4.6.2 Coyolar Dam Rehabilitation Plan

Rehabilitation of Coyolar dam has two major purposes as follows:

-to keep the structural stability
-to rehabilitate and/or improve the existing spillway so as to match the design flood discharge

(1) Rehabilitation Methods

1) Securing of dam stability

In order to secure the stability of the dam, certain reinforcement of the dam body is required. Reinforcement methods of the dam are elaborated and studied as follows.

- Dam body widening methods
  The basement of the structure is widened for securing the stability of structures. There are three ways to widen the dam body i.e., pouring additional concrete on the upstream, downstream and both sides of the dam body.
  However, pouring concrete on the upstream is quite difficult due to the following reasons;

  ① Because of underwater work, accurate construction is difficult.
  ② Enclosing work is required for dry work. It's quite difficult to discharge inflow water to outside.

- Anchor method

  Base rock and the dam body are connected by anchors and shoulders a part of the loads. However, according to the result of laboratory tests, the unconfined compression strength of the dam body is partially small and the strength of the dam body is not enough for anchorring method.

Therefore, widening the dam body by pouring concrete on downstream is judged to be the optimum method technically and in a view of easy construction. This method is employed for the dam rehabilitation plan. Fig.4.6-1 shows typical cross section of the rehabilitation plan.

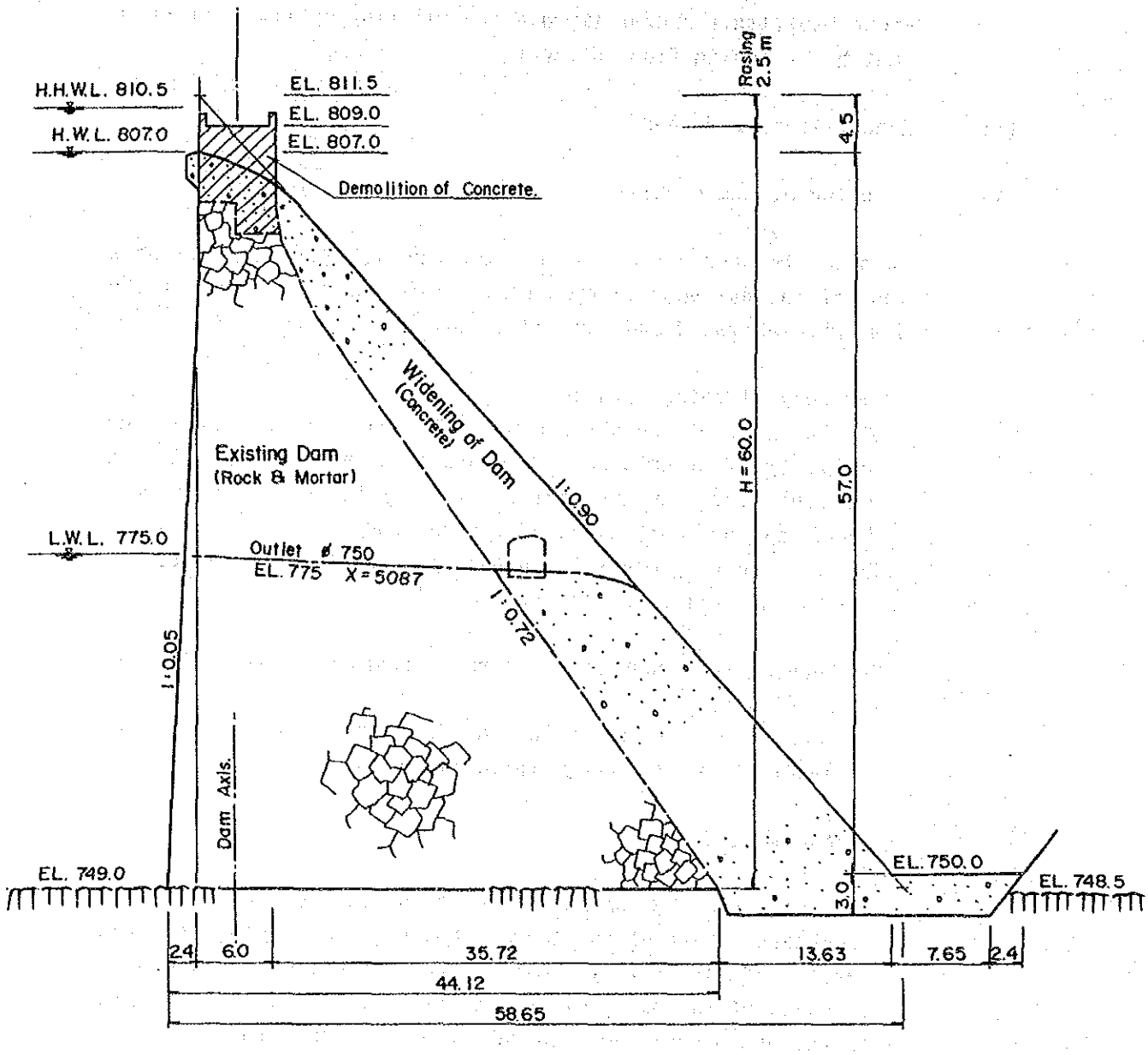


Fig.4.6-1 Typical Cross Section of Dam Rehabilitation Plan

2) Rehabilitation/Improvement of Spillway

Since the design flood discharge of the existing spillway is 288 m^3/sec and quite small, the present one cannot pass the new design flood discharge of 700m^3/sec (200 years return period, specific discharge is 3.6 m^3/sec/km^2) safely. Therefore rehabilitation of the existing spillway or improvement including new construction is required.

Following three countermeasures are considered.

- Plan B-1 : Construction of a new spillway on the right bank of the dam
- Plan B-2 : Construction of overflow type spillway at the middle of the dam crest
- Plan B-3 : Utilization of existing spillway together with Plan B-2

Comparison study is made for the determination of spillway rehabilitation way as follows (Table 4.6-1). Construction quantity of the dam rehabilitation works is included because the spillway works are not independent from the dam rehabilitation works.

Table 4.6-1 Comparison Study of Spillway Rehabilitation

Description		Plan B-1	Plan B-2	Plan B-3
Excavation				
Excavation	(m^3)	14,000	16,000	16,000
Spillway	(m^3)	84,000	-	-
Sub-dam	(m^3)	10,000	10,000	10,000
Total	(m^3)	108,000	26,000	26,000
Concrete				
Dam	(m^3)	33,100	34,900	34,900
Spillway	(m^3)	14,000	-	-
Sub-dam	(m^3)	5,100	5,100	5,500
Total	(m^3)	52,100	40,000	40,400
Grouting(m)		34,500	34,400	34,200
Access road		Improvement of existing road		
		Const. of new road(6km)		
Construction cost (million Lps.)		68	44	45
Construction period (year)		5	3	3
Overall evaluation		C	A	B

As the result of the above evaluation, there are little difference of construction cost between Plan B-2 and Plan B-3. However, it is recommended to avoid the utilization of the existing spillway in a view of its safety. In this regard, Plan B-2 is employed in this project plan.

(2) Outline of Coyolar Dam Rehabilitation

Outline of the Coyolar Dam Rehabilitation is shown below (Fig.4.6-2).

- The elevation of the dam crest is EL.811.5 m
- Widening concrete is poured at the downstream of the dam body
- The inlet of the existing spillway is closed by concrete (sub-dam) as the extension of the dam body. Flood is overflowed through a new spillway at the middle of the dam body.
- The apron at the downstream is not installed. A dissipator is designed downstream of it.

(3) Design Criteria

- Design Seismic Intensity

It is required to study previous results of earthquakes, seismic character of the area, previous design considering earthquake in the surrounding area, etc., synthetically and determine the design seismic intensity.

The trial value of the seismic intensity obtained from the data of previous earthquakes was less than 0.10. However, an earthquake was occurred in Comayagua in 1980. The other earthquake of 0.15g was recorded at the Cajon Dam located in the downstream of Humuya River. The design seismic intensity of Cajon Dam is 0.36. No construction drawing which shows the configuration of Coyolar Dam basement exist, it's impossible to to analyse its seismic character. Considering enough safety, the design seismic intensity of Coyolar Dam is determined as K=0.15.

- Up-lift Pressure

The up-lift pressure against the dam body (=U) was decided as U=50% by considering the treatment condition of the dam basement, the condition of base rock, record of groundwater level in boring holes, etc..

