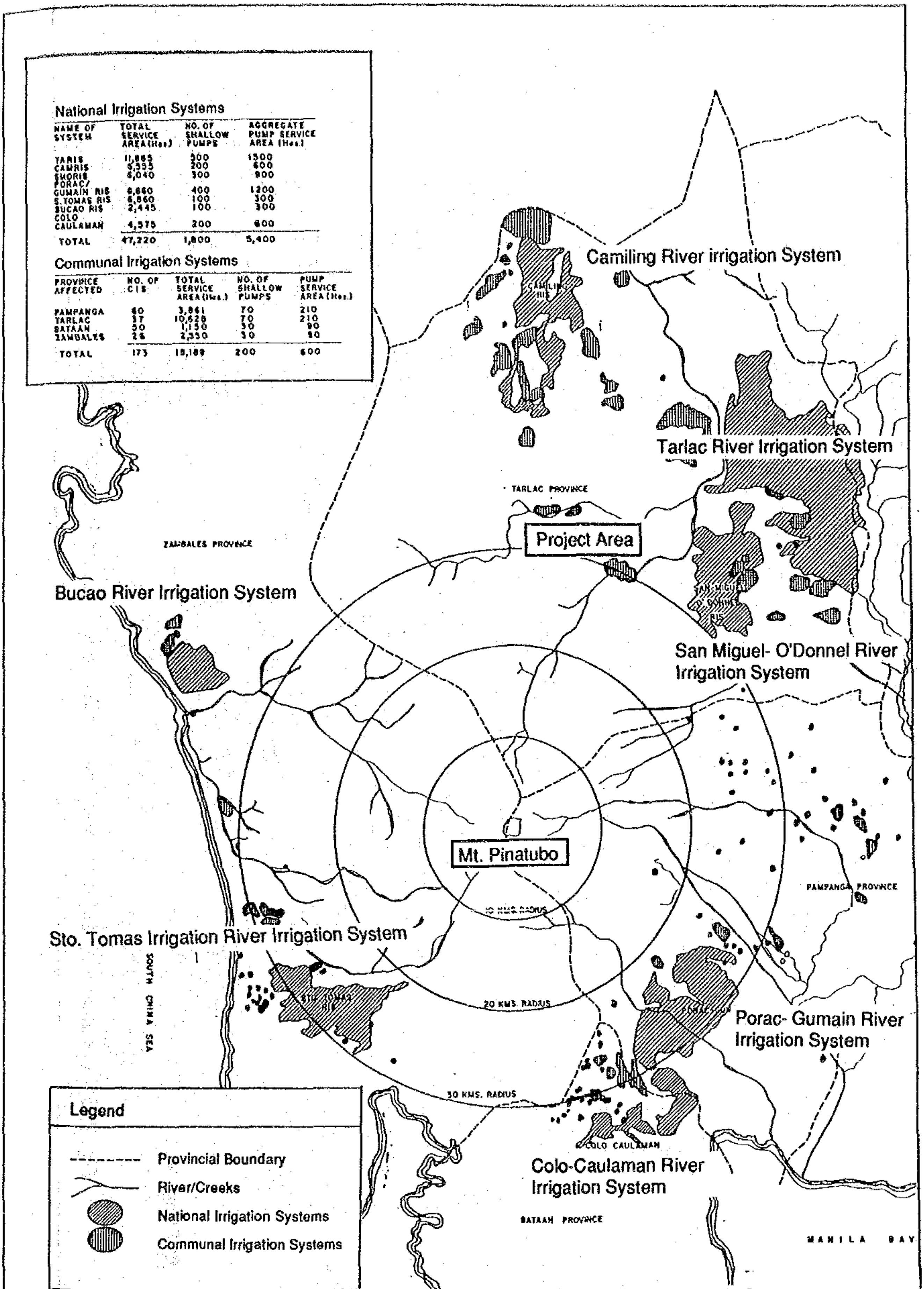


National Irrigation Systems

NAME OF SYSTEM	TOTAL SERVICE AREA (Has.)	NO. OF SHALLOW PUMPS	AGGREGATE PUMP SERVICE AREA (Has.)
YARIS	11,865	300	1500
CAMRIS	5,355	200	600
SMORIS	6,040	300	900
PORAC/ GUMAIN RIS	8,860	400	1200
S.TOMAS RIS	6,860	100	300
BUCAO RIS	2,445	100	300
COLO CAULAMAN	4,575	200	600
TOTAL	47,220	1,800	5,400

Communal Irrigation Systems

PROVINCE AFFECTED	NO. OF CIS	TOTAL SERVICE AREA (Has.)	NO. OF SHALLOW PUMPS	PUMP SERVICE AREA (Has.)
PAMPANGA	60	3,861	70	210
TARLAC	37	10,628	70	210
BATAAN	50	1,150	30	90
ZAMBALES	26	2,350	30	90
TOTAL	173	15,189	200	600

