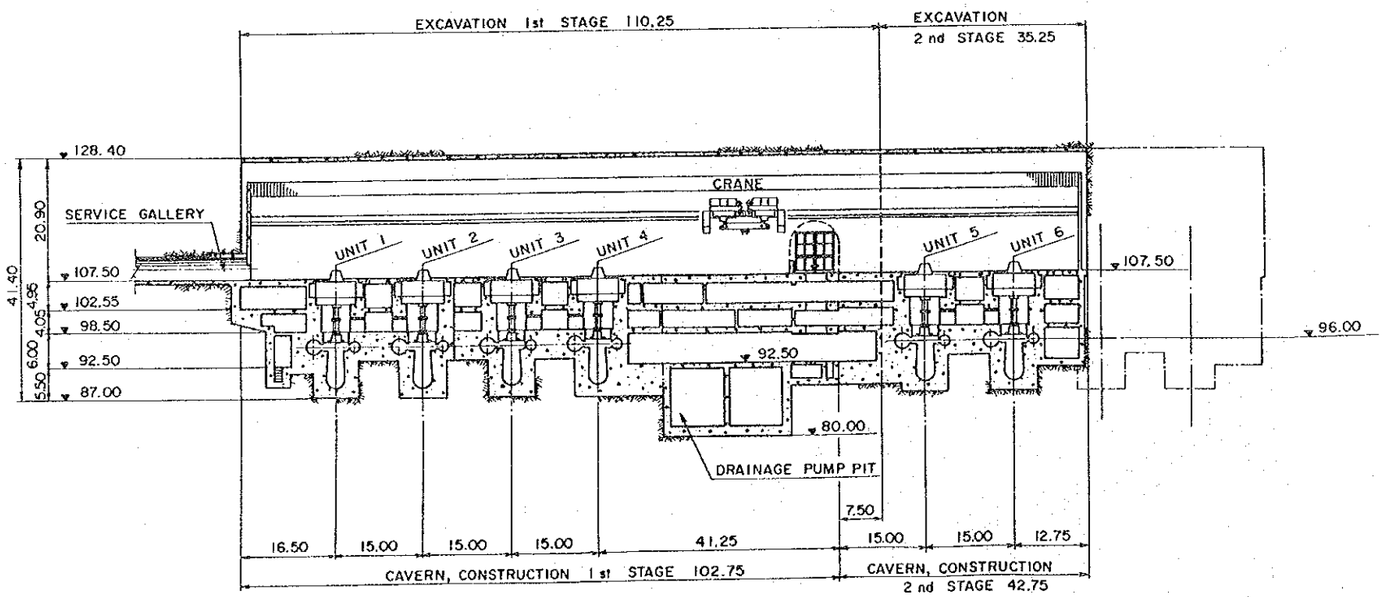
PLAN AT EL. 107.50



B – B



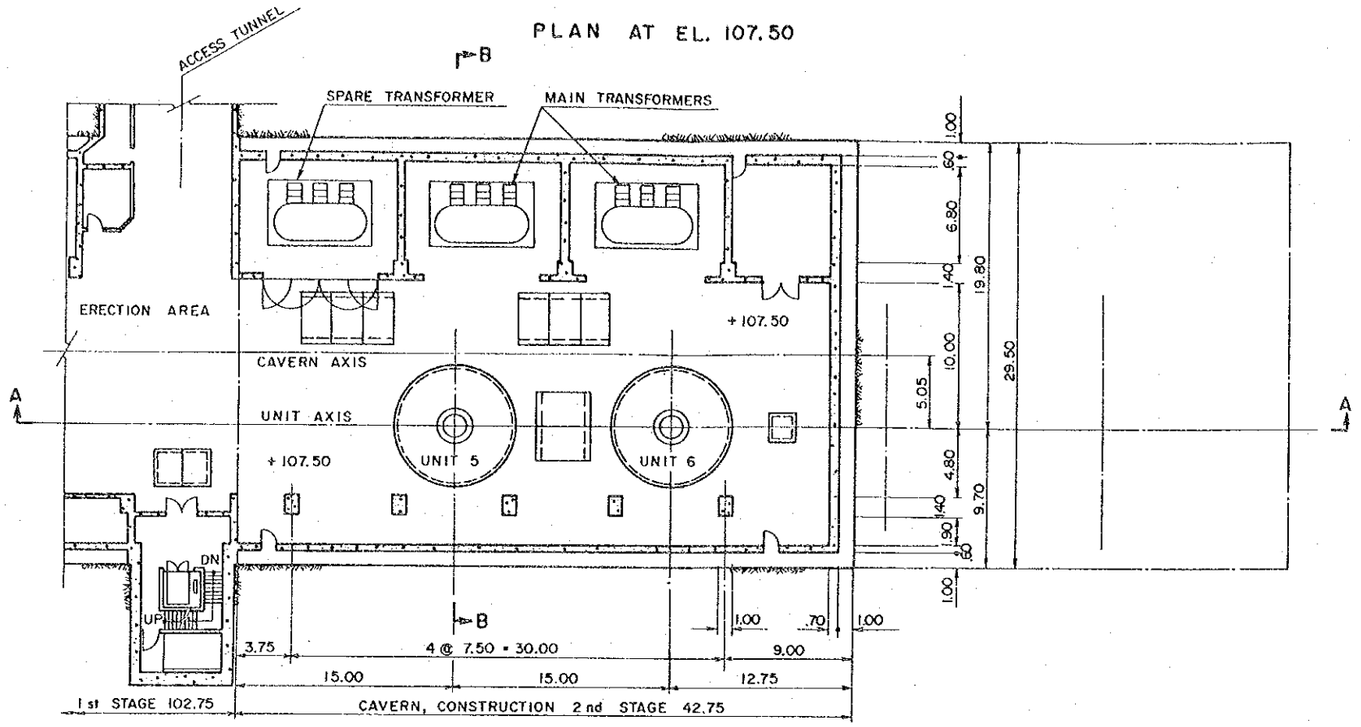
A – A



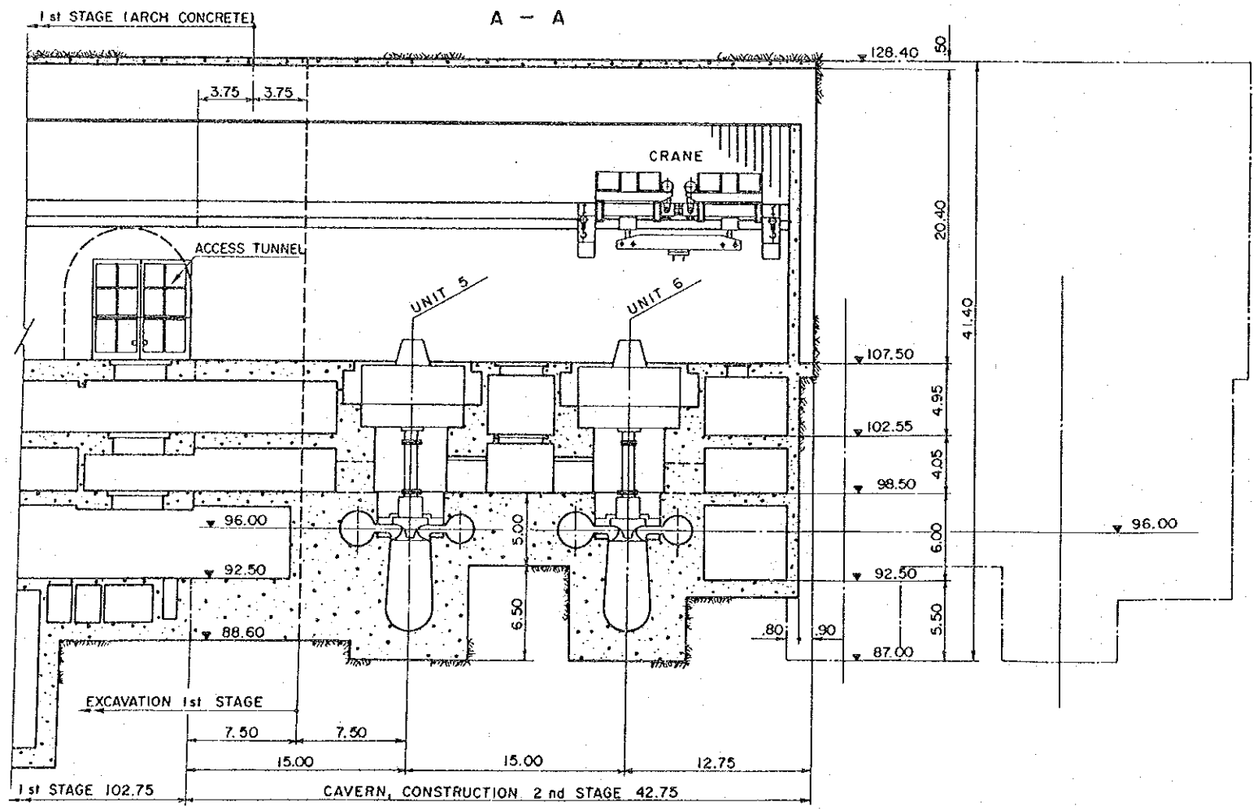
0 50 m

REPUBLIC OF HONDURAS
AMPLIFICATION PROJECT OF EL CAJON HYDROELECTRIC POWER PLANT
POWERHOUSE PLAN, PROFILE AND SECTIONS (I)
Figure 11-6