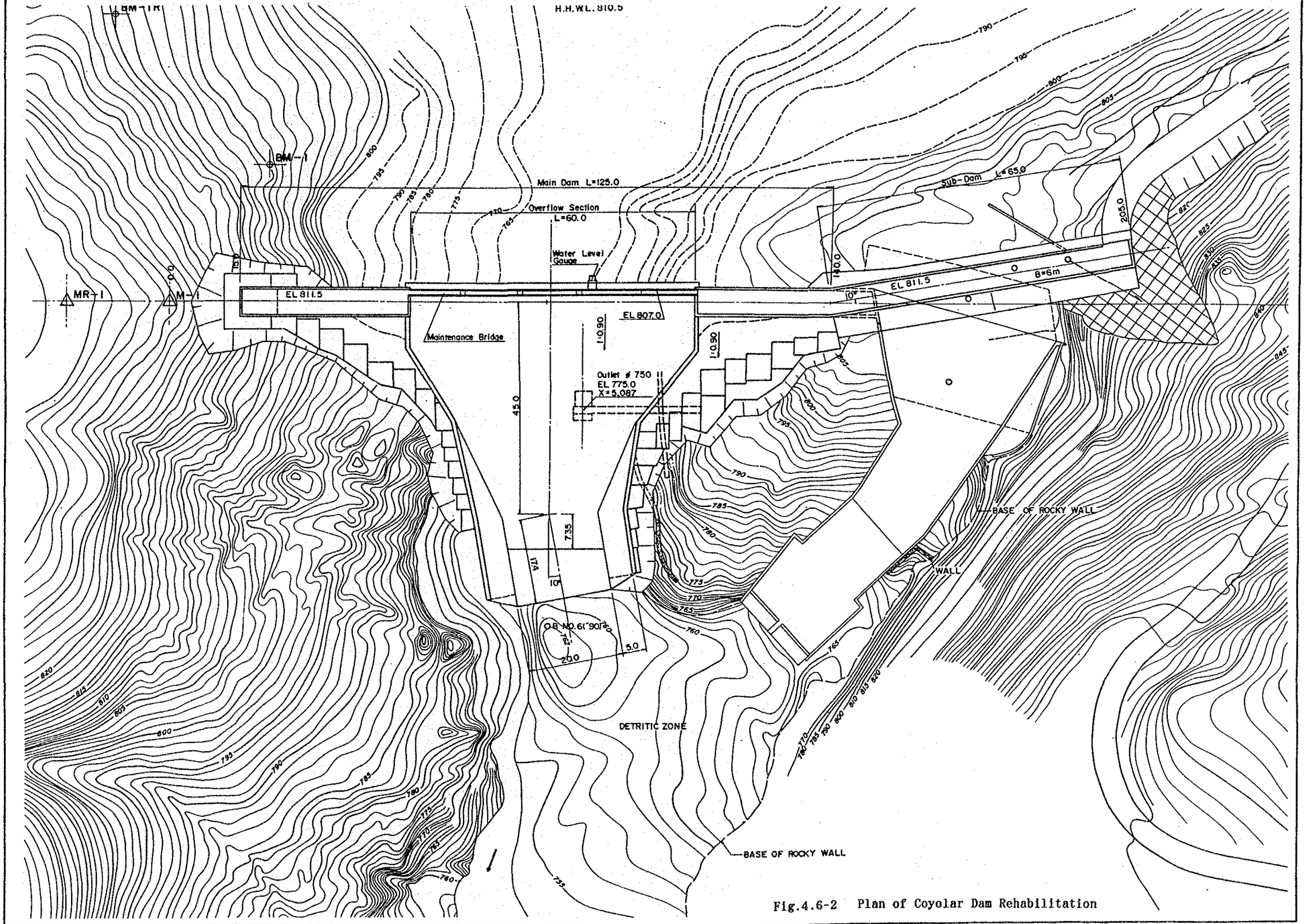


Fig.4.6-2 Plan of Coyolar Dam Rehabilitation

- Unit Weight

Unit weight should be decided for the existing and new concrete. The unit weight of the existing dam body is 2.0 t/m^3 from the result of the laboratory test. The one of new concrete is 2.3 t/m^3 which is the unit weight of ordinary concrete.

- Foundation rock

Foundation rock is classified as class CM-CH. 250-500 kgf/cm^2 of uniaxial compression strength can be expected and this strength is quite sufficient as the bearing capacity of the dam. However, shearing resistance of the rock as the dam foundation is decided from the result of a laboratory test and values of other dams as follows.

ζ=150 t/m^2	ζ: Shearing resistance
$\tan\phi$ =0.8 ϕ=38°	ϕ: Internal friction angle

(4) Outline of construction work

1) Flow of dam rehabilitation work

Flow chart of the rehabilitation work is shown in Fig.4.6-3.

2) Excavation and concrete works

- Excavation

Cutting for widening of the dam body occupies mostly in excavation work. Therefore crushing excavation by regulated blast is carried out from upper side to river bed so as not to give excessive vibration. Concrete at the existing dam body is demolished with the same method. Since the site for cutting site is steep slope and there is only a small work space, it is necessary to regulate the construction schedule with other works.

Mucking is transported and disposed with a cable crane and vessels.

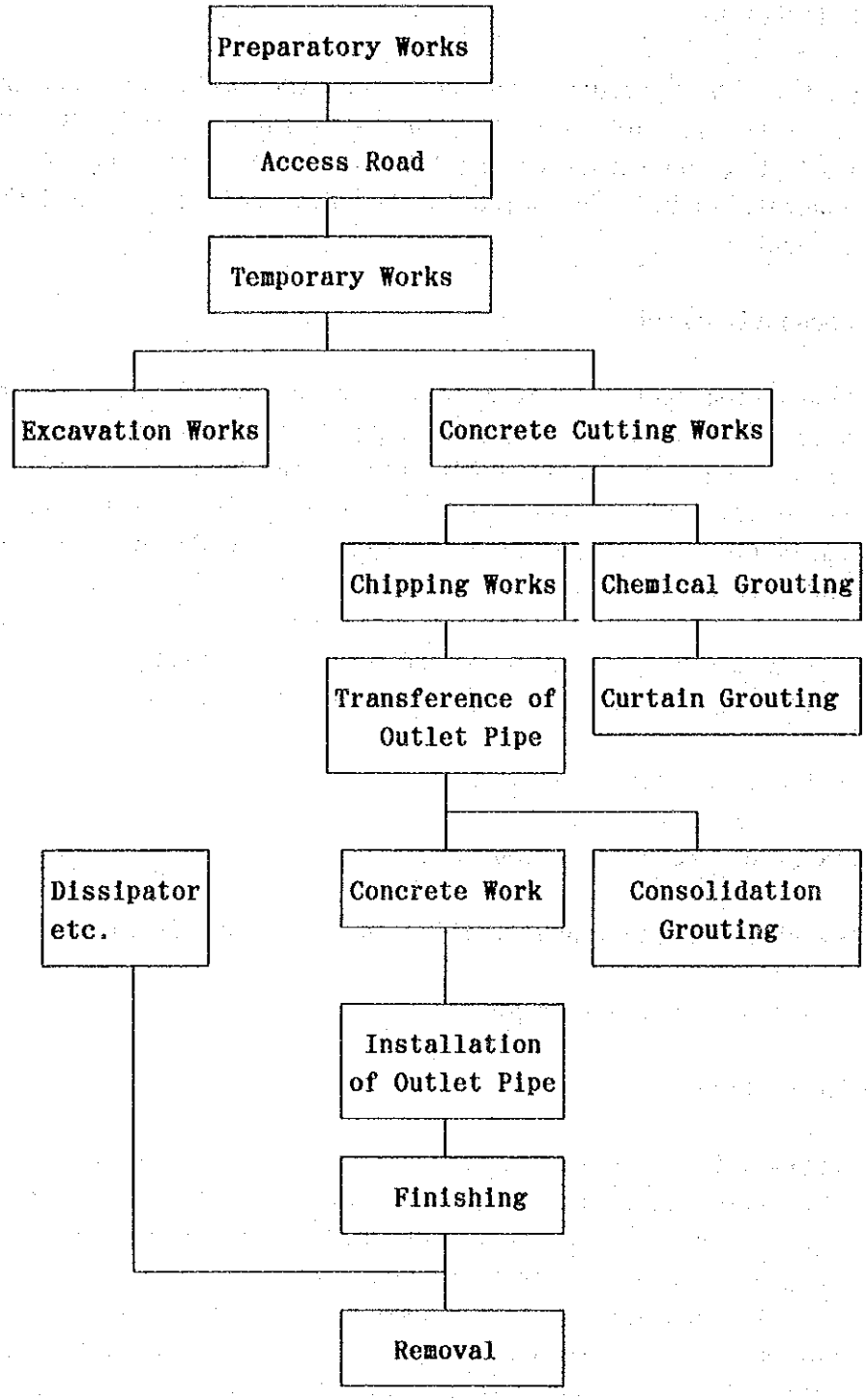


Fig.4.6-3 Dam Rehabilitation Work Flow

- Concrete work

Concrete work is divided into as following.

a. Widening by additional concrete downstream the dam body
b. Modification of the dam crest

Widening is practiced at all surface of concrete downstream the dam body and the maximum concrete thickness is 14 m. The maximum concrete thickness for dam crest modification is 11 m at the unoverflowing part.

A valve room and an access way for operation/maintenance is designed in the widening concrete. Concrete is poured with column method. Cooling of concrete is not required due to small diurnal range.

Concrete is mixed in the concrete plant at the left side and upstream the existing dam and transported/poured with the cable crane passing both river sides.

Cement and aggregate are provided from the cement plant at the north of Comayagua City and the aggregate plant near the Selguapa River along the National Way No.5 respectively. Those are storage at the site and yard next to the concrete mixing plant. Distance of those transportation is approximately 40 km in both.

3) Grouting

The following groutings are designed.

- Curtain Grouting

In order to stop or decrease the leakage from the dam body, joint of dam body/baserock and baserock, curtain grouting along the full dam width is practiced. Drilling is executedfrom the existing dam crest with an inclination of 60 degree, 2 m interval and double lines. Its depth in the base rock is 30 m at the river bed. Deeper grouting is necessary at the fault at the left side of the spillway. Chemical grouting is taken place from the dam crest vertically for stopping the leakage temporally in order to

improve the liability of the curtain grouting at the left side of the dam body where leakage is obviously observed.

There is a possibility that the volume of he chemical grout may be increased as a result of further detailed investigation.

- Consolidation Grouting, Joint Grouting

Consolidation grouting is executed in order to unify the additional concrete and base rock. Joint grouting is also taken place for the purpose of connecting the existing and new concrete.

It is essential to fall the water level of the reservoir to improve the effect of grouting at the construction stage. Description of grouting are as follows.

Dam body and spillway

Pressure	1 kgf/cm^2
Combination	1:5 - 1:8

Foundation rock

Pressure	3 - 5 kgf/cm^2
Combination	1:2 - 1:4 or 1:2:2 (sand)

Grouting is previously necessary to decide the detailed items for grouting before the Dam rehabilitation works.

4) Outlet work and energy dissipator

Outlet work and valves are required to be available during widening work. So it can be divided into temporary work and permanent work. The outlet pipe will be bended to left before the existing valve, installed with crank shape along the small hill and discharged at the point having no effect on the site.

It requires installation of thrust block against the vibration judging from large discharge and fast flow velocity. It also requires protection facility against rock fall caused by excavation of surrounding area.

After the construction work, the outlet pipe is lengthened in straight and water is discharged. The valve room and the access road is constructed along the joint of old and new concretes.

The energy dissipator which reduce flowing water energy and make subcritical flow is constructed far from the dam body independently. The energy dissipator of slit dam type is designed with surrounding big stones, musking, used rail.

5) Temporary works

The most of the rehabilitation work is shared by grouting, excavation and concrete pouring. For this purpose, the following equipment are installed:

- Aggregate bins and conveyers
- Cement silos, batcher plants and bunker lines
- Cranes (H-shape type, 4.5 ton class with 1.0 m^3 bucket volume)
- Boring machines, grouting machines and grouting plants
- Compressors

Electricity necessary for construction work is obtained from a hyper-voltage line maintained by ENEE.

6) Access road

Access road is collasped and lost at the just upstream of the dam. It requires rehabilitation of collasped /lost portion (30,000m^3 of hard rock excavation) and re-making of road. In other portions, the following rehabilitations are necessary.

- Enlargement of partial road width, construction of refuge track
- Installation of side dicth as a countermeasure of rainfall drainage
- Random asphalt paving

(5) Study Item prior to Construction

- Physical Characteristics of the Present Dam Body
  Study of Physical characteristics of the present Dam Body

such as strength and condition of masonry and motar, unit weight , and elasticity coefficient by large-hole boring method, seismic prospect, etc..

- Physical Characteristics of New Dam Body
  Study of concrete strength and temperature transference in order to classify the cement, pouring method and volume.

- Consolidation of the Present and New Dam Body
  The study of the countermeasure concerning the consolidation between the present and new Dam Body must be carried out at the time of the design of the construction period.