Fig. 2. 4 Location Map of National and Communal Irrigation System

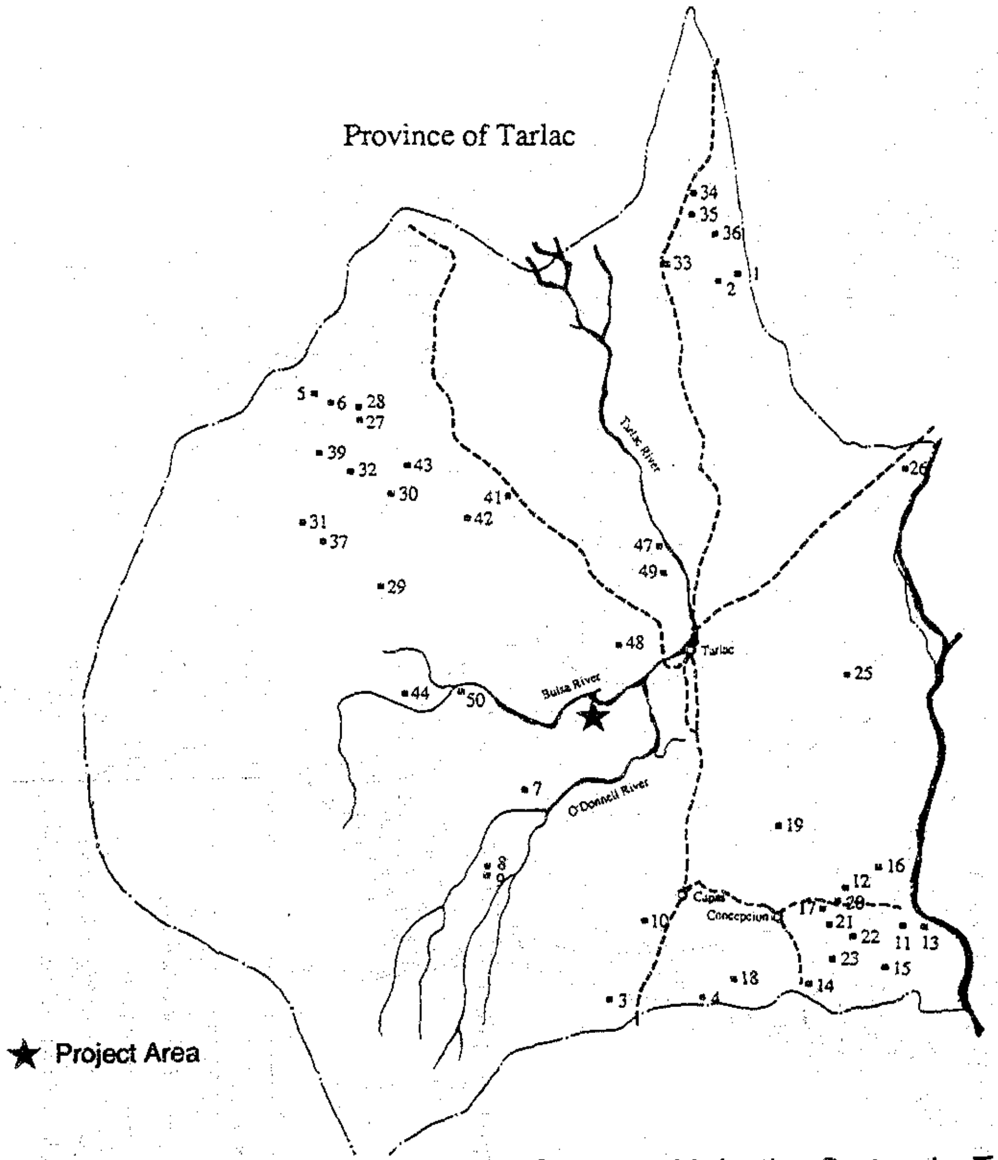


Fig. 2. 5 Location Map of Communal Irrigation System in Tarlac Province

EXISTING COMMUNAL SYSTEMS OF
TARLAC PROVINCE

TOWN / NAME of SYSTEM	POTENTIAL IRRIG. AREA (ha.)	WATER SOURCE
ANAO		
1 ANAO CIS	928	QUINABUNTOK CREEK
2.CAPATAAN CIS	312	CAPATAAN CREEK
BAMBAN		
3 BAMBAN CIS	1,045	BAMBAN RIVER
4 MALONZO CIS	320	BAMBAN RIVER
CAMILING		
5 BACSAY CIS	162	BACSAY CREEK
6.MAMALL CIS	80	BACSAY CREEK
CAPAS		
7 LAS. CIS	340	O'DONNEL RIVER
8 O'DONNEL #1	240	O'DONNEL RIVER
9 O'DONNEL #2	25	BANGOT CREEK
10.SUSUBA (CUT-CUT)	40	SUSUBA CREEK
CONCEPCION		
11 LILIBANGAN CIS	153	PAPUA RIVER
12.LUCONG CIS	2,250	LUCONG RIVER
13 MAGAO CIS	750	SALICO CREEK
14.SAN BARTOLOME	350	SAPANG BALEN CREEK
15.SAN ISIDRO CIS	600	DALANDANUM CREEK
16.STA.MONICA CIS	740	CAAGUSAN CREEK
17.STA.RITA CIS	165	QUARTEL CREEK
18.TEL ABANCA CIS	328	PAPUA RIVER
19.TINANG CIS	336	TINANG CREEK
20.STO.ROSARIO CIS	150	CAAGUSAN CREEK
21.MARITA CIS	100	PARUA RIVER
22.SAN MARTIN CIS	230	PARUA RIVER
23.BALUTO CIS	405	PARUA RIVER
GERONA		
24.PANGIBUNAN CIS	33	PANGIBUNAN CREEK
LAPAZ		
25.AMUCAO CIS	206	MASALASA CREEK
26.MASALASA CIS	146	MASALASA CREEK
MAYANTOC		
27.AMBALINGIT CIS	290	CAMILING RIVER
28.BAYBAYAOAS	110	CAMILING RIVER
29.BIGBIGA CIS	91	GURONG-GURO CREEK
30.MAMUNIT CIS	134	SAGSAGAT CREEK
31.MAPANDAN CIS	200	SAGSAGAT CREEK
32.Sn.JOSE CARABAOAN	260	TETE RIVER
MONCADA		
33.MONCADA PUMP #1	30	SAN ISIDRO RIVER
#2	10	-DO-
#3	10	-DO-
#4	40	-DO-
#5	50	-DO-
34.SAN JUAN CIS	213	BAKIT-BAKIT CREEK
35.TOLEGA NORTE CIS	140	BAKIT-BAKIT CREEK
36.TOLEGA SUR CIS	308	-DO-
SAN CLEMENTE		
37.MAASIN CIS	700	BATACAN RIVER
38.BAMBAN CIS	176	-DO-
39.DALDALAYAP CIS	168	-DO-
40.PIT-AO CIS	98	-DO-
STA.IGNACIA		
41.BALDIOS CIS	110	SAPANG TABLA
42.PUGONG DANUM CIS	400	SAPANG TABLA
43.STA.IGNACIA CIS	30	CABATUAN
TARLAC		
44.IBA-SULA CIS	250	MABULOD CREEK
45.LAONG CIS	150	BANEG CREEK
46.SAN ISIDRO CIS	40	TARLAC RIVER
47.STA.MARIA CIS	416	TARLAC RIVER
48.SAPANG MARAGUL	205	SAPANG MARAGUL
49.SINAIT DOLORES	150	TARLAC RIVER
50.LUBIGAN CIS	155	MORIONES RIVER
TOTAL	15,492	
No. of Pumps	850 Units	
Irrigable Area	2,550 Has.	