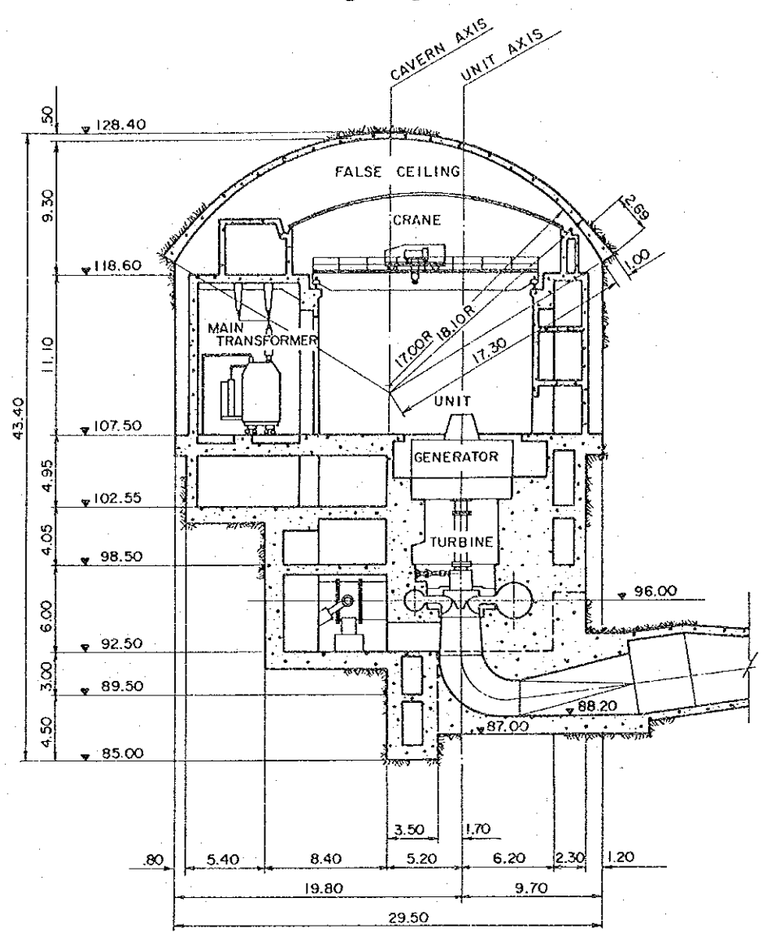
PLAN AT EL. 107.50



A – A



B – B



0 — 20m

REPUBLIC OF HONDURAS

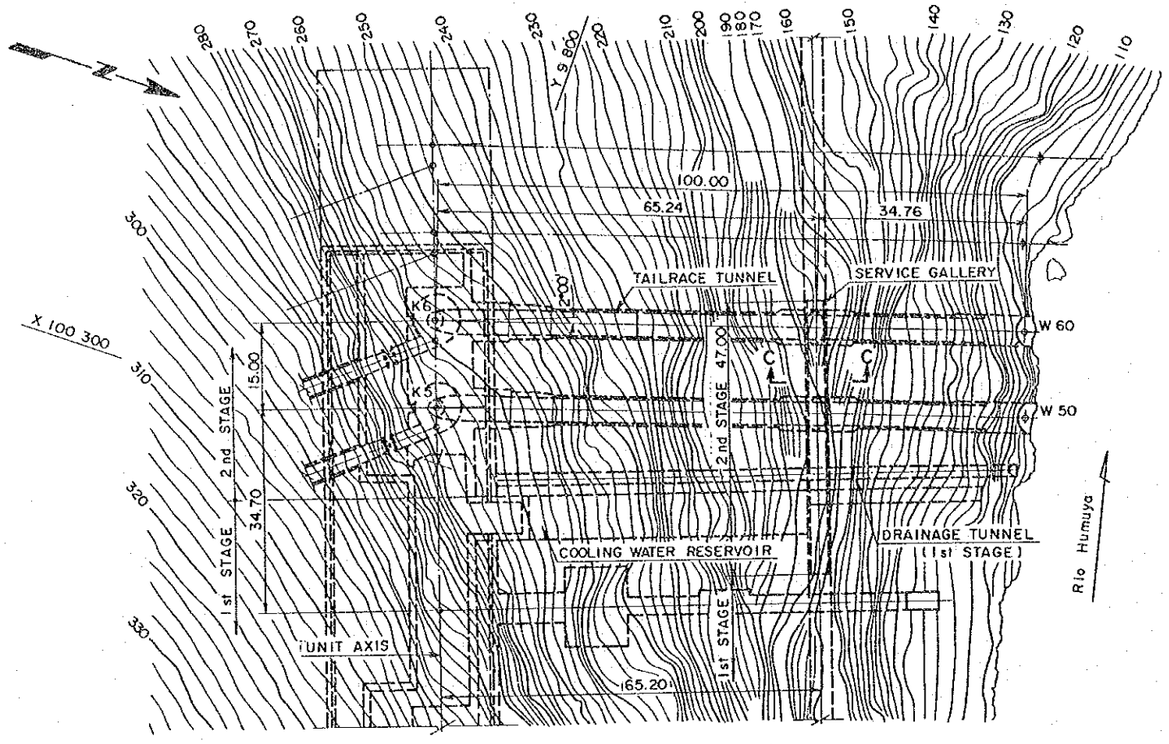
AMPLIFICATION PROJECT OF
EL CAJON HYDROELECTRIC POWER PLANT

POWERHOUSE

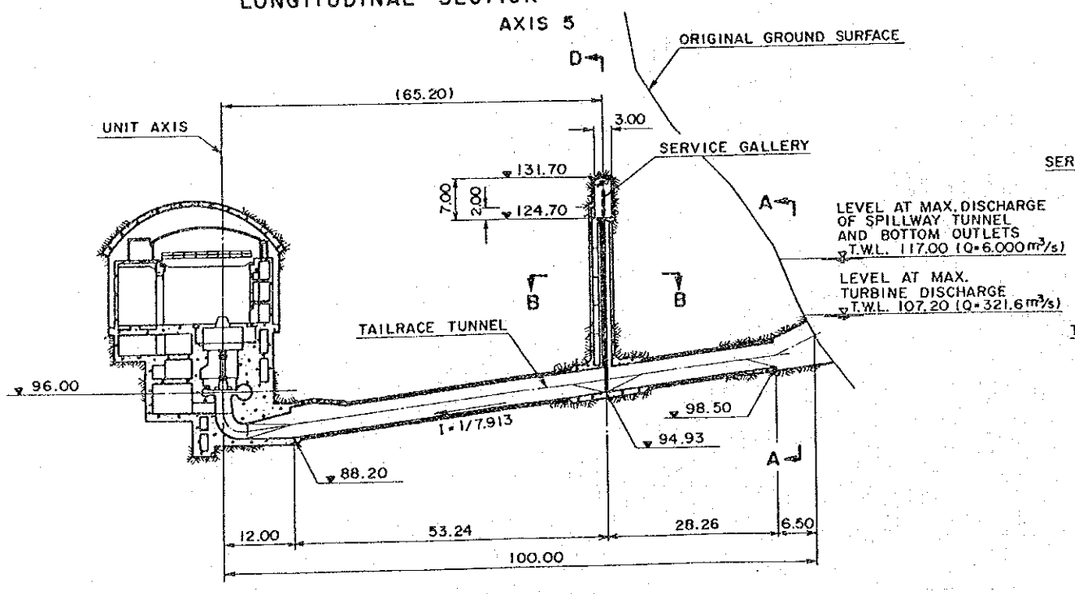
PLAN, PROFILE AND SECTIONS (2)

Figure 11-7

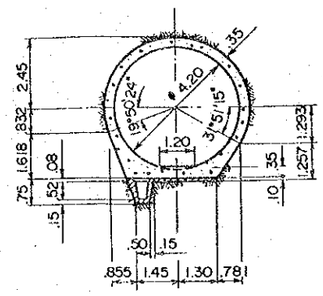
PLAN



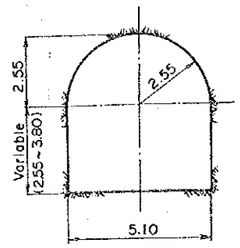
LONGITUDINAL SECTION AXIS 5



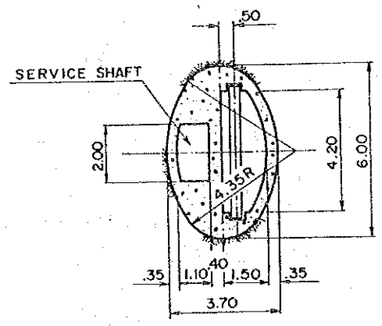
TYPICAL SECTION OF TAILRACE TUNNEL



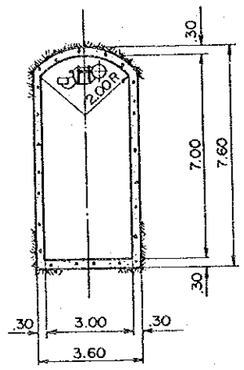
A – A



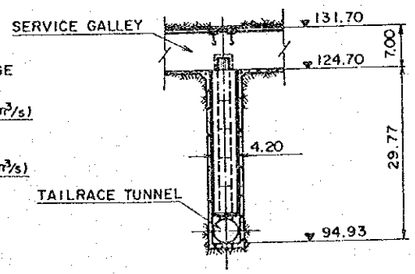
B – B



C – C



D – D



0 10 m
(TYPICAL SECTIONS A-A, B-B, C-C)

0 50 m
(PLAN, LONGITUDINAL SECTION D-D)

REPUBLIC OF HONDURAS

AMPLIFICATION PROJECT OF
EL CAJON HYDROELECTRIC POWER PLANT

TAILRACE
PLAN, PROFLE AND SECTIONS

Figure 11-8

PLAN

SECTION A – A

ACCESS TUNNEL TO POWERHOUSE

MAIN CABLE CANAL

CONTROL BUILDING

TRANSFORMER

RETAINING WALL

EXISTING POSTS

FOUNDATION 2nd STAGE

1st STAGE

ACCESS ROAD

Rio Humuya

ORIGINAL GROUND SURFACE

BUSBAR

RETAINING WALL (EXISTING)