- Investigation of the Base Rock
  The following tests must be carried out:
  Shearing force test at the horizontal-bored holes, Load test at the spillway and Stress distribution of the base rock.

- Construction Schedule
  Construction schedule must take into account the rapid raising of water level of reservoir during the rainy season due to a lack of drainage capacity.

4.6.3 Rehabilitation of Flores Irrigation System

(1) Diversion works

The existing two diversion works are made of cobble stones with low intake efficiency and it disturbs contemplated irrigation plan. It is proposed to construct a new diversion works with concrete and establish water intake system.

- Topography and geology

Distance of two diversion works for Sector I and II is 200 m in the San Jose River. The diversion works are located at the turning area from the mountaineous area to Flores plain. The river course turns to right at the 150 m downstream the point. Cross section of the surrounding area in the San Jose River is about 40 m height and 60 m at bottom width.

Geological feature at this point consists of tuffaceous parent rock. Cobble stones of about 30cm thickness and/or fine sand of approximately 2.0 to 3.0 m thickness are deposited on the tuffaceous parent rock on the right side of the river. While the left side is not deposited by any materials and only the parent rock is seen.

- Location of diversion works

The site of new diversion work is proposed at about 50m downstream the Sector II diversion works in the San Jose River as the most suitable site by means of suitable topographical/geological conditions, economical construction, execution of water supply and operation/maintenance services.

- Type of diversion works

The new diversion works is designed to close the all span of the river section with a fixed weir structure except a scouring sluice way and water intake mouth at right side on the river. After taking water, a settling basin is provided for physical water treatment and the water supply to the benefited area is controlled by two gates installed at the end of the settling basin.

- Elevation of dam crest

Concerning the elevation of the dam crest, it is proposed at EL 667.80m above sea level. This elevation is 0.6m higher than EL 667.15m which is the intake water level at the intake mouth considering necessary head loss and loss by inflow in dry season in February, 1990.

- Outline of the design

Considering topographical, geological and hydraulic condition, the following dimensions are decided (Fig.4.6-4).

a. Total width :63.0 m
b. Fixed weir :53.5 m
c. Movable weir : 9.5 m (one scouring sluice way and three intake gates)

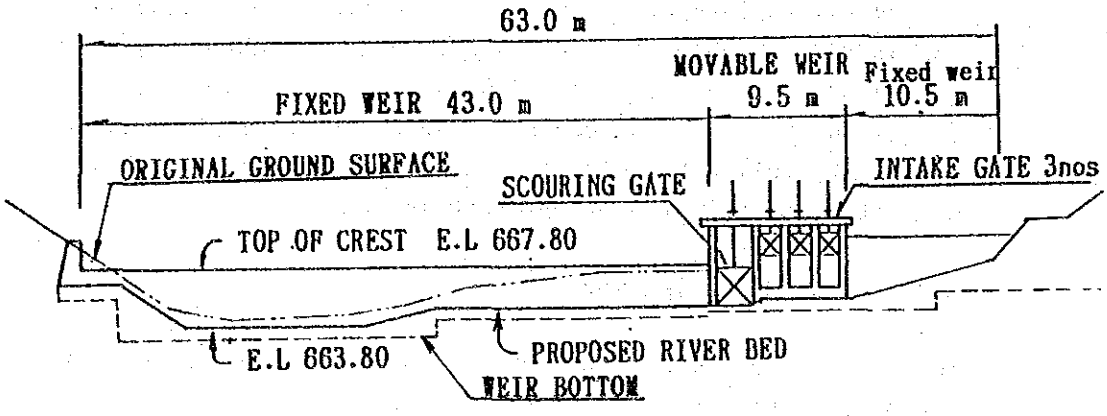


Fig.4.6-4 Schematic Cross Section of Proposed Diversion Works

a. Fixed weir

The height of the fixed weir is 4.0 - 2.7m since the dam foundation is reached to the river bed rock directly. Meanwhile this fixed weir plays a part of spillway for 48.0km^2 of downstream area. The energy dissipator at the downstream the weir and the protection work of the river bed is designed.

b. Water intake mouth

The elevation of the water intake mouth is 0.8m higher than

that of the river bed to prevent inflow of sand and stones since the flow velocity is comparably fast.

The design intake discharge is 3.5 m^3/sec and inflow velocity is set less than 0.6m/sec. This means 17% increase of the value of preliminary designed by DGRH and 75% increase of the actual intake discharge. The breakdown of the discharge is 3.0 m^3/sec for irrigation and 0.5 m^3/sec for water service (estimated water requirement of the villages after ten years).

c. Scouring sluice way

A scouring sluice way is installed to dispose deposited sand and silt near the intake mouth through it. The capacity and type of the sluice way are taken care for the size and volume of deposits in the river bed. As for this sluice way, the designing maximum size of the river bed material is about 30mm.

d. Settling basin

On account of lacking of a settling basin along the existing main canals, water conduction is disturbed by deposited sand and clay in several places. It is highly required to construct the settling basin before the main canal. It is designed to be located just after the intake mouth and flow velocity is 0.2m/sec. The depositing sand and silt are flashed out to the San Jose River by gravity system. For this purpose, the bottom of the basin is formed as similar type of the ship bottom and has a ditch on the center for deposits being flashing out easily. Such task may be operated by a gate.

e. Water supply to Sector I and II

Water distribution is regulated by two gates at the terminal of the settling basin after its treatment. Water for the Sector II is conducted immediately to the existing feeder canal. However, water for Sector I is drived through a siphon across the San Jose River and connected to the existing feeder canal.

(2) Canal System

The canal system is constituted from 40.2km of open canal, drops and siphons. Revision of open canal section is only required in case that its capacity is not enough for water conduction. The side slope of the canal is within the range of 1:1 to 1:1.5. The width, depth and space height are not revised at the drops.

The elevation of the embankment for canal is designed 0.4m higher than that of surrounding area in order to avoid inflow of drained water. A side ditch of 20cmx40cm is installed at the end of the embankment slope in mountaineous side. Drained water is flown to the side ditch and drained through a crossing chute over the canal. The existing siphons and drops are continuously used. Lining of canal is designed to keep good hydrological condition. There are several lining materialssuch as concrete, wet masonry and brick. Lining with brick is employed in this project plan judging from easy construction, economic profit, procurement of material, experience in Honduras, etc.. Brick can be procured in Comayagua, however, it is recommended to install a brick kiln along the canal in view of economic atractiveness and easy construction.

The operation and control of water is not conducted well at present because there is not any regulating gate. Therefore a check gate is designed after every division works. A stop-log is installed before a drop in order to simplify water distribution to the irrigated area at lateral canals.

(3) Maintenance road

Existing maintenance roads along canals are unpaved and not connected to the national road except three routes. Vehicles cannot pass in some routes in rainy season. New maintenance roads of 3.0m width and gravel pavement are designed along the canals of 40.2 km. This arrangement of maintenance roads simplifies operation/maintenance of irrigation facilities and transportation of agricultural products.

It requires plenty of sand and stones for improvement of the maintenance roads. The alluvial sand and stones from

surrounding hills and plains except farming area are available as those materials. Gravels are provided from an aggregate plant of the Selguapa River. Construction is executed with heavy machineries.

4.6.4 Rural Water Supply

Rural water supply is constituted from the construction of common use facilities where bathing and washing are possible. The target area of the project is six villages, i.e. Valle San Antinio, Flores, Las Mercedes, Los Mangos and Los Palillos). The objective population of 9760 inhabitants is gained from the present population by the census and inspection in 1988 plus estimated population increase untill 2000 under increase rate of 3%.

(1) Rural water supply

Water for rural supply is conducted from a near lateral canal with open canal, once stored in a reservoir and drived to villages through a pipeline. Fig.4.6-5 shows outline of the rural water supply system.

Water is provided to villagers through stopcocks for common use. Inhabitants can take water from these stopcocks in all time. Water is supplied to six schools and two clinics directly. Water demand is estimated based on 30 lit/person/day as an average of 20 - 50 ℓ/person/day which is obtained from recent data of development countries.

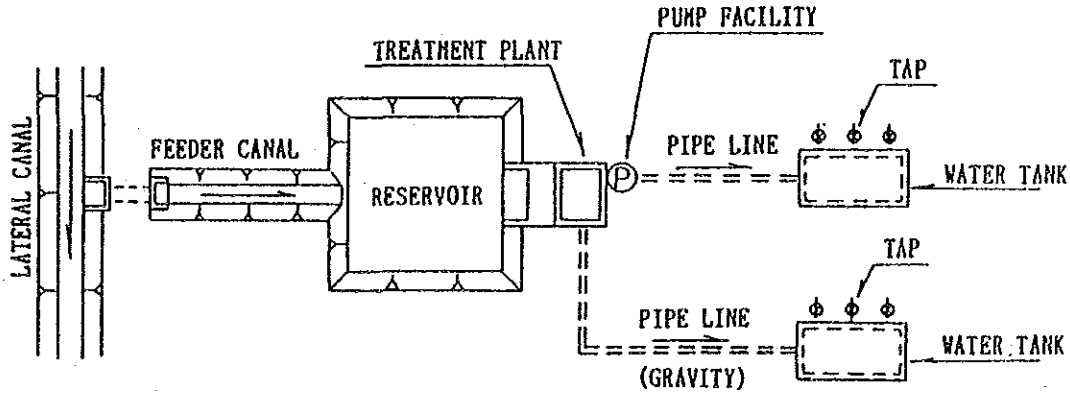


Fig.4.6-5 Rural Water Supply System

(2) Facility of water common use

Bathing and washing are observed severally at the present canal. This cause collaspe of embankment and leakage of canal. In compliance with the request of village life, a facility for common use of water is designed. Summary of the representative facility is shown in Fig.4.6-6.

Water is conducted from the lateral canal, filtered and drived to the facility. Therefore the location where necessary water head can be secured should be selected.