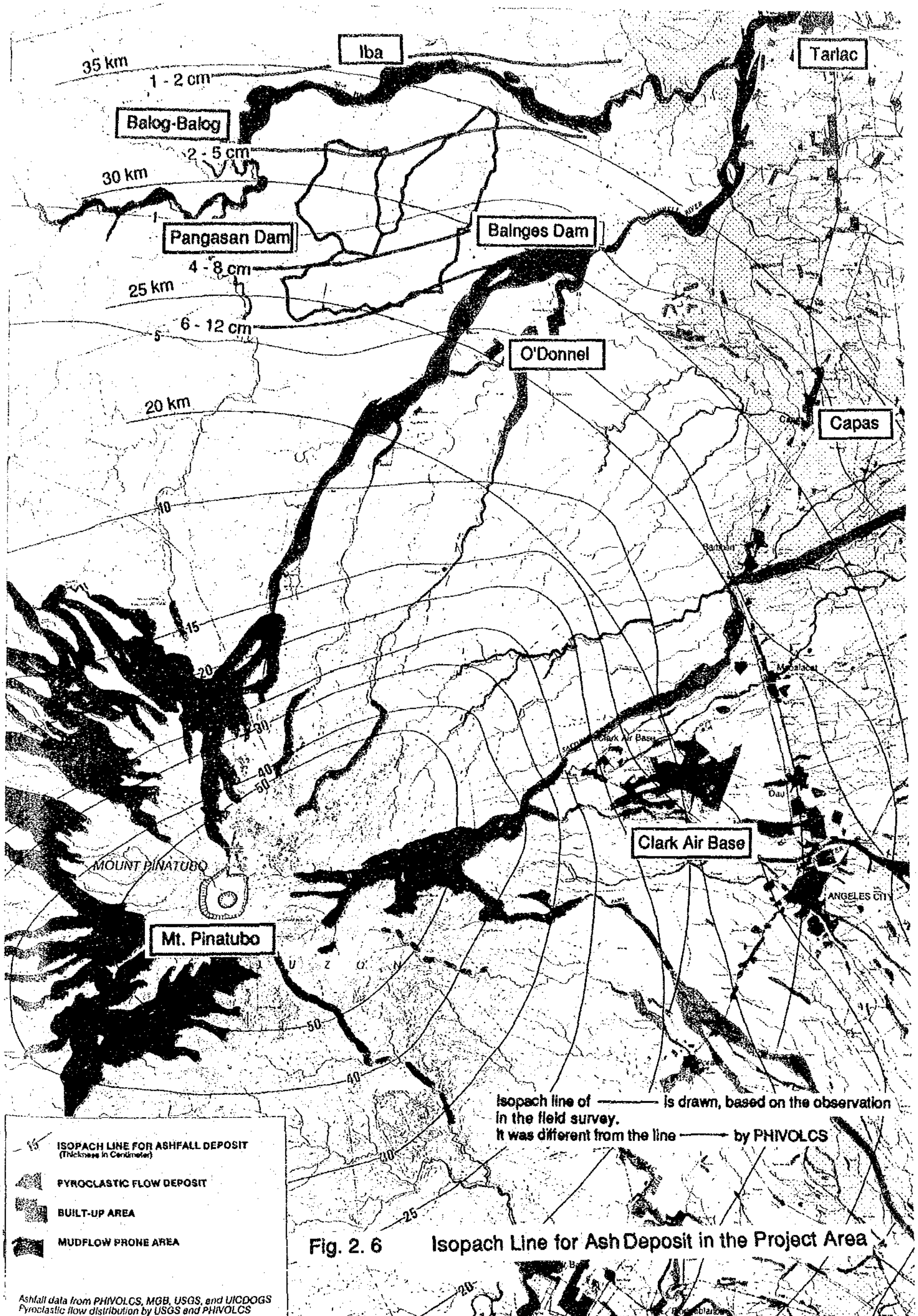


Fig. 2. 6 Isopach Line for Ash Deposit in the Project Area

Chapter 3 Outline of the Project

3.1 Objectives

The irrigation project under the Western Barrios Impounding Irrigation Project aims to realize alleviation of poverty and promotion of social equity through the improvement of agricultural infrastructures, which are also the purposes in the Medium-Term National Development Plan and the Medium-Term Central Luzon Region Development Plan. In the project area, paddy production has remained at a low level because of a lack of water sources, inadequate irrigation systems and uneven distribution of rainfall in the rainfed paddy fields before the said system was completed. Since 1981, the Government of the Philippines aggressively encouraged the implementation of the Small Water Impounding Management Project (SWIM) all over the country as an important national project. The Western Barrios Impounding Irrigation System is expected to contribute considerably to increasing agricultural productivity and uplifting the living standards of rural areas, and to eventually direct the activation of rural economy and the prosperity of rural society, as a pilot project of the said SWIM Project.

The cropping plan of the System is composed of rice cropping in the wet season and upland cropping in the dry season. Thus, the achievement of the System is realized with use of dam storage water, however, damages to the said dams and irrigation facilities caused by the ashfalls could completely obstruct the objectives of the System. Whereas, prevention of the ash deposition in the reservoirs, by taking appropriate countermeasures to ensure the intake function and maintain the dam storage capacity is substantially necessary to sustain the objectives of the System.

3.2 Study and Examination of the Request

The proposed project aims to devise proper countermeasures to maintain the dam storage capacity and to prevent malfunction of certain intake facilities caused by the inflow of the ash into the reservoirs. Proposed facilities are categorized according to construction purpose, as listed below:

Table 3.1 Proposed Facilities

Items	Balnges dam/Pangasan dam
Intake function	Installation of intake gates
	Installation of sand scouring valves
Storage capacity	Construction of structures to prevent ash from flowing into reservoirs
	Dredging of ash deposition in dam storage area

Installation of intake gates and outlet valves is inevitable to secure not only dam intake function but to control dam water levels for maintenance of the dam embankment itself. Construction of the structures to prevent ash from flowing into the reservoirs, dredging of ash deposition in the dam storage areas and vegetation in the watersheds of the reservoirs are mostly necessary to secure the dam storage capacity, which directly influence the level of agricultural productivity in the project area.

In order to formulate the project components, it is important to precisely evaluate the effectiveness induced by the construction of each component and the damages to the dam storage capacity and dam intake facilities caused by the ash deposition in the reservoirs on the supposition that no countermeasure is applied.

Ash distribution in the reservoir and its watershed is expected as shown in Table 3.2 and Fig. 3.1 to 3.4.