+154.00

+148.00

+146.50

+139.00

+136.00

+131.00

+124.00

148.50

140.00

36.25

11.25

50.15

42.35

17.50

22.50

20.00

27.50

11.00

9.00

140.00

1:1.0

1:1.5

0 50m

REPUBLIC OF HONDURAS

AMPLIFICATION PROJECT OF EL CAJON HYDROELECTRIC POWER PLANT

SWITCHYARD PLAN AND SECTION

Figure 11-9

12. CONSTRUCTION SCHEDULE AND CONSTRUCTION COST

12.1 Construction Schedule

The construction period required for this Amplification Project is approximately 4 years for Stage I (for Unit-5, commissioned in 2002), and approximately 2 years for Stage II (for Unit-6, commissioned in 2006).

The construction schedule is presented in **Fig. 12-1**

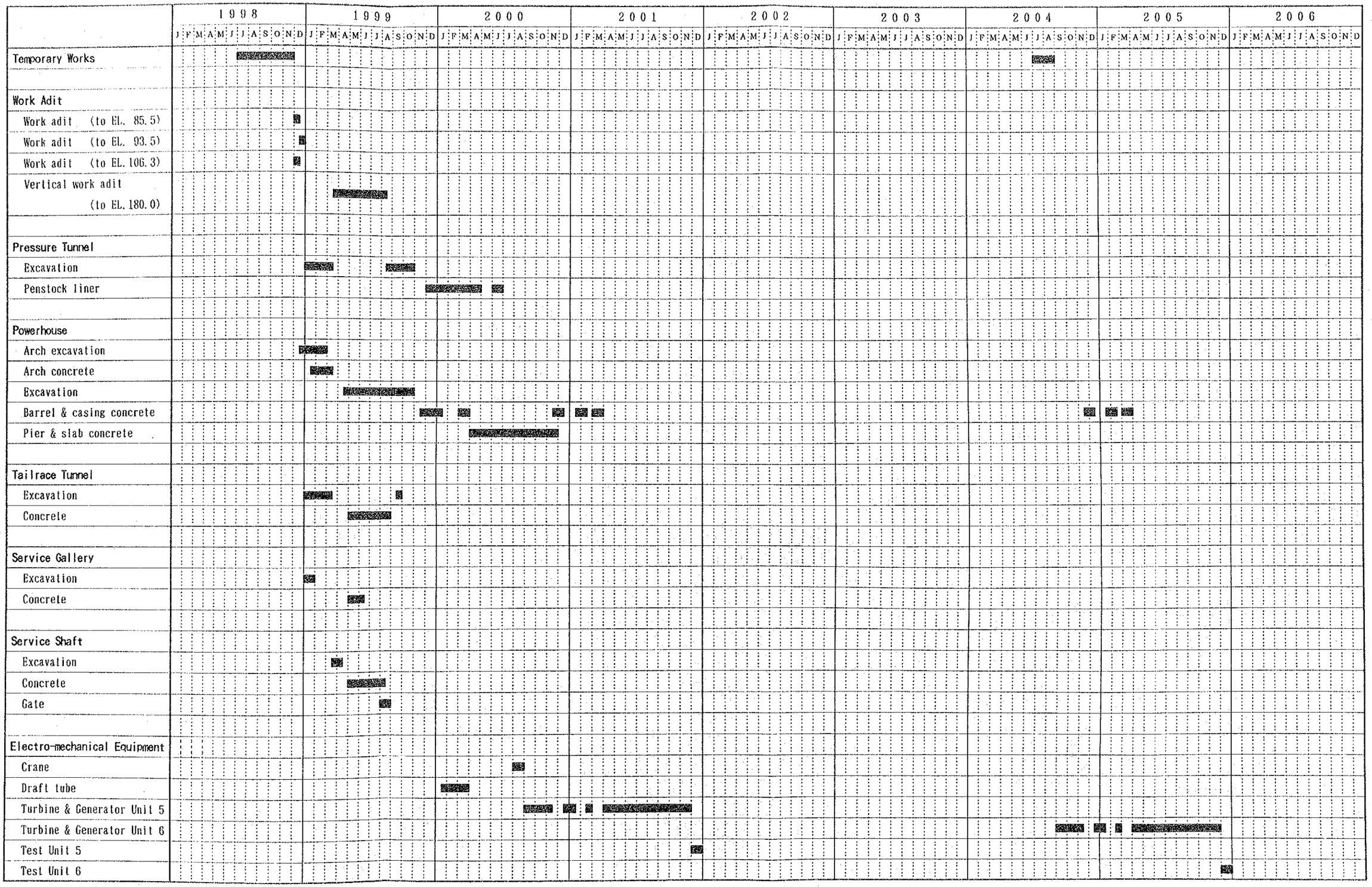
12.2 Construction Cost

It was considered that designs, construction methods, materials, and products of the technical levels which can be expected at the present time will be applied to the construction cost. Estimation was made considering the geological and topographical conditions of the project site, construction scale, etc. The time of estimation was taken as October 1992. (The foreign exchange rate was considered as US$1 = 5.8 Lempira.)