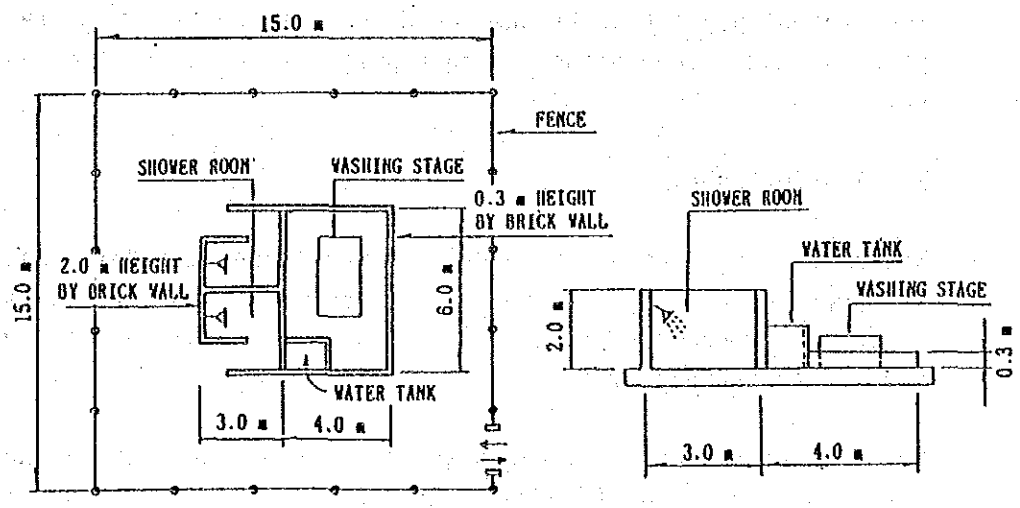


Fig.4.6-6 Schematic Plan of Facility of Water Commun Use

4.7 Estimation of Project Cost

The Project consists of Coyolar Dam Rehabilitation, Flores Irrigation System, Rural Water Supply, etc.. Major items of project cost consist of pre-engineering cost (survey, geological investigation), detailed design, implementation cost, construction cost, land acquisition and compensation, Indirect cost, administration cost, consultant service, physical contingency and price escalation are also considered besides the total project cost as a necessary expense.

4.7.1 Estimation method

The project cost is estimated based on the following conditions.

- Civil works is carried out by the contract basis. The contractor is responsible for heavy equipment necessary for civil works. Therefore the construction equipment cost is estimated as depreciation cost.

- The basic cost such as labor wage, material cost, and equipment cost are estimated on the basis of market price in February, 1990.

- The price of import construction material and the construction equipment are on the basis of CIF San Lorenzo or Puerto Cortés plus inland freight, including tax of import duty.

- The price of domestic construction material is quoted on delivery at site basis.

- The unit price is expressed in foreign currency and in local currency for each work item. The reference foreign currency value is CIF price in 1990, and reference local currency value is actual price in the same period.

- The physical contingency is 20% of civil work for the Coyolar Dam rehabilitation plan and 10% of civil work for the improvement of Flores irrigation system plan. The price escalation is subject to annual interest rate of 4.2% for foreign currency and 7.0% for local currency.

- The applicable foreign exchange rate is US$ 1.00 = Lps. 2.0 = ¥ 150, the official rate in February, 1990.

4.7.2 Total Project Cost

The total project cost can be divided into foreign currency and local currency. The cost estimation is executed in each year from the beginning of pre-engineering till completion of the project for six years.

The total project cost except price escalation is as follows;

	L.C.($x10^3$ Lps.)	F.C.($x10^3$ US$)
Coyolar dam rehabilitation (Phase I)	22,516	13,876
Flores Irrig.System Improv.	19,043	4,425

Details of the project cost and the annual disbursement schedule is shown in Table 4.7-1 and 4.7-2, respectively.

Table 4.7-1 Total Project Cost

ITEM	CONSTRUCTION COST L. C. (Lps.)	F. C. (US$)
I. COYOLAR DAM REHABILITATION (PHASE I)		
1. SURVEY AND GEOLOGICAL INVESTIGATION	500,000	
2. CONSTRUCTION COST		
2.1 PREPARATORY WORK	398,504	187,080
2.2 ACCESS ROAD	920,527	1,002,886
2.3 COYOLAR DAM		
(1) EXCAVATION	442,955	823,294
(2) GROUTING	3,137,804	2,486,658
(3) CONCRETE CHIPPING	32,665	82,979
(4) DEMOLITION OF CONCRETE	140,418	214,600
(5) CONCRETE WORK	7,742,405	1,094,418
(6) OUTLET WORKS	69,421	138,843
(7) MAINTENANCE HOUSE	32,541	156,198
(8) ENERGY DISSIPATOR	563,710	115,176
(9) DAM CREST WORK	20,229	24,563
(10) SUB-DAM SPECIAL WORK	180,806	96,377
(11) INDIRECT COST	2,673,667	4,250,834
SUB-TOTAL	16,355,652	10,673,906
3. ADMINISTRATION COST	754,069	
4. CONSULTING SERVICE	1,635,565	1,067,391
5. CONTINGENCY	3,271,130	2,134,781
Sub-Total 1. ~ 5.	22,516,417	13,876,078
II. FLORES IRRIGATION SYSTEM (PHASE II)		17,078,250
1. SURVEY AND GEOLOGICAL INVESTIGATION	275,000	
2. CIVIL WORKS	13,589,354	2,864,513
2.1 PREPARATORY WORKS	395,806	83,432
2.2 DIVERSION WORKS	1,070,523	392,711
2.3 CANAL SYSTEM	11,344,025	1,195,370
2.4 RURAL WATER SUPPLY	600,000	600,000
2.5 O & M OFFICE EXTENSION	179,000	593,000
3. LAND ACQUISITION & COMPENSATION	1,228,000	
3.1 DIVERSION WORKS	3,000	
3.2 CANAL SYSTEM	1,200,000	
3.3 RURAL WATER SUPPLY	24,000	
3.4 O & M OFFICE EXTENSION	1,000	
4. ADMINISTRATION COST	386,368	
5. CONSULTANT SERVICE	1,358,935	286,451
6. CONTINGENCY	1,358,935	286,451
Sub-Total 1. ~ 6.	18,196,593	3,437,416
GRAND TOTAL	40,713,010	17,313,494

Table 4.7-2 Annual Disbursment Schedule

(UNIT : L.C. Lempira*1,000, F.C. US$*1,000)

ITEM	1991		1992		1993		1994		1995		1996		1997		1998		TOTAL	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I. Coyolar Dam Rehabilitation (PHASE I)																		
1. Survey and Geological Investigation						500											0	500
2. Detailed Design					67	102	67	102									133	204
3. Civil Works																		
3.1 Preparatory Works									75	159					112	239	187	399
3.2 Construction Road									836	767	167	153					1,003	921
3.3 Cable Crane											1,578	789					1,578	789
3.4 Batcher Plant, etc											2,673	1,885					2,673	1,885
3.5 Coyolar Dam																		
(1) Excavation											494	266			329	177	823	443
(2) Grouting											678	856	904	1,141	904	1,141	2,487	3,138
(3) Chipping of Concrete													83	33			83	33
(4) Demolition of Concrete													215	140			215	140
(5) Concrete Works											243	1,721	486	3,441	365	2,581	1,094	7,742
(6) Outlet Works											104	52	35	17			139	69
(7) Maintenance House															156	33	156	33
(8) Dissipator Works													115	564			115	564
(9) Dam Crest Work															25	20	25	20
(10)Sub-Dam Special Work															96	181	96	181
4. Project Administration						89		133		133		133		133		133	0	754
5. Consulting Services					133	204	67	102	133	204	200	307	200	307	200	307	934	1,431
6. Physical Contingency	0	0	0	0	0	0	0	0	182	185	1,187	1,144	368	1,067	398	874	2,135	3,271
Sub-Total from 1. to 6.	0	0	0	0	200	895	133	338	1,226	1,449	7,325	7,305	2,406	6,843	2,585	5,686	13,876	22,516
II. Froles Irrigation System (PHASE II)																		
1. Survey and Geological Investigation								275									0	275
2. Detailed Design							11	50	21	101							32	151
3. Civil Works																		
3.1 Preparatory Works									28	132	56	264					83	396
3.2 Diversion Work											327	892	65	178			393	1,071
3.3 Canal works											299	2,836	598	5,672	299	2,836	1,195	11,344
3.4 Rural Infrastructure													300	300	300	300	600	600
3.5 O & M Office Extension													297	90	297	90	593	179
4. Land Acquisition & Compensation										1,228							0	1,228
5. Project Administration								77		77		77		77		77	0	386
6. Consulting Services							42	201	21	101	64	302	64	302	64	302	255	1,208
7. Physical Contingency	0	0	0	0	0	0	0	0	3	13	68	399	126	624	90	323	286	1,359
Sub-Total from 1. to 7.	0	0	0	0	0	0	53	604	73	1,652	814	4,770	1,449	7,243	1,049	3,927	3,437	18,197
Total I+II	0	0	0	0	200	895	186	941	1,299	3,101	8,139	12,076	3,855	14,086	3,634	9,613	17,313	40,713
III. PRICE ESCALATION F.C. 4.2 %, L.C. 7.0 %	0	0	0	0	17	130	24	212	232	964	1,859	4,861	1,079	7,053	1,213	5,823	4,425	19,043
GROUND TOTAL	0	0	0	0	217	1,025	211	1,153	1,532	4,065	9,997	16,937	4,935	21,140	4,847	15,436	21,739	59,756

CHAPTER 5 PROJECT IMPLEMENTATION PLAN

5.1 Project Implementation System

In the light of implementation and smooth management of the Project, organizations responsible for the design work and supervision work must be centralized.
Civil works relevant to rehabilitation of Coyolar Dam and the irrigation system in Flores District are main construction works being involved in this Project. However, the following agricultural extension works are indispensable in order to succeed the Project implementation.

- Explanation to beneficiaries relevant to project benefit.
- Technical transfer to farmers.
- Explanation of the Project.

SRN will be given the entire responsibility for the Project implementation followed by DGRH, the authorized agency for the execution of the Project. DGRH will execute construction and operation/maintenance of facilities. The irrigation/drainage section under the Director governs all works relevant to the Project implementation and shift the actual works to the site office in cooperation with hydrology/meteorology section and CEDA. The site office should have tight connection with PRORIEGO. It also proceed practical supervision in cooperation with a consultant. DGRH is also requires cooperation of relevant organization such as Comayagua Municipality. Fig.5.1-1 shows the organization of authorities in charge of implementation of the Project.

5.2 Project Implementaion Method

Generally, two type of implementation method such as direct and management by the government or contract base with contractor(s) is employed.