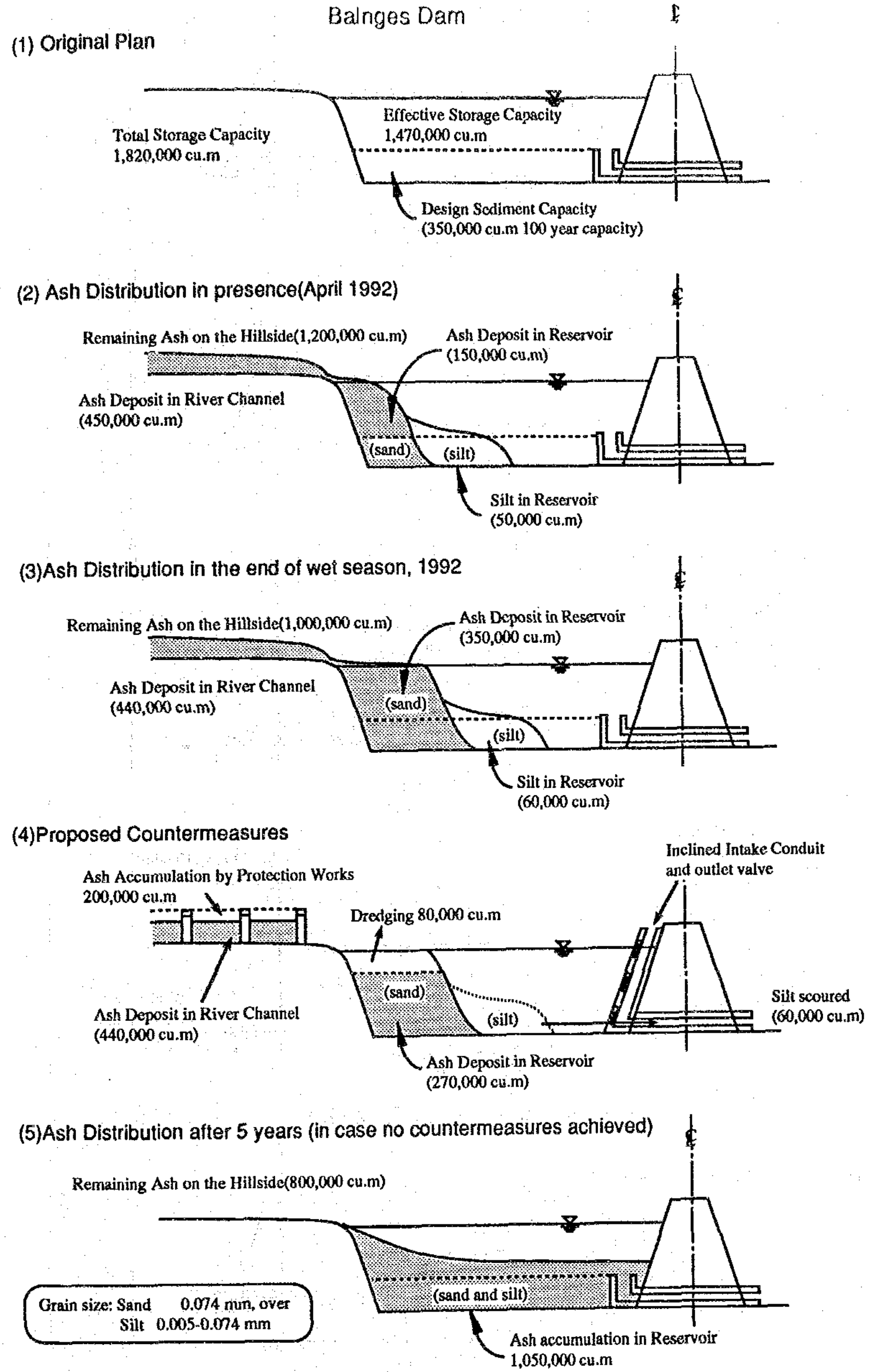


Fig. 3. 1 Ash Distribution in Balnges Reservoir / Watershed

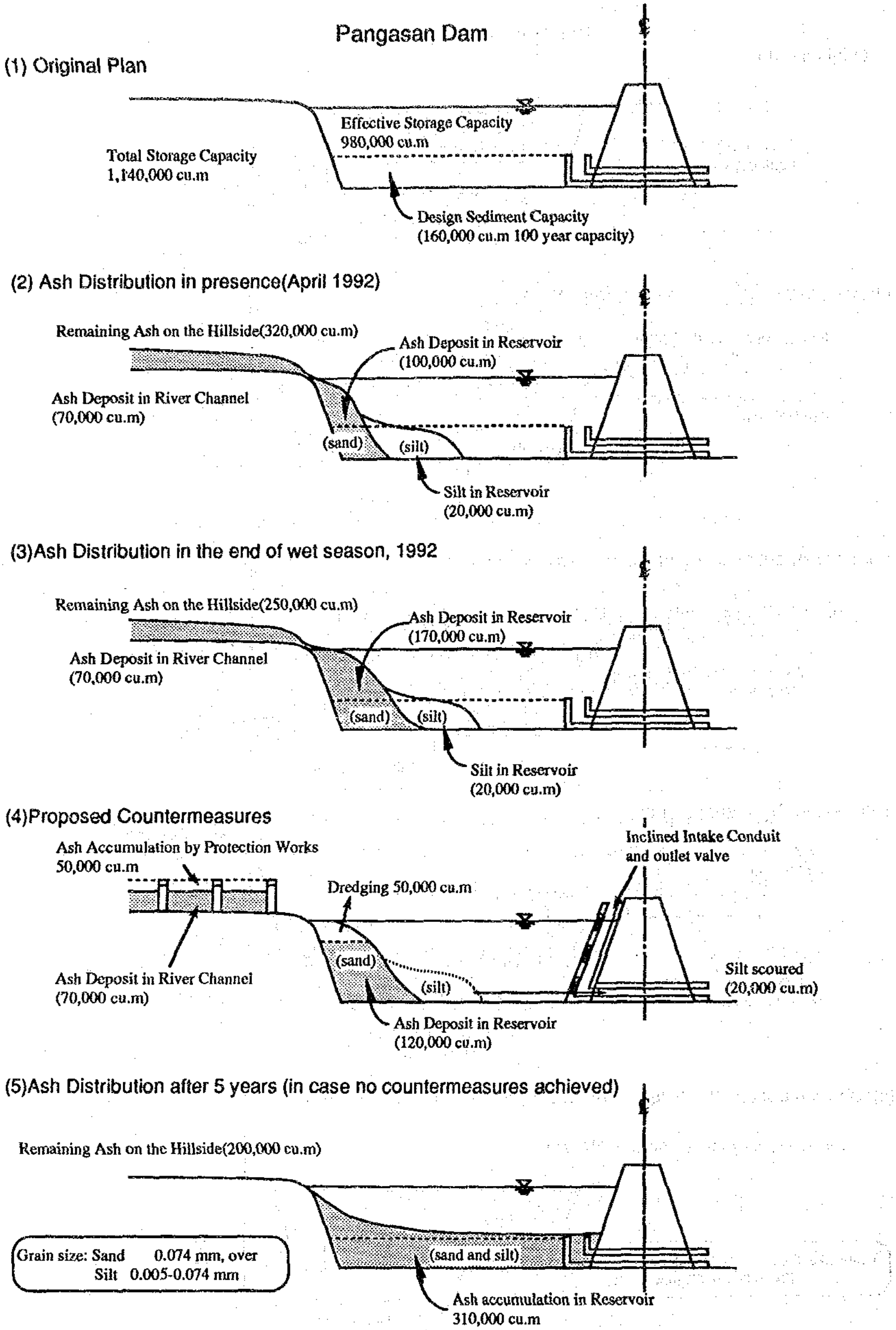


Fig. 3. 2 Ash Distribution in Pangasan Reservoir / Watershed

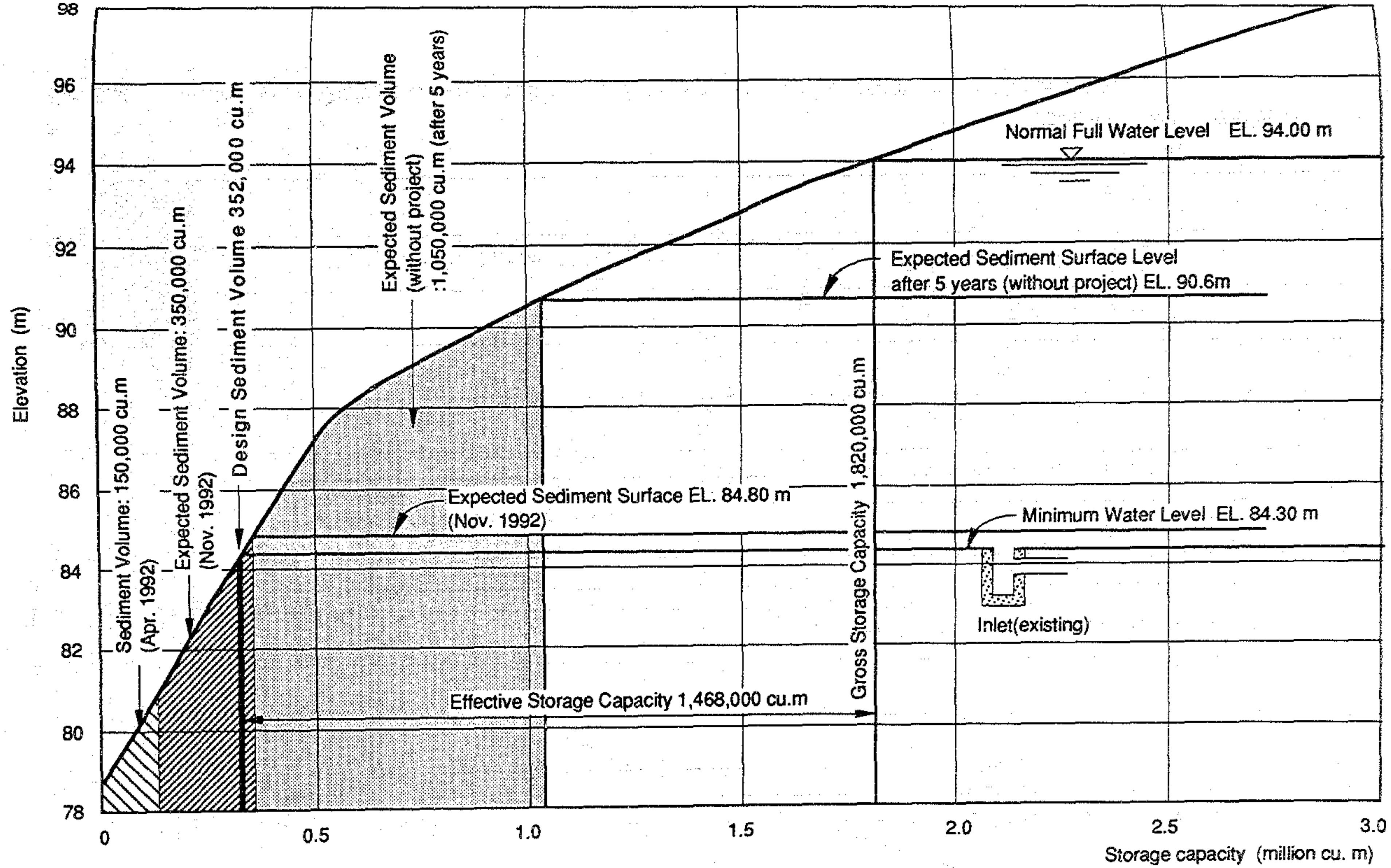