The construction cost will be US$110,077,000. Local and foreign currency requirements in terms of U.S. dollars are as follows:

Local currency: US$17,692,000
Foreign currency: US$92,385,000

Figure 12-1 Construction Schedule



13. IMPACTS ON ENVIRONMENT

A new power plant amplification project is now studied and this chapter describes study results of impacts of the amplification project on environment in the reservoir and downstream area.

This project is an amplification project and the main cause to change the present state of environment is increased discharge for power generation. Such being the case, emphasis is placed on the above point in discussion of impacts on environment and their countermeasures.

13.1 Impacts of Power Plant Amplification on Environment

(1) Flow-duration Change in Downstream

(a) Water Level Fluctuation Range

Non uniform flow calculation was made concerning the dam discharge rate and water level rise rate in the downstream.

The dam discharge increases by approximately 100 m^3/sec as a result of the extension and the calculation shows that the water level rises by about 0.4 to 0.6 m in each cross section except particular points.

The water level fluctuation range over an overall length of the water system is estimated at about 1 plus or minus alpha meter, including the present fluctuation and fluctuation due to the plant amplification. Impacts on nearby residents can be eased by making them known to every resident without exception. However, in the rainy reason or a flood, the downstream water level rises higher and even the above rise may affect banana and other farms near Santa Rita and downstream.

(b) Water Level Rise Rate

If the plant is operated after the expansion to reach the peak output within three hours in the morning in accordance with the existing operation rules, the water level rise rate will be (About 1 m)/3 hrs = About 33 cm/hr. The Japanese standards may be a guide to the limit of the discharge change which does not cause any river disasters nor any accident resulting in injury, death and damage downstream. The judgment standard in "Dam Operation Rules" stipulated by the Ministry of Construction provides that safety can be secured if the fluctuation in 30 minutes is 50 cm or less and that about 30 cm/30 minutes is the standard. Even if compared with the above standard, the water level rise rate indicated may give no problem.

(2) Water Quality

Judging from the existing vertical distribution of water quality of the reservoir, quality of discharge water may remain unchanged even if the discharge rate increases. In the rapid stream part extending over several km downstream right below the dam, dissolved oxygen may increase and sulfide concentration may decrease but some impact may be given to aquatic life before a big branch joins the stream.

(3) Items During Construction Work

According to the field investigation, private houses are hardly seen in the dam site and its vicinity and existence of scarce animals and plants is not reported. Existing roads to the dam site are kept in good condition for transportation of construction materials and power generation equipment. Impact on the vicinity of work may not cause a serious problem except that due care must be paid to proper processing of excavated earth and sand by construction work.

13.2 Environmental Protection Measures

(1) Items after Plant Amplification

The following items are considered as environmental protection measures against the above.

- Residents downstream from the dam live in full recognition of the present water level variation by discharge for generation. We think they will show some understanding of the water level rise by the plant amplification and all possible measures will be implemented to make the changes of the present situation known to every resident.
- It is seen that a small boat is used to get across the river as the current traffic means. Other river-crossing means are arranged depending on the request of residents having boats.
- Gravel collection as industry and fishing as food hunting are seen in small scale in the downstream areas. Compensation for them is considered as possibility.

It is proposed to install discharge warning means to secure safety of downstream residents. As one of the means, the discharge alarm equipment used in Japan is considered. Details are shown in "**8. Remote Transmission System**".

(2) Items During Construction Work

The following items are considered as environmental protection measures.

- Excavated earth and sand produced by construction work, switchyard work, etc. are estimated at about 40,000 - 50,000 m^3. Spoil banks are prepared to process the above earth and sand. Attention is paid in this work not to impair the nearby scenery and to prevent outflow of earth and sand from spoil banks.

14. ECONOMIC AND FINANCIAL ANALYSIS

14.1 Economic Evaluation

(1) Method of Economic Evaluation

"Alternative facility approach method" is adopted in the Project. A thermal power generation facility is assumed to be an alternative project, since the Project is designed to be a peak load power generation plant. Thus, a gas turbine power generation facility which has an output capacity equivalent to the Project is assumed to be its alternative project.

Construction cost, operation and maintenance cost, etc. are to be calculated as the cost, while these costs for the alternative project are taken as the benefit of the Project, and economic evaluation is to be made, by calculating Net Present Value (B-C), Benefit/Cost Ratio (B/C) and Economic Internal Rate of Return (EIRR).

(2) Economic Cost of the Project

The project costs were appropriated in consideration of the project's characteristics that an increase of energy production cannot be expected from the expansion of power generating facilities. Namely, they are:

- construction cost of the power plant's expansion
- construction cost of a base-load, coal-fired power plant to be required with the expansion
- operation and maintenance cost of the above power stations (including fuel cost)

(3) Economic Benefit of the Project

"Alternative facility approach" method is adopted in the Project and a gas turbine power generation plant with an installed capacity equivalent to the Project is assumed to be the benefit.