Rehabilitation of Coyolar Dam and improvement of irrigation system in Flores involve various works and the direct management by the government requires procurement of construction machines, upbringing of dam engineers, an increase in engineers, etc. In order to realize the earlier implementation of the Project, the Government is presumed to encounter difficulties in satisfying

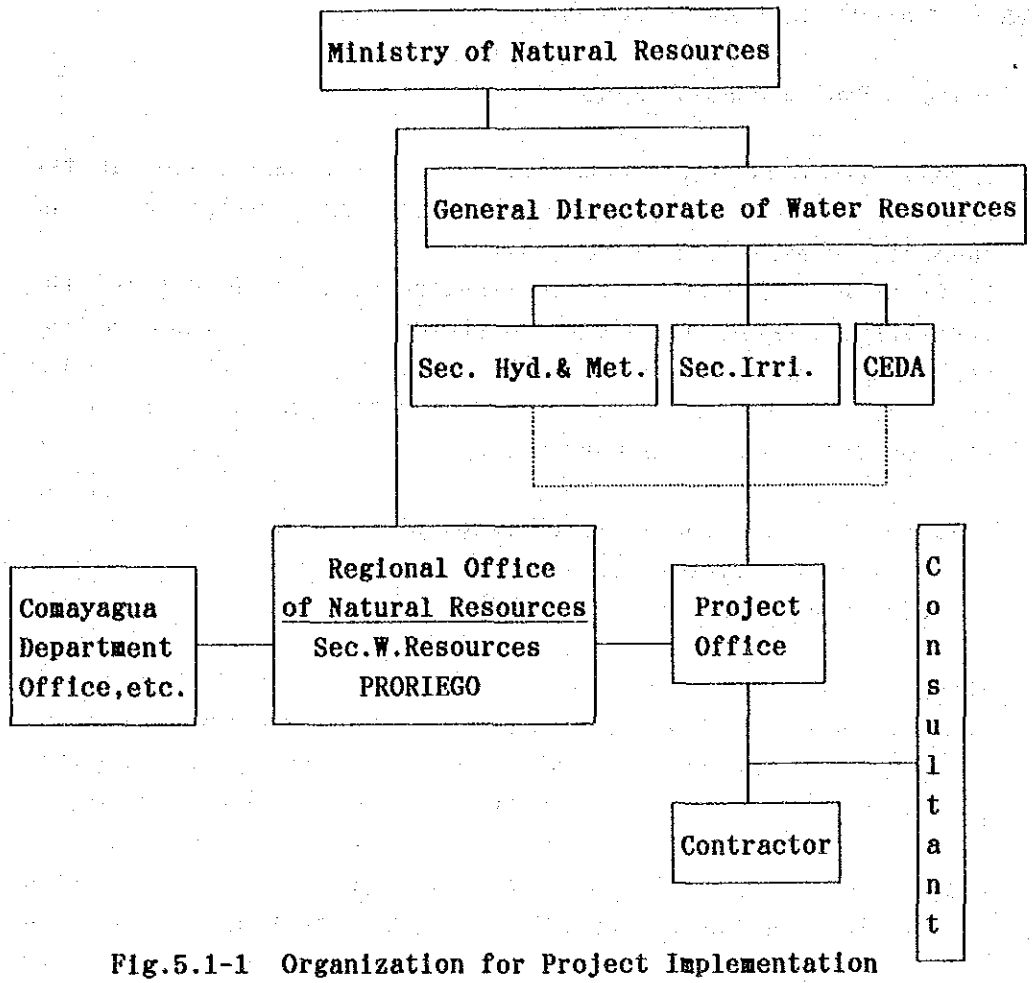


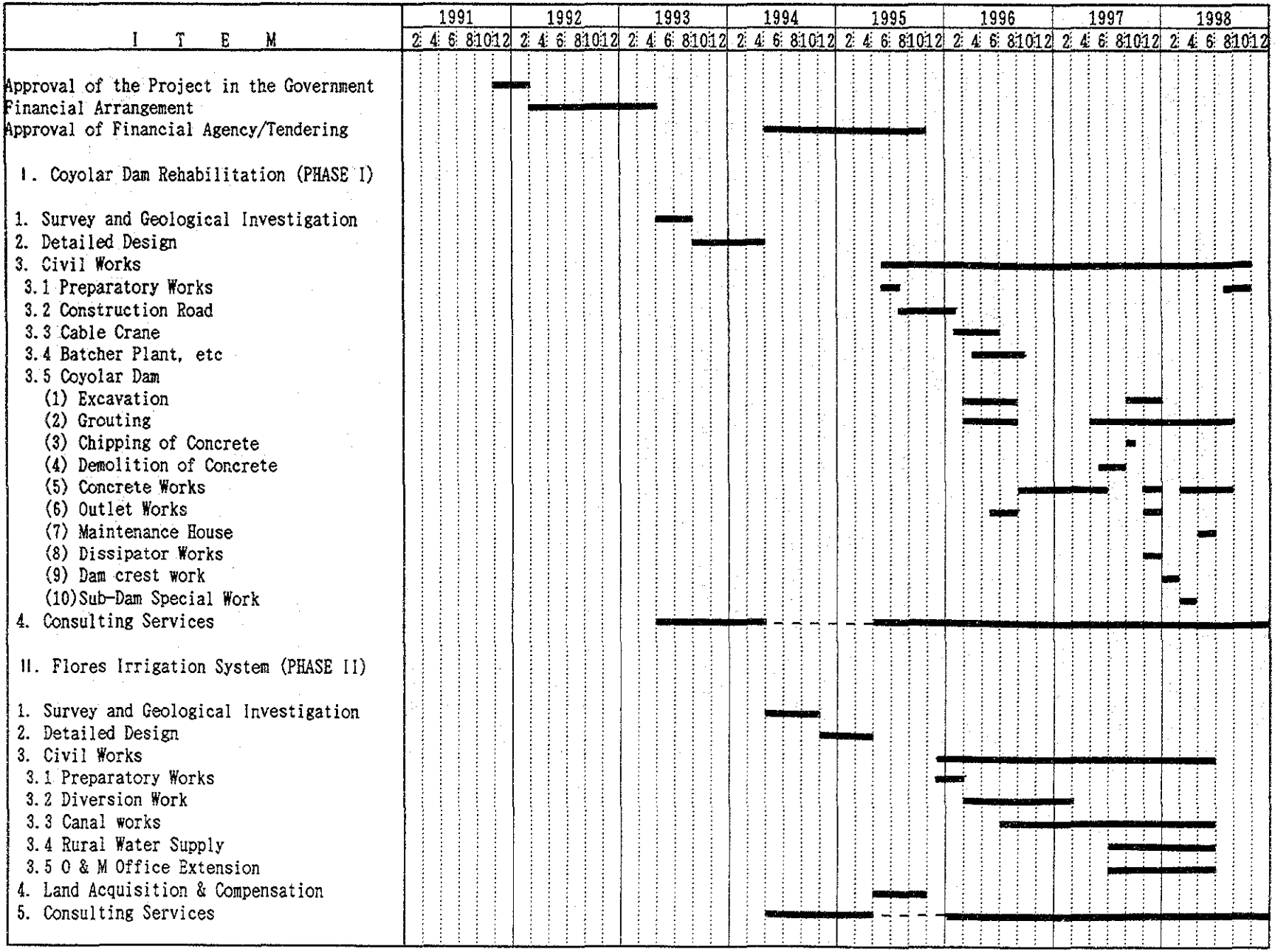
Fig.5.1-1 Organization for Project Implementation

the above requirement. Therefore, the work should be started earlier by means of the contact basis. The Government contract with a consultant for smooth implementation of the Project. The consultant stand neutral and provide technical services. Practically, candidate contractors are invited to an open tender, screened by prequalification, and listed as bidders. In the open bid, a successful tenderrer is nominated.

5.3 Project Implementation Plan

The project implementation program is roughly divided into pre-engineering, detailed design, tender, and construction work. The Project is scheduled for five year and eight months. Fig.5.3-1 shows the project implementation schedule.

Fig. 5.3-1 Project Implementation Schedule



(1) Pre-engineering

Pre-engineering is composed of topographical survey, longitudinal and cross leveling, geological investigation, etc..Pre-engineering is scheduled for four months in Phase I and for six months in Phase II.

- Topographical survey

Coyolar Dam: The survey for the dam body is mainly quoted from the topographical map made by LAVALIN-GATESA and supplemental survey is carried out. The temporary lay-down area is required to be surveyed topographically.

Diversion works: Topographical survey is carried out in the planned area for diversion works, settling basin, river bed protection and siphon.

Rural water supply: It is necessary to make a topographical map with suitable scale which identify roads and location of facilities. It enables design for water reservoir, water treatment plant and other facilities.

O/M office: Topographical survey is carried out in the model farm area.

- Longitudinal and cross leveling

Longitudinal and cross leveling is carried out in the following areas:

a. Access road from the national road to the Dam site
b. Diversion works
c. Existing main and lateral canal

Bench mark leveling is also required.

- Geological investigation

Geological investigations of several types are required for detailed design for the rehabilitation of the Dam and construction of diversion works as follows:

a. Boring
b. Physical and chemical test of aggregate, clay, concrete, etc.
c. Seismic prospection
d. Loading test in gallery
e. Grouting test

(2) Detailed design

Detailed design includes the general specification, special specification, technical specification, drawings, estimation of quantity and cost, work plan, and work program. Detail design is scheduled for eight months in Phase I and six months in Phase II.

(3) Tenderring and Construction

- Rehabilitation of Coyolar Dam

On completion of detailed design, candidate contractors are invited by publications and qualified in prequalification. Qualified candidate contractors are registered in the short list and approved as tenders. Selection of tenderrers is immediately followed by the international tender, and the contract is awarded to a successful tenderrer Prequalification and selection of tenderers are scheduled for 13 months.

The construction period according to the construction schedule approximately 41 months.

Main items of the construction work are as follows:

a. Temporary work(enlargment of the access road between the national road and the Dam site, residence for stuffs and labors, site office, motor pool, plants for electricity, water, aggregate and concrete, etc.
b. Concrete work
c. Rock excavation

Irrigation water to Flores District should be supplied during the construction period.

- Improvement of Flores irrigation system

Prequalification and selection of tenders are scheduled for 13 months and construction work is scheduled for 31 months. The construction of the diversion works is carried out in dry season under the condition of undisturbing irrigation and water supply to villages. Lining work of canals and adjustment of maintenance road is gone side by side.

- Rural water supply

Adjustment of rural water supply is scheduled within 12 months.

- Enlargment of O & M office

The construction includes the construction of an administrative office and arrengement of the model farm. It also requires construction machineries, agricultural machineries and other equipments. The construction schedule is within 12 months including order of materials and machineries to foreign countries and their arrival to the site.

CHAPTER 6 OPERATION AND MAINTENANCE PLAN

6.1 Operation and Maintenance Policy

The project composing of the rehabilitation of Coyolar Dam and improvement of Flores irrigation system aims to propel agricultural development. The operation and maintenance system which includes not only for facilities but also agricultural guidance and regulation of synthesized production should be organized. The present system of Flores irrigation office practices operation & maintenance of irrigation facilities and agricultural extension however the function is not sufficient. It is required to arrange well-planned and effective system which enable to utilize the present organization maximum and execute smooth agricultural extension and operation / maintenance. Facilities which necessitates operation and maintenance are dam, diversion works, main and lateral canal, ancillary facilities, road for maintenance, model farm, etc. Facilities for rural water supply is operated by users and the operation & maintenance cost is shouldered by them. Each operation & maintenance system is shown below:

- Coyolar Dam

  It is required to provide operation manual in order to take irrigation and service water,to control flood and outfall for operation and control of the dam. Valves of the dam should be operated and controlled based on the manual. The operation of the dam is executed according to the instruction of Flores O&M office. Installation of wireless communication apparatus is proposed. The operation staff of the dam practice not only valve operation but also guard and measurement of water level/meteorological data.