Fig. 3. 3 Water Level - Storage Curve and Expected Sediment Level on Balnges Dam (without Project)

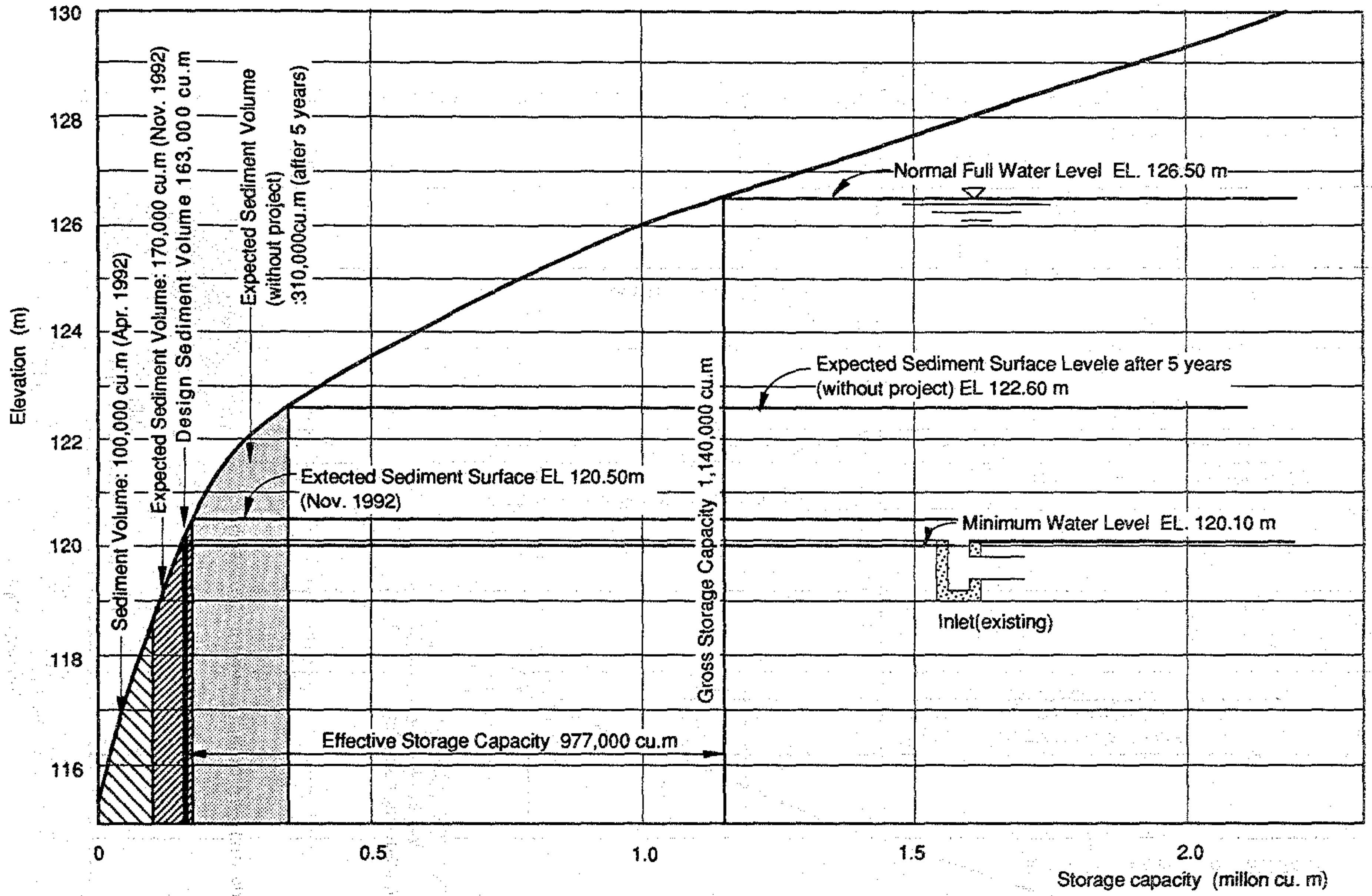


Fig. 3. 4 Water Level - Storage Curve and Expected Sediment Level on Pangasan Dam (without project)

Table 3.2 Ash Distribution in Reservoir and Watershed

(unit: '000 cu.m)