(4) Economic Evaluation of the Project

As a result of evaluation, it has been revealed that the Project is feasible with any index. (See **Table 14-1**)

- Net Present Value (B-C): US$15,076 x 10^3
- Benefit/Cost Ratio (B/C): 1.12
- Economic Internal Rate of Return (EIRR): 16%

(5) Sensitivity Analysis

As sensitivity analysis for the Project, effects are calculated for the following cases:

- when discount rate is changed to be 8%, 10%, and 12%
- when construction cost is increased by 5 to 20%

The results show that the Project is economically feasbile in all cases.

14.2 Financial Evaluation

(1) Method of Financial Evaluation

It is not appropriate to apply usual method of financial evaluation for the Project, because an increase of energy production cannot be expected from installation of additional generators. Therefore, in place of a usual financial evaluation, a study is to be made as to how much of internal reserve will enable the realization of the Project, in other words, how much of incremental income from electric power sale will make the Project viable financially.

(2) Financial Cost and Benefit of the Project

Financial costs of the Project are the initial investment at market prices, renovation cost, and operation and maintenance cost, and taxes are added.

Financial benefit of the Project is to be the incremental income of selling electric power by ENEE as a whole, and the amount of incremental income is estimated using an incremental unit price of electricity which is made available by price increase and power demand forecast by ENEE (low case). The average unit price of US$ 0.088/kWh is used as the unit electricity price.

(3) Financial Evaluation of the Project

Financial Internal Rate of Return (FIRR) has been calculated based on the incremental income from the sale of electric power resulting from price increase.

Rate of Increase	3%	4%	5%	10%
FIRR	6.3%	9.6%	12.4%	14.9%

From this table, it is concluded that some 5% of price increase is necessary to make the Project viable financially, or to obtain an FIRR which exceeds the expected borrowing rate of interest in terms of domestic fund (12%). (See Table 14-2)

Table 14-1 Economic Evaluation

EL CAJON PROJECT (unit: 1000 US dollar)

No.	Year	COST						BENEFIT				B - C
		EL CAJON		BASE LOAD THERMAL				GAS TURBINE				
		INVEST	O & M	INVEST	O & M	FUEL	TOTAL(C)	INVEST	O & M	FUEL	TOTAL(B)	
-4	1998	6,880					6,880				0	-6,880
-3	1999	29,364					29,364				0	-29,364
-2	2000	15,092		11,826			26,918	35,320			35,320	8,402
-1	2001	11,708		7,884			19,592	15,137			15,137	-4,454
1	2002	0	672		899	2,731	4,301		2,301	5,622	7,923	3,621
2	2003	0	672		899	2,731	4,301		2,301	5,622	7,923	3,621
3	2004	18,113	672	11,826	899	2,731	34,241	35,320	2,301	5,622	43,243	9,003
4	2005	11,708	672	7,884	899	2,731	23,893	15,137	2,301	5,622	23,060	-833
5	2006		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
6	2007		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
7	2008		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
8	2009		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
9	2010		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
10	2011		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
11	2012		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
12	2013		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
13	2014		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
14	2015		1,109		1,798	5,462	8,368	35,320	4,602	11,244	51,166	42,798
15	2016		1,109		1,798	5,462	8,368	15,137	4,602	11,244	30,983	22,615
16	2017		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
17	2018		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
18	2019		1,109		1,798	5,462	8,368	35,320	4,602	11,244	51,166	42,798
19	2020		1,109		1,798	5,462	8,368	15,137	4,602	11,244	30,983	22,615
20	2021		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
21	2022		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
22	2023	1,106	1,109		1,798	5,462	9,475		4,602	11,244	15,846	6,371
23	2024	11,497	1,109		1,798	5,462	31,692		4,602	11,244	15,846	-15,846
24	2025	11,517	1,109	11,826	1,798	5,462	27,770		4,602	11,244	15,846	-11,924
25	2026	11,517	1,109	7,884	1,798	5,462	19,886		4,602	11,244	15,846	-4,040
26	2027	0	1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
27	2028	0	1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
28	2029	17,276	1,109	11,826	1,798	5,462	37,470		4,602	11,244	15,846	-21,625
29	2030	11,517	1,109	7,884	1,798	5,462	27,770	35,320	4,602	11,244	51,166	23,396
30	2031		1,109		1,798	5,462	8,368	15,137	4,602	11,244	30,983	22,615
31	2032		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
32	2033		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
33	2034		1,109		1,798	5,462	8,368	35,320	4,602	11,244	51,166	42,798
34	2035		1,109		1,798	5,462	8,368	15,137	4,602	11,244	30,983	22,615
35	2036		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
36	2037		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
37	2038		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
38	2039		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
39	2040		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
40	2041		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
41	2042		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
42	2043		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
43	2044		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
44	2045		1,109		1,798	5,462	8,368	35,320	4,602	11,244	51,166	42,798
45	2046		1,109		1,798	5,462	8,368	15,137	4,602	11,244	30,983	22,615
46	2047		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
47	2048		1,109		1,798	5,462	8,368		4,602	11,244	15,846	7,478
48	2049		1,109		1,798	5,462	8,368	35,320	4,602	11,244	51,166	42,798
49	2050		1,109		1,798	5,462	8,368	15,137	4,602	11,244	30,983	22,615
50	2051		1,109		1,798	5,462	8,368	-80,731	4,602	11,244	-64,885	-73,254
TOTAL		157,297	53,684	78,840	86,282	262,187	638,290	322,930	220,883	539,721	1,083,534	445,244
[NPV i=12%]							122,564				137,640	15,076