- Diversion Works and Main/Lateral Canal

  Operation of the diversion works and division works are necessary basing on the irrigation water requirement of each benefited area. The area of operation/maintenance is until the diversion works before lateral canals and lateral canal are operated by beneficiaries.

- Maintenance Road

  Maintenance road along main/lateral canal should be regulated so as to pass vehicles. Rapid repairing is taken place with heavy machineries by operation/maintenance office when road is damaged.

- Model Farm

  Agriculture machineries and irrigation facilities of the model farm requires operation/maintenance in all time.

6.2 Operation and Maintenance System

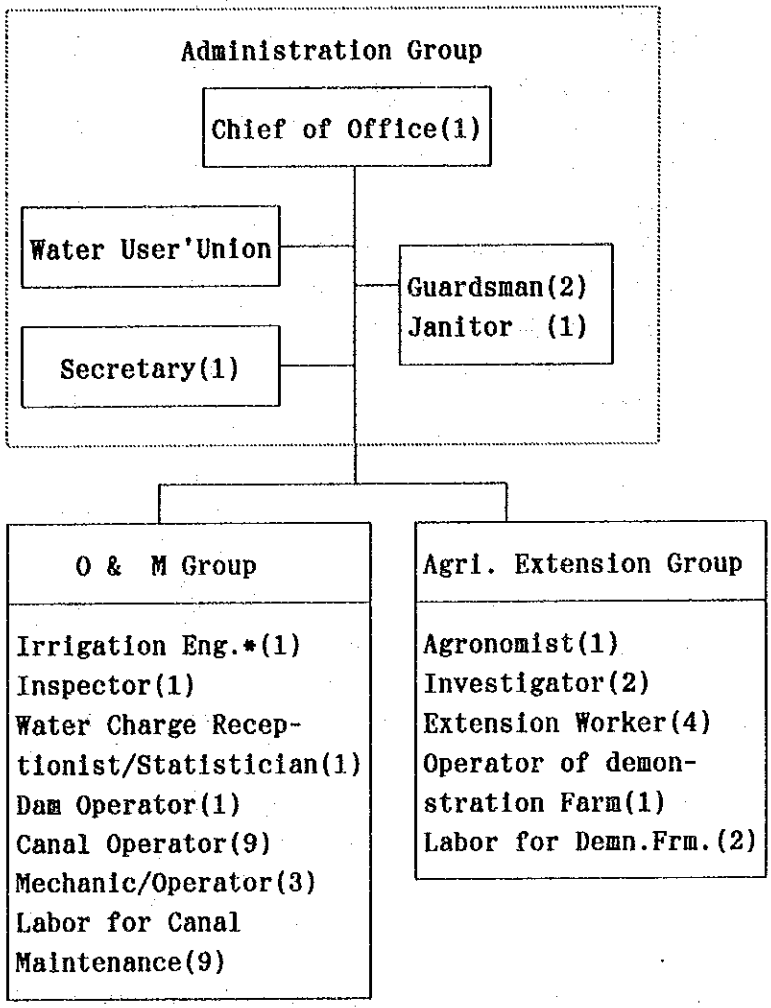
Existing Flores O & M office should be enforced since the present system function insufficiently the office is divided into three groups ,i.e. administration, agricultural extension and operation/maintenance clearly and managed by the director. Fig. 6.2-1 shows the organization of operation/maintenance and assignment of staffs.

The existing Flores O&M office with 22 staffs has difficulty for operation/maintenance work due to a shortage staffs. Therefore, 18 staffs will be added and the new office will consist of 40 staffs (Table 6.2-1). Temporary staffs will be employed in busy season. The agricultural extension staffs take short course of CEDA at the rate of five person-month/yard and gain the latest information and technology to extend them to farmers.

Main tasks of the operation/maintenance are summarized as follows.

- Operation of the dam
- Control of irrigation facilities and its ooperation / maintenance nce.
- Estimation of possible water supply and irrigation of irrigated area based on the annual planting area.
- Water control
- Operation of the model farm
- Guidance of agricultural technology
- Training and instruction to farmers

- Collection of water cost and necessary information for operation
- Treatment of information and planning of water distribution
- Control of water distribution, and
- Guidance and orientation to the farmers' association



* Chief of office holds an additional post.

Fig.6.2-1 Organization of Irrigation Office

Table 6.2-1 Proposed Increase of Administrative Personnel

	Present	Plan	Increase
Administration Group			
Chief of Office	1	1	0
Secretary	0	1	1
Guardsman	2	2	0
Janitor	1	1	0
Agricultural Extension Group			
Agronomist	0	1	1
Investigator	2	2	0
Extension Worker	3	4	1
Operator of Demonstration Farm	0	1	1
Labor for Demonstration Farm	0	2	2
Operation & Maintenance Group			
Irrigation Engineer	(1)	(1)	0
Inspector	1	1	0
Water Charge Receptionist /Statistician	1	1	0
Dam Operator	1	1	0
Canal Operator	4	9	5
Mechanic/Operator	0	3	3
Labor for Canal Maintenance	7	9	2
Total	22	40	18

* Chief of office holds an additional post.
Exclude labors of temporary contract.

6.3 Machineries and Facilities for Operation and Maintenance

Machineries necessary for operation/maintenance of facilities are listed below.

		Unit
Back hoe	0.35 m^3	1
Loader	1.2 m^3	1
Dump truck	4 ton	2
Bulldozer	6 ton	1
Motor Grader	2.2 m	1
Road roller	8 ton	1
4 WD pick up		1
Tank truck	6000 lit.	1
Communication system		1 set

Facilities and machineries necessary for agricultural extension are listed below.

Office with a hall		60 m²
Model farm with perfect irrigation system		2.1 ha
Agricultural machineries for model farm		
Tractor	40 - 50 HP	1unit
Plow	disk plow	1
Harrow	disk harrow, tooth harrow	1
Planter		1
Cultivator		1
Sprayer	boom type	1
Communication and transportation machineries		
4WD truck		1
Auto bike		3
Telephone		1

Facilities of agricultural extension and model farm is summarized in Fig. 6.3-1.