	Balnges dam	Pangasan dam
April 1992		
Ash deposit on hillside	1,200	320
Ash deposit in rivers/tributaries	450	70
Ash accumulation in reservoir (sand)	150	100
Ash accumulation in reservoir (silt, clay)	50	20
After wet season in 1992		
Ash deposit on hillside	1,000	250
Ash deposit in rivers/tributaries	440	70
Ash accumulation in reservoir (sand)	350	170
Ash accumulation in reservoir (silt, clay)	60	20
After 5 years (1997)		
Ash accumulation in reservoir (sand)	1,050	350
(reduction rate of dam capacity)	58 %	31 %

The amount of ash that flowed into the reservoirs occupied at least 60 % of total design sediment capacity in the Balnges reservoir and 80 % of that in the Pangasan reservoir in April 1992, and it is expected that the amount of ash will fully occupy the design sediment capacity by the end of the wet season in 1992. It is furthermore presumed that the amount of ash will largely exceed the design sediment volume and will occupy around 58 % of the total dam storage capacity in the Balnges reservoir and 31 % of that in the Pangasan reservoir as shown in Table 3.2 and as illustrated in Fig. 3.1, 3.2. If the aforesaid situation occurs, inflow of the ash into the reservoirs will result in a decrease in effective dam storage capacity and then inevitably cause a reduction of the irrigable areas of both dams. Reduction is estimated at around 50 % reduction for the total irrigated area of 350 ha in the Balnges reservoir for five years, and 15 % for the total irrigated area of 200 ha in the

Pangasan reservoir for three to four years. Furthermore, the said ash deposition around the dam embankment will clog the intake and cause malfunction of the intake facilities. It also involves the dam embankment stability to be in an unsafe condition due to the dam water level being uncontrollable.

As mentioned above, installation of intake gates and outlet valves are particularly necessary to ensure the intake and discharge functions of the dams.

While, vegetation is able to mitigate outflow of ash remaining on the hillside in the watersheds of the reservoirs. The vegetation works and dredging of the ash that previously flowed into the reservoirs are also recommended to secure the storage capacity of both reservoirs.

3.3 Project Description

3.3.1 Executing Agency and Operation Structure

The NIA is responsible for the execution of the construction and operation and maintenance of the Project. The NIA has established the project office in the project site, and the office has undertaken the management of the System since the dams and irrigation facilities have turned over to the NIA. The organization chart of the NIA and the project office are illustrated in Fig. 3.5. The personnel necessary in the project office are shown below:

Table 3.3 Personnel Necessary in the Project Office

Construction stage	No.	Operation and management	No.
(NIA Central Office)			
Project Manager	1		
Financial support	1		
(NIA Regional Office)		**(NIA Regional Office)**	
Technical support	1	Technical support	1
(NIA Provincial Office)		**(NIA Provincial Office)**	
Agricultural scheme	1	Agricultural scheme	1
(Project Office)		**(Project Office)**	
Chief Engineer	1	Chief Engineer	1
Dam operation	4	Dam operation	4
Assistant	4	Assistant	4

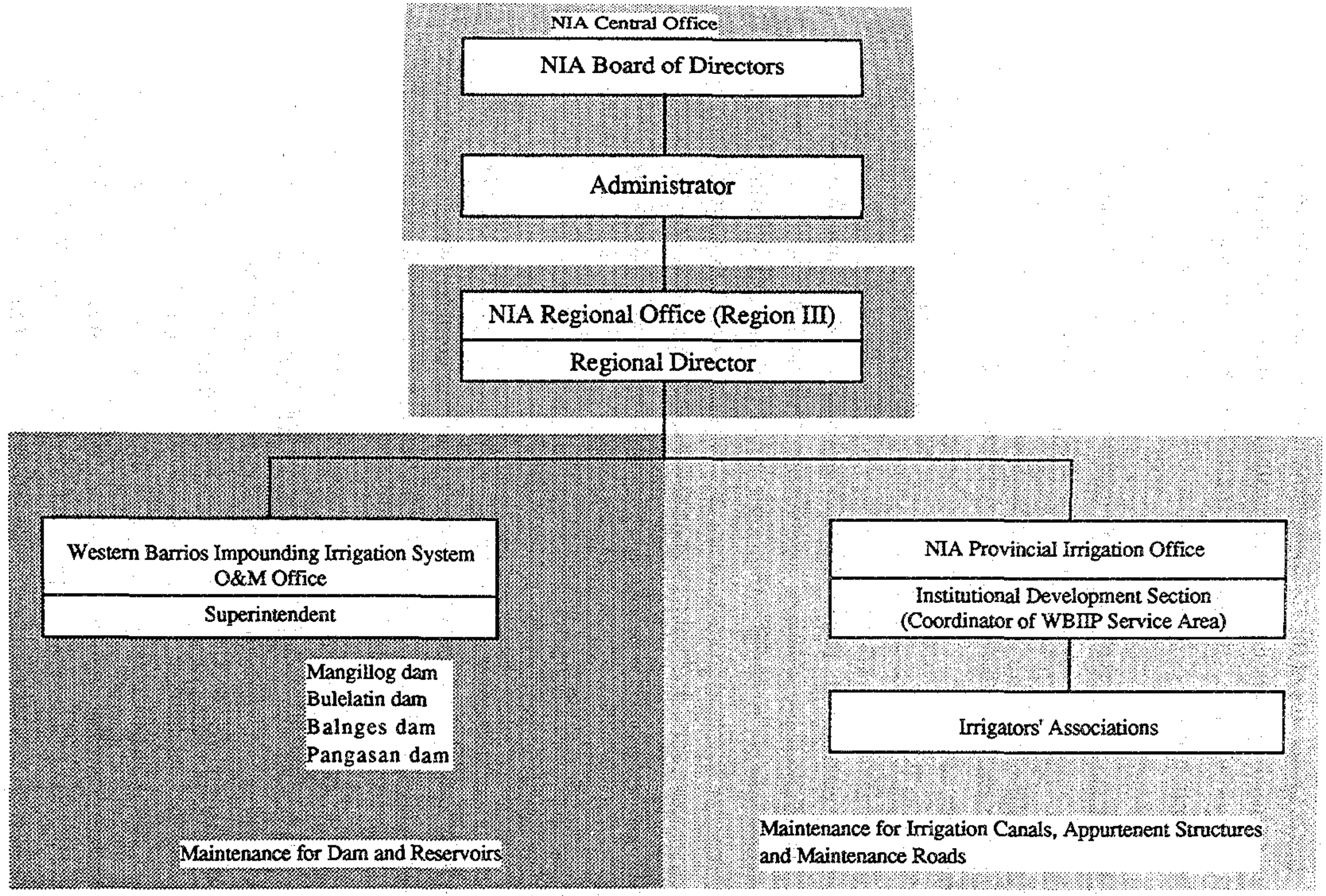


Fig. 3. 5 Operation and Maintenance Organization Chart of WBII System

3.3.2 Location and Condition of Project Site

The project sites are located at the right side bank of the Bulsa river and the dam watersheds of both reservoirs consist of mountainous area ranging from around 90 to 760 m in elevation. Features of the reservoir watersheds and beneficial areas are shown below:

Table 3.4 Features of the Dam Watershed

	Balnges dam	Pangasan dam
Watershed area (sq.km)	27.9	10.8
Range of elevation of watershed (El. m)	94 - 764	126.5 - 639
Beneficial area (ha)	350	200

The barangays related to the Project are Moriones (Balnges dam) and San Pedro citio, Iba (Pangasan dam), and have a population of 1,150 and 490 persons, respectively. Almost all of the inhabitants earn a living from agriculture. Electricity, potable water and tele-communication are not available in the project area. Income from rice production and bamboo craft for construction use is principally appropriated for daily necessities. An elementary school is constructed in each barangay.