Discount rate 12% B-C 15,076

B/C 1.12

IRR 16%

Table 14-2 Financial Evaluation

(Unit: 1000US$)

No	Year	C O S T			BENEFIT	B - C
		Invest	O & M	Total		
-4	1998	8,613		8,613		-8,613
-3	1999	37,630		37,630		-37,630
-2	2000	20,060		20,060		-20,060
-1	2001	15,893		15,893		-15,893
1	2002	0	2,002	2,002	14,013	12,011
2	2003	0	2,002	2,002	14,778	12,776
3	2004	24,519	2,002	26,520	15,583	-10,937
4	2005	15,893	2,002	17,894	16,439	-1,455
5	2006		2,495	2,495	17,341	14,846
6	2007		2,495	2,495	18,295	15,800
7	2008		2,495	2,495	19,301	16,806
8	2009		2,495	2,495	20,362	17,867
9	2010		2,495	2,495	21,482	18,987
10	2011		2,495	2,495	21,482	18,987
11	2012		2,495	2,495	21,482	18,987
12	2013		2,495	2,495	21,482	18,987
13	2014		2,495	2,495	21,482	18,987
14	2015		2,495	2,495	21,482	18,987
15	2016		2,495	2,495	21,482	18,987
16	2017		2,495	2,495	21,482	18,987
17	2018		2,495	2,495	21,482	18,987
18	2019		2,495	2,495	21,482	18,987
19	2020		2,495	2,495	21,482	18,987
20	2021		2,495	2,495	21,482	18,987
21	2022		2,495	2,495	21,482	18,987
22	2023	1,504	2,495	3,999	21,482	17,483
23	2024	15,631	2,495	18,126	21,482	3,356
24	2025	15,659	2,495	18,153	21,482	3,329
25	2026	15,659	2,495	18,153	21,482	3,329
26	2027	0	2,495	2,495	21,482	18,987
27	2028	0	2,495	2,495	21,482	18,987
28	2029	23,488	2,495	25,983	21,482	-4,501
29	2030	15,659	2,495	18,153	21,482	3,329
30	2031		2,495	2,495	21,482	18,987
31	2032		2,495	2,495	21,482	18,987
32	2033		2,495	2,495	21,482	18,987
33	2034		2,495	2,495	21,482	18,987
34	2035		2,495	2,495	21,482	18,987
35	2036		2,495	2,495	21,482	18,987
36	2037		2,495	2,495	21,482	18,987
37	2038		2,495	2,495	21,482	18,987
38	2039		2,495	2,495	21,482	18,987
39	2040		2,495	2,495	21,482	18,987
40	2041		2,495	2,495	21,482	18,987
41	2042		2,495	2,495	21,482	18,987
42	2043		2,495	2,495	21,482	18,987
43	2044		2,495	2,495	21,482	18,987
44	2045		2,495	2,495	21,482	18,987
45	2046		2,495	2,495	21,482	18,987
46	2047		2,495	2,495	21,482	18,987
47	2048		2,495	2,495	21,482	18,987
48	2049		2,495	2,495	21,482	18,987
49	2050		2,495	2,495	21,482	18,987
50	2051		2,495	2,495	21,482	18,987
Total		210,207	122,772	332,979	1,038,361	705,383
					FIRR:	12.4%

15. FURTHER INVESTIGATIONS

This project will be implemented after 2002; however, preparation works for construction shall be started in 1996, assuming that it takes approximately 2.5 years for detail design etc. prior to start of construction works and approximately 3.5 years for construction.

Meteorological, hydrological and geological investigations are stated as items of future works.

(1) Meteorology and Hydrology

It is recommended that telemetering system be attached to meteorological and hydrological gauging stations and that statistical analysis and arrangement of observed data be continued as before.

(2) Geology

Amplified powerhouse is to be constructed next to the existing powerhouse, so additional boring is not necessary.

Test boring will be necessary to confirm geological characteristics of each structure to every detail.

Geological investigation records shall be kept in custody not to be scattered and lost because they are important data for the future construction work.

Water leakage around the dam body shall be watched and observed from now on.