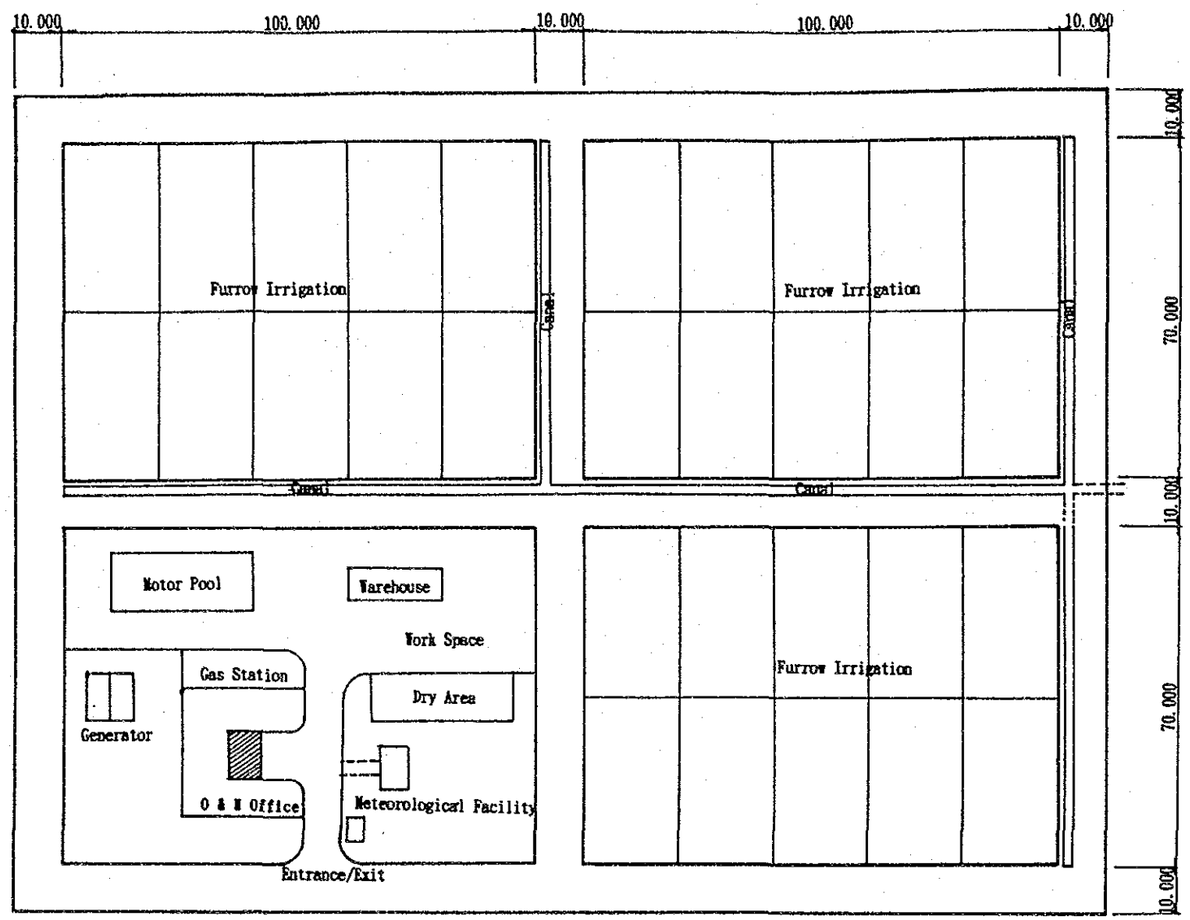
6.4 Operation and Maintenance Cost

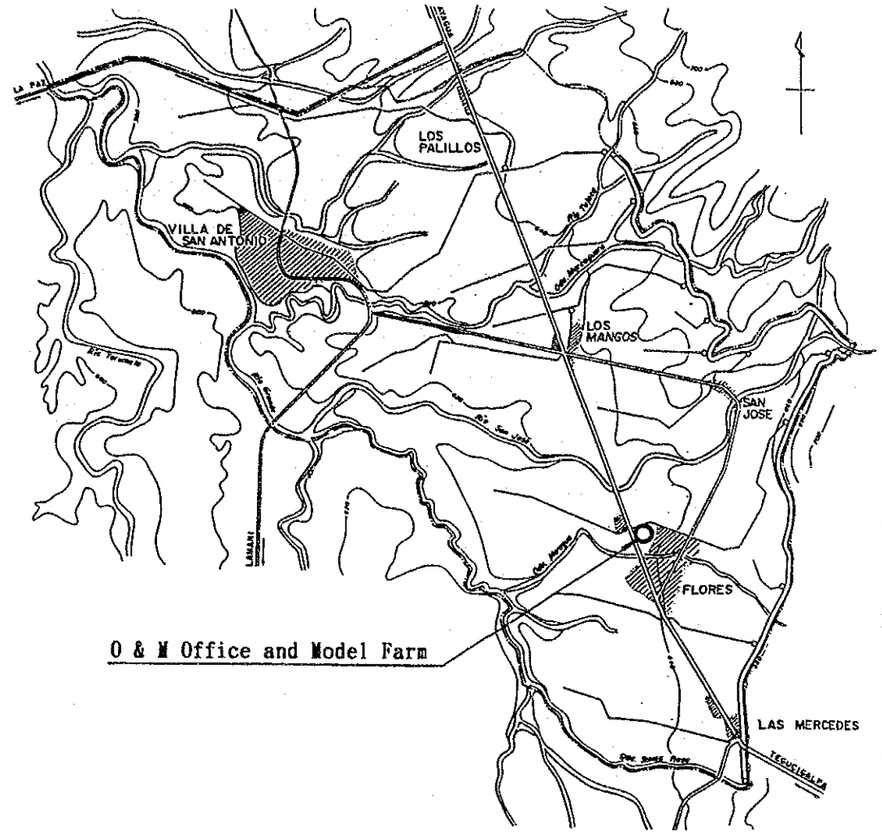
Annual operation and maintenance cost estimated as 12,000 Lps.for O & M office, 528,600 Lps. for irrigation facilities and 85,700 Lps. for agricultural extension. The cost is estimated 293 Lps. per ha. The breakdown is shown in Table 6.4-1.

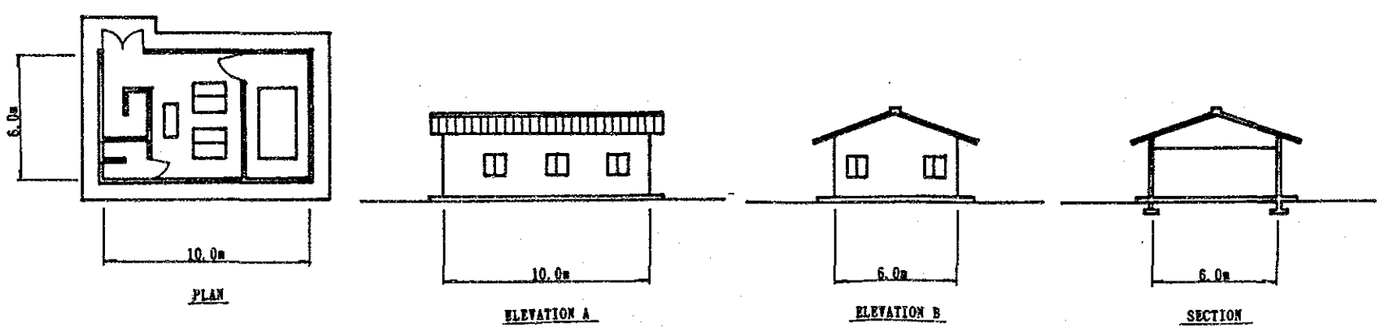
Table 6.4-1 Annual Operation and Maintenance Cost

	Administration	O & M	Agricultural Extension
Salary	12,000	171,600	71,600
Depreciation of facilities	--	109,000	14,100
Material/ machinery cost	--	248,000	0*
Total	12,000	528,600	85,700
per ha	626,300/2140 = 293 Lps/ha		

* Material cost of agricultural extension group(seed, agricultural medicine, fertilizer, etc.) is covered by the benefit of crops produced in the model farm.







O & M Office

Fig.6.3-1 General Plan of Operation & Maintenance Office

CHAPTER 7 PROJECT EVALUATION

7.1 Evaluation Criteria

7.1.1 General Concept of Evaluation

(1) Economic and Financial Evaluation

The proposed project is justified through the economic analysis including cost-benefit ratio, present net value and internal rate of return based on both financial and economic prices. These parameters are obtained from benefit estimation by comparing with and without cost -benefit projections, and project cost estimation as given in the previous chapter.

Financial analysis in the proposed evaluation is employed as a project evaluation from the standpoint of private farm economy.

Besides, a different approach is tried to justify the proposed project from the point of view of damage prevention through the estimation of potential damages from an accidental dam collapse as a tangible social analysis.

(2) Social Evaluation

As mentioned above, tangible social evaluation is based on the estimation of potential damages by delineating affected area, value of existing assets and rate of damages from the assumed collapse. This type of damage estimation is better dealt in social evaluation because the probability of accident occurrence is not so easily measurable as in the cases of meteorological disasters.

Intangible impacts are also evaluated to examine induced effects from the project implementation, by assessing various impacts on the functions of rural communities in and around the Project Area.

7.1.2 Basis of Evaluation

The evaluation is based on the following criteria and terms:

- All the values of costs and benefits for US dollar is adopted and the evaluation is based on the basis of local currency at the exchange rate of US$1=Lps.2.0 on February, 1990.

- Economic prices for tradable goods are derived from the border prices in terms of export(FOB) and import (CIF) to which inland transportation from cargo ports to the Project site is added. As to non-tradable goods calculated conversion factors are applied to the locally prevailing or farm-gate prices to obtain shadow prices for estimating economic prices.

- Residual values of the existing dam, canals and pertaining structures are estimated as nil, considering the time span of over twenty five years after construction and current dilapidated state. Initial construction costs thereof are treated as a sunk cost through parts of them are still to be used in the proposed Project.

- Farm-gate prices are estimated from the collected date through farm interview surveys and currently available statistical data on farm prices in Comayagua. Weighted mean values are applied to goods with price differences between marketing and material supply for processing.

- The Project life has been projected as fifty years, starting from the implementation of the detailed design. The Project benefit starts at the six year of the Project flow when part of the canal rehabilitation works is completed. Considering the practice of irrigation at present and reasonable enough levels of the proposed crop yields to be attainable within a few years, a rate of 25 % is applied to the projected rate of benefit increment per year to reach the target at the ninth year. On the other hand, operation and maintenance costs are evenly expended from the sixth year to the last year of the project life.

- The inflation rate of 7%, equivalent to the long term trend of domestic price change for construction materials is

applied to estimate price escalation for non-tradable, domestically supplied goods. Regarding tradable goods, inflation indexes for G-5 countries (forecast by the World Bank)is applicable to estimate the foreign portion of the construction costs, and a 4.2% is adopted. Notwithstanding the application of the above estimated deflator to the financial cost, no inflation rate is to be applied to the economic project cost because it should be evaluated at "present" values regardless of future prospect.

- The cropped area under "without project" is concerned, although irrigable area has been virtually declined from the originally designed due to dilapidation, and this trend will further continue. However, the influence of area curtailment on benefit value would not exceed 1% and hence practically negligible Estimation of without-project yields is based on the currently prevailing levels taking account of positive background trends.

- At present, Opportunity cost in Honduras is generally estimated as 12 %, and this could be universally applied to construction projects. But, this is not interpreted as a fixed rate criterion, and lower levels could be employed especially for rehabilitation projects in the light of higher "without project value" and of additional merit of avoiding risk of accidental collapse.

- Replacement costs are included in the operation and maintenance cost. Costs for land acquisition are neglected in the economic evaluation.

- Sensitivity analysis is performed to check the possible changes in financial and economic parameters of project evaluation caused by casual upsurge rate of 30 % is adopted to see whether the Project is still feasible under the doubled rate of inflation during the proposed construction period. Whereas 20 % is offered as the degree of benefit failure, equivalent to average rate of crop failure. The multiplier effect of these two disadvantages is also examined. The effect of delay in construction schedule gives much less impact on the project economy than of cost or benefit changes.

7.1.3 Method of Tangible Social Evaluation

Estimation of possible damages from the accidental collapse of the Dam has various erratic factors and estimated damaged -area coverage and extent of damage suffering vary with the state of accidental collapse. However, the most serious degree of collapse induced by a radical cleavage of the Dam body is assumed here to occur during rainy season, when the water level in it remains often high due to larger discharge.

The potential area suffering damages area swept by it and that ultimately flooded are delineated taking account of height and velocity of the wave as well as quantity of released water, micro-topography in river basin or on the alluvial fan along San Jose river.

It is estimated that a huge surge wave would hit San Jose village located at the top of alluvial fan where a large tract of irrigable land is found. Then the wave would collide with mounds in the basin, splitting into two torrential flows, one over threatening urban quarter of Flores and the other attacking lower part of Los Mangos. These would eventually reach as far as the urban center of San Antonio located in the bottom of the alluvial fan, leading to a casual inundation with muddy water. The damaged area by the surge wave is estimated at 800 ha, while the inundated area would cover 1,250 ha.

According to this estimation, public facilities and private properties distributed in these estimated areas are identified through the collected catastral/statistical data supplied from the offices concerned. Then the possible damages are estimated as the costs incurred to compensate the loss or rehabilitation to its original function.

Along with such direct damages estimation as presented above, indirect damages are also estimated from forecast traffic interruption entailed mainly along the National Highway No.5 as well as from a long-term aftermath effect of depressed productivity in crop and livestock production. Such depression is caused by erosion or deposition of land surface through the removal of mud and stones from it and reconstruction of fence/bunds or irrigation canals are estimated in the costs for direct damages. The relevant data for estimating indirect

damages are collected either from traffic survey by the road transportation office or from agricultural data by regional agricultural offices concerned.

7.2 Results of Economic and Financial Evaluation

According to the calculation of economic indices based on the conditions mentioned in 7.1.2, the following results are derived from the proposed project(Table 7.2-1).

From the analysis of EIRR and FIRR of the Project gives the values with higher levels than the rate of overall opportunity cost of 12% for investment in Honduras. B/C ratios by economic and financial prices at the discount rate of 12% ranges 1.3-1.4, while NPFV and NPEV outweighs Lps.16 million at the same discount rate as that adopted in B/C. It follows that when the proposed Project is implemented at least a contribution comparable to other public sector can be expected from it.