3.3.3 Basic Plan of Projected Facilities

The volume of ashfalls and ash deposition in the dam storage areas and watersheds was estimated in different locations as follows (refer to Fig. 3.1, 3.2 (2)/(5)):

Table 3.5 Ash Distribution **(Balnges dam)** (unit: '000 cu.m)

	after wet season in 1992	after five (5) years (in 1997) (*1)
Deposit on hillside	1,000	800
Deposit in river channel	440	-
Deposit in dam storage area (sand)	350	950
Deposit in dam storage area (silt, clay)	60	100

(*1: in case no countermeasure achieved)

Table 3.6 Ash Distribution **(Pangasan dam)** (unit: '000 cu.m)

	after wet season in 1992	after five (5) years (in 1997) (*1)
Deposit on hillside	250	200
Deposit in river channel	70	-
Deposit in dam storage area (sand)	170	280
Deposit in dam storage area (silt, clay)	20	30

(*1: in case no countermeasure achieved)

As shown in the tables above and in Fig. 3.1, 3.2, the ash deposition volume of 1.05 million cu.m in the Balnges reservoir, which is equivalent to 58 % of the total storage capacity and 0.31 million cu.m in the Pangasan reservoir, which is equivalent to 31 % of that, will consequently flow into the reservoir for five years without any countermeasures taken. The said ash deposition in the reservoir will result in the decrease of effective storage capacity and in the blockade of the inlet of dam facilities which functionally results in the intake function being disordered and the dam water level being uncontrollable.

The following are concluded for design of the proposed facilities.

(1) Intake facilities

The installation of intake gates at the different elevations including one at a low water level is proposed in consideration of the ash deposition volume of 270,000 cu.m in the Balnges reservoir (see Fig. 3.1 (4)) and 120,000 cu.m in the Pangasan reservoir (see Fig. 3.2 (4))which remains in the reservoir area even after the dredging of ash deposition, and also the sediment yield produced in the watershed not being captured by the structures which prevent the ash from flowing into the reservoir. Each gate can be separately operated and has complete water tightness. The elevations of the gates are relatively determined by the depth of the dam water and sediment capacity at the gate elevations.

(2) Outlet works

The outlet valve is installed alternatively for the purpose of scouring ash accumulated in the reservoir area and thus an outlet discharge for drawdown of dam storage water because the existing outlet facilities, outlet valve and also energy dissipator are not suitable for the said purposes. Sand scouring, using adequate water is continuously operated for three (3) to four (4) months during the wet season to avoid ineffective drainage of the storage water in the reservoir. Hydraulic jump type is used as an energy dissipator to minimize the energy of discharge from the valve to avoid the ash accumulation in the energy dissipator. The velocity of the canal downstream from the energy dissipator must be settled, not allowing ash to accumulate in it.

(3) Structures works to prevent ash from flowing into reservoirs

It is expected that the additional ash volume of 640,000 cu.m. in the Bainges reservoir and 120,000 cu.m in the Pangasan reservoir will eventually flow into the reservoirs by floods. Meanwhile, the allowance of the dam sediment capacity is estimated at about 25% out of the design sediment capacity in both of the reservoirs even after the dredging of ash as stated in next paragraph (4) is carried out to secure the dam storage capacity. In this connection, the sediment capacity trapped by the structures is settled on the total volume of 640,000 cu.m. in the Bainges reservoir and 120,000 cu.m in the Pangasan reservoir. The structures shall be constructed in the river not to reduce the dam storage capacity. However, the structures in the Pangasan reservoir are to be constructed at the upstream of the dam storage area at where ash dredging work is planned, because the suitable cross-sectional site of the river is not found in the said reservoir watershed.

(4) Dredging of ash

In the end of the wet season in 1992, the total volume of ash deposited in the reservoir is approximately estimated at about 350,000 cu.m in the Bainges reservoir and 170,000 cu.m in the Pangasan reservoir. These volumes are almost equal to the design sediment capacity of the dams. It is, therefore, necessary to dredge all of the ash deposits in the reservoirs in order to secure the original sediment capacity of 100 years. However, it requires at least three years of construction period with a huge construction cost so that the dredging volume, which is equivalent to that of a one year construction period is appropriated considering its urgency. Consequently, around 80,000 cu.m and 50,000 cu.m. of ash shall be dredged in the reservoirs of the Balnges and the Pangasan, respectively. These amounts are in correspondence to the dam sediment capacity of 20 to 25 years.

(5) Vegetation

It was observed that the vegetation is very effective in mitigating outflow of ash and soil erosion through the field investigation of the watersheds of both reservoirs. In this connection, vetiver hedge plantation is recommended especially for bare lots in both of the watersheds. Vegetation should be applied in the total barren area of 200 ha, comprised of around 150 ha in the watershed of the Balnges reservoir and 50 ha in that of the Pangasan reservoir. It can reduce the erosion of at least 30 % of soil yield according to the survey result described in the report of Method of Vegetative Soil and Moisture Conservation (World Bank).

3.3.4 Plan of Operation and Maintenance

(1) Plan of operation and maintenance

The facilities of the System are being well operated and maintained by the NIA for the dam facilities and reservoirs, and by the Irrigators Associations (IAs) for irrigation canals and its maintenance roads (see Fig. 3.5). The contents of operation and maintenance works are constructively described below:

(a) Completed irrigation facilities

i) Dam facilities (Four dams)
Gate operation and water management are carried out on the basis of the description in Agreement for irrigation between the NIA and the IAs. As to dam embankment, reservoir and surrounding area, it is comprehended on the basis of the descriptions in dam structural

criteria. Dam facilities and reservoirs are directly operated and maintained by the NIA.

ii) Irrigation facilities (Four canal systems)

Operation and maintenance in terms of the stop log gate operation for water distribution and cleaning of the canals are carried out by the IAs in conformity with the said Agreement for irrigation between the NIA and the IAs.

iii) Maintenance roads

The repairing of maintenance roads for irrigation canals and dam facilities is the responsibility of the IAs as agreed between the NIA and the IAs.

(b) Proposed facilities of the Project

i) Intake and outlet facilities of dam (proposed 2 dams)

Gate operation and water management are carried out on the basis of the description in Agreement for irrigation between the NIA and the IAs. Gate operation of intake and outlet for irrigation water use, sand scouring and water level control of the dam are responsible for the NIA. Maintenance works undertaken for these facilities are re-painting of steel structure, inspection and repair of gate hoists, and so on. The NIA is responsible for the operation and maintenance for them.

ii) Structures to prevent ash from flowing into reservoirs

Repair works of the structures, such as re-welding of gabion caused by flood or scour of river bed are required. The NIA is responsible for the said works.

iii) Dredging of ash(Disposal sites of both of reservoirs)

Periodical observation against the collapse or flow-out of ash is required. The NIA is responsible for the maintenance works of the ash disposal sites of both reservoirs.

iv) Vegetation

Periodical observation and monitoring of the growth of grass and effects by vegetation are necessary. The NIA is responsible for the works.