The results obtained from sensitivity analysis implies that FIRR and EIRR still remain the level of above 12% even though construction cost is escalated by 30% with and extra rate added on the long term trend or target benefit is under fulfilled by 20%. However, the values of NPEV and NPFV per hectare ranges only 20-26% of the construction cost per hectare, showing rather low turnover rates. Similarly, sensitivity analysis shows that both FIRR and EIRR fail to keep 12% once the Project is subject to the multiplier effect of cost hike and benefit shortfall. Of the two factors adopted in sensitivity analysis, slack growth of benefit has stronger adverse impact on economic indices than the additional price escalation in the construction costs does on it.

These observations will lead to a view that the Project could be economically justified from national and private economy point of view, though not as lucrative as privately manageable enterprises.

Table 7.2-1 Results of Economic and Financial Evaluation

Descriptions	F.I.R.R (%)	E.I.R.R (%)	B/C	N.P.F.V (Lps)	N.P.E.V (Lps)	Cost/ha (Lps)	N.P.F.V/ha (Lps)	N.P.E.V/ha (Lps)
On Financial Price Basis								
	15.00		1.00	0		48.2		
BASE CASE	12.00		1.30	21,422			10.0	
	0.00		6.80	787,204			367.9	
Sensitivity Analysis								
	9.80		1.00	0				
5 Years Delay in Benefit Accrual	12.00		0.73	-19,542			-9.1	
	0.00		6.02	680,889			318.2	
	12.27		1.00	0				
2 Years Delay in Benefit Accrual	12.00		1.03	2,216			1.0	
	0.00		6.49	744,678			348.0	
	12.38		1.00	0				
20% Decrease in Benefit	12.00		1.04	2,617			1.2	
	0.00		5.44	602,619			281.6	
	11.96		1.00	0		62.7	0.0	
30% Increase in Cost	12.00		1.00	-355			-0.2	
	0.00		5.23	746,513			348.8	
	14.99		1.00	0			0.0	
2 Years Delay in Construction	12.00		1.29	16,943			7.9	
	0.00		6.56	746,118			348.7	
	14.97		1.00	0			0.0	
5 Years Delay in Construction	12.00		1.29	11,868			5.5	
	0.00		6.18	684,489			319.9	
	9.73		1.00	0			0.0	
20% Decrease in Benefit	12.00		0.80	-19,160			-9.0	
30% Increase in Cost	0.00		4.19	561,928			262.6	
On Economic Price Basis								
		15.71	1.00		0	29.4		
BASE CASE		12.00	1.37		16,359			7.6
		0.00	7.25		509,414			238.0
Sensitivity Analysis								
		10.17	1.00		0			
5 Years Delay in Benefit Accrual		12.00	0.77		-10,106			-4.7
		0.00	6.42		441,494			206.3
		12.79	1.00		0			
2 Years Delay in Benefit Accrual		12.00	1.09		3,951			1.8
		0.00	6.92		482,246			225.3
		13.00	1.00		0			
20% Decrease in Benefit		12.00	1.09		4,211			2.0
		0.00	5.80		391,233			182.8
		12.56	1.00		0	38.2		
30% Increase in Cost		12.00	1.05		3,044			1.4
		0.00	5.58		484,967			226.6
		15.70	1.00		0			
2 Years Delay in Construction		12.00	1.37		12,955			6.1
		0.00	6.99		483,070			225.7
		15.69	1.00		0			
5 Years Delay in Construction		12.00	1.36		9,098			4.3
		0.00	6.58		443,554			207.3
		10.25	1.00		0			0.0
20% Decrease in Benefit		12.00	0.84		-9,104			-4.3
30% Increase in Cost		0.00	4.46		366,786			171.4

7.3 Results of Social Evaluation

7.3.1 Tangible Evaluation

It was found from the proposed damage estimation that the potential loss of the communities concerned (Flores, Villa de San Antonio) will reach over Lps.60 million, or a value equivalent to 104% of the rehabilitation cost (including contingencies equivalent to 20% of the lump-sum cost). It follows that the estimated construction cost of the dam more than offsets the estimated potential (human casualties not included in the estimation) loss from the possible dam accident. Estimated potential damages from assumed collapse of the Dam are shown in Table 7.3-1.

The estimated total value of potential damages consists of direct damages (71% of the total value) and indirect ones (29%), of which damages by the agro-pastoral sector comes to over 41% (total of direct and indirect ones). ABout 20% of the total loss will be derived from damages suffered by social infrastructure for public use, but the largest loss or around 25% of it will be shared by private properties(houses,etc.). Provided that per capita loss could be obtained from the allocatable potential losses divided by population concerned. It would be estimated at Lps.5.5 thousand, without considering the toll of human life. Taking account of other intangible inconveniences likely attributable to the aftermath effects preventive works of the dam will have due grounds for early implementation, apart from its feasibility deduced from economic analysis.

7.3.2 Intangible Evaluation

The largest plausible benefit will be expected in the activating impact on cropping and agro-related industries brought about by the expanded crop/livestock production, as well as that on the creation of labour opportunities through the public works for the Project.

Table 7.3-1 Estimated Potential Damages from Assumed Collapse of the Dam

(unit:thousand Lempiras)

Item of Loss	Scale of Damages	Total Estimated Damage Value		(%)
Direct Damages				
Houses/properties	2 townships etc.	28,487	22,039	24.5
Highway/roads	61 km, 3 bridges	5,535	4,584	(x)
Potable water System	6.7km, 1 line	939	480	(x)
Electricity System	20 km, 3 lines	366	293	(x)
Crop field,Pasture	1,847ha	11,550	9,116	15.2(y)
Standing/harv.crop	947ha, 2,797tons	3,578	2,694	(y)
Livestock/horses	1,773 heads,etc.	2,763	2,183	(y)
Vehicules/machinery	44 vehicules, etc	1,779	1,372	
Total Direct Cost		54,997	42,761	71.2
Indirect Damages				
Traffic interruption	2 months		6,618	(x)
Prolonged crop slack	10 years 1,344ha		8,953	14.9(y)
Prolonged livestock	5 years		1,741	(y)
Total of Indirect Damages			17,312	28.8
Total Estimated Potential Damages			60,073	100.0

Note: excluding loss of human lives, loss of social activities, VAlues are estimated as costs for recoverring original functions or utilities of lost goods at the price prevailing on Feburary, 1990. (x): losses of social facility (19.9%), (y): those of agro-pastoral sector (41.1%).

Potentially affected area: total 2,050ha of which washed-out area:
800ha inundated area:1,250ha
Potentially affected population: 5,050

As far as the manpower requirement is concerned, the Project is desired to create about 2,700 unskilled and skilled casual labour for at least three years (or 900 man-year every year) for its construction works, then farm labour equivalent to 1,390 man-year more than currently hired in farm practices. Besides, presently prevailing under-employed conditions among workers hired in agro-processing sector will be improved to fully employed state (around 400 man-year for 400 workers) and

even some extra labour demand will arise to cover the expanded activities in processing, transport and marketing. At the same time, currently over invested situation in these industries will be mitigated through steady supply of better quality materials to the extent that most of idle processing lines are put into operation for better capital efficiency.

These activating effects on the linked industries will eventually trigger export promotion with subsequent foreign currency earning, stabilized supply of farm products to the domestic markets, improved employment as well as creation of labour opportunity. Such multiplier effects can be expected in the local commercial, transport and services subsectors in line with greater farm income as the result of expanded agricultural production within the Project Area. This never fails to stimulate enterprises linked with agro-pastoral sector in urban quarters of Flores and Villa de San Antonio where underemployment problem becomes chronical, leading to an effective solution for it.

Another benefit is expected in a way that when water supply from the dam is secured by the rehabilitation, stable supply for potable and household water demand is also guaranteed, thus contributing to the improved living standard for population in and around the Project Area.

7.4 Comprehensive Evaluation

The proposed Project is considered feasible in terms of national economy, in the light of the obtained values of economic indicators. Both EIRR and FIRR give superior rates to the general discount rate for investment in Honduras, or overall opportunity cost. It can be justified from private economy point of view because NPFV discounted by the rate equivalent to that for opportunity cost. FIRR and B/C of the proposed Project show reasonable values. The justification will be further endorsed by reviewing the projected farm economy estimated in 4.4.3., where considerable farm income surplus is expected on with-project basis.

The Project Area is situated adjacent to the capital Tegucigalpa, enjoying a set of favourable location conditions for an influential supply area of horticultural products for domestic

markets, and of no-traditional agricultural commodities for export. The Project assists to form a reliable base not only meeting self-sufficiency of basic food but harnessing cash-crop oriented farming in a way that farm income gained per unit area can be maximized. In addition, it can be help labour opportunity to small-holders within agriculture as well as in related industries. Its economic feasibility will remain valid even with cost or benefit variation of considerable extent without losing competitiveness with project in other sectors.

Finally, the significance of preventing potential damages from a dam accident, as a subsidiary impact of the proposed Project can be proved from social analysis for evaluation.

CHAPTER 8 CONCLUSION AND RECOMMENDATIONS

8.1 Conclusion

Implementation of the Project is judged as valid technically as a result of economic and financial evaluation. In addition, Socio-economic impact evaluated from unquantifiable benefit is also judged as sufficiently expectable.

8.2 Recommendations

Early Implementation of the Project

Considering possible economical damages and loss of people's life by the accidental collapse of the Dam the early implementation of the Project is recommended. Implementation of the Project promotes the irrigation agriculture in the area as a result bring to the country economical and social profits.

Construction of Facilities

In the light of the scale of the Project, it is recommended to phase in the construction works; Rehabilitation of the Coyolar Dam (Phase I) and Improvement of the Flores Irrigation System (Phase II).

- Cropping adjustment by O & M office in Flores will be required during the construction period due to limited irrigation water.
- Farmers living in the area should be given priority in employment of labors for the construction works in order not to reduce their income.

Management of the Project and Operation and Maintenance

- For the purpose of efficient management of the Project, operation and maintenance of facilities is quite importance. The present O & M system is enforced and composed of relevant institutes headed by DGRH and of beneficiaries.
- DGRH is respnsible for operation and maintenance of fundamental facilities such as the Dam Diversion Weir, Main and lateral canal, however beneficiaries should be responsible for the tertiary canal.

Agricultural Extension

- For the effective agricultural extension, backup of institutions such as CEDA is required.

- Expansion of cropping rate requires finance for farmers. DGRH is requested to respond to demand of farmers for finance in close cooperation with finances.

- In order to rising up the household income, promotion, encouragement etc. to individual farmers are required in order to let them establish the cooperative.

Installment of Meteorological and Hydrological Observation System

- In order to carry out effective dam operation, observation of inflow to the reservoir and rainfall in the catchment area are necessary. Therefore, installation of observation station on the three inflow rivers of reservoir is recommended. Roughly estimated cost for construction of station excluding access road is 104,000 Lps.

Further Survey Required

- Prior to the implementation of the Project further geological and topographical surveys should be carried out. Necessary survey in details are described in Annex-E and F.