(2) Annual operation and maintenance cost

The annual expenses for operation and maintenance of proposed facilities including the completed irrigation system are estimated at around 611,000 pesos in total, as calculated below. These expenses will be accommodated by the irrigation fee collected from the members of the Irrigators' Associations (IAs). The irrigation fee of two (2) cavans (one cavan = 50 kg) per one (1) ha has already been agreed upon between the NIA and the IAs. Total irrigation fee is estimated at 618,000 pesos (1,030 ha x 100 kg x 6 pesos = 618,000 pesos). The annual irrigation fee of 350 pesos per a household is less than 5 % of the average farm income of 16,900 pesos expected after the project completion. Its payment will not present problem.

1) Reservoir, intake and outlet facilities

One (1) chief engineer and four (4) operators and four (4) assistant operators in dams have already been employed for operation and maintenance of the dam facilities and reservoirs. The personnel expense is calculated below:

Personnel expense

Chief engineer	₱6,000/mon.x12mon.=	72,000 pesos
Operator	₱4,000/mon.x12mon.x4hd=	192,000 pesos
Assistant operator	₱2,000/mon.x12mon.x4hd=	96,000 pesos
Total		360,000 pesos

2) Irrigation facilities

Maintenance works should be carried out along the canal twice a year. The required amount of labor for the works has been estimated at: 23.83 km x 2 times/year / 0.5 km/man•day = 96 man • day

The replacement costs of concrete lining and slide gates at turnouts have been considered in the expenses. The annual costs have been estimated at 5 % of the construction costs concerning these works based on the assumption of a durable period of 20 years.

Personnel expense	₱118 /day x 96 man•day =	11,300 pesos
Replacement	₱1,303,000 x 0.05 =	65,150 pesos
Overhead expenses	(10 % of the above)	7,650 pesos
Total		84,100 pesos

3) Maintenance roads

Based on the Equivalent Maintenance Kilometer (E.M.K) of ₱17,100 / year / km in the Philippines, the maintenance expenses of the maintenance road have been estimated with adjustment factors of 0.55 (gravel pavement) and 0.5 (one-lane road)

Personnel/materials expenses	23.83 km x 17,100 x 0.55 x 0.50 =	112,100 pesos
Overhead expenses	(10 % of the above)	11,210 pesos
Total		123,310 pesos

4) Intake and outlet facilities of the dam

The re-painting cost for intake facilities are considered once a year. Re-painting of the outlet valves is negligibly small.

Personnel/materials expenses	100 sq.m x ₱400 / sq.m=	40,000 pesos
Overhead expenses	(10 % of the above)	4,000 pesos
Total		44,000 pesos

(3) Technical assistance for O&M of the projected facilities

Intake and outlet gates shall be certainly operated to achieve appropriate scouring of ash deposited on the bottom of the reservoirs. In this connection, periodical maintenance works for gate operation of both of the intake and outlet gates and valves are necessary to ensure their hoist, hoist-down capability. The NIA has enough operation and maintenance viability. O&M manual shall be prepared for the aforementioned works. Technical guidances regarding gates and valves operation and their maintenance works can be held by the consultant during the construction period.

Chapter 4 Basic Design

4.1 Design Policy

The proposed facilities and construction works are composed of the intake facilities comprised of the inclined type intake conduit, and outlet works comprised of the sand scouring valve installation and its energy dissipators construction, the structures to prevent ash from flowing into the reservoirs, dredging of ash and preparation of its disposal sites, and vegetation works.

As for the basic design for the intake and outlet works, its dimensions and appearance, such as the diameter of gates, valves and conduit pipes shall be determined to satisfy the intake and discharge capacities corresponding to the design capacities of the existing facilities. Regarding structural design of these facilities, emplacement of the facilities related to the locations of the existing dam intake and outlet facilities, and also its simplicity for operation and maintenance shall be considered. Construction materials of the said facilities, such as concrete, reinforcing bar and structural steel, are procurable in the Philippines.

As for the planning of the structures to prevent the ash from flowing into the reservoirs, the height and sectional appearance of the structures shall be decided upon to prevent the scouring of the river bed by floods. Cobble stone, which is easily gathered near the project site is aggressively used for the facilities from the economical point of view, and a simple structure is also recommended for its workability in consideration to the worse condition and the difficulty of access to the construction sites, which are located around four to six kilo meters upstream of the reservoir areas .

In planning the dredging of ash, it is particularly important to select the disposal sites of dredged ash in close distance from the dredging sites from the economical point of view. Meanwhile, a flat area is recommended in order to prevent secondary damages induced by outflow of ash from the disposal sites to the paddy fields adjacent to the disposal sites.

The construction period is limited to the dry season, from November to June. In particular, the intake facilities construction, which may commence after the dam water level reaches in the lowest elevation, is severely restricted to a short period of three (3) months from April to June due to the effective use of the dam storage water for irrigation in consideration to the farming activities as a high priority.

The following are the design policies of each proposed facility.

1) Intake facilities

Intake gates are additionally installed at the different elevations to secure intake function against the ash sedimentation on the bottom of the reservoir, especially around the intake facilities. The ash sedimentation is produced from the rest area not being covered by the structures to prevent ash from flowing into the reservoirs.

2) Outlet works

Additional discharge valves are installed. Discharge valves possess sand, ash scouring, and drainage capabilities for reservoir drawdown. It has the capacity for sand scouring only subjects of fine grain materials, such as soil, silt, clay, and so on.

3) Structures to prevent ash from flowing into the reservoirs

Construction of the gabion works are recommended for the purposes of trapping the ash deposited in the main rivers, its tributaries and hillsides in the watersheds. The locations, height and sectional appearances of the structures shall be decided upon to prevent the scouring of the river bed by floods.

4) Dredging of ash

The construction plan is made in consideration to the fluctuation of water stage of each reservoir and temporary road planning so as to complete the works in the limited period of around five (5) months. A drainage canal and culvert are necessary to prevent the outflow of ash from the ash disposal sites by rainfall, etc.

5) Vegetation

Slope, soil conditions of the proposed planting areas and the method of planting in terms of its interval of slips are studied to ensure the effectiveness of the vegetation works against ash and soil erosion.

4.2 Basic Design

4.2.1 Study and Examination of Design Conditions

(1) Intake facilities

The dimensions of the intake gates are determined on the basis of the maximum design discharge regulated in the irrigation plan. Water depth of the storage water and the interval of each proposed intake gate, as well as the storage capacity of sediments in each elevation, of which the intake gate is installed, are generally referred to in deciding the numbers and the elevations of the intake gates, as well as its diameter. The following are the maximum discharges regulated in the irrigation plan and diameters of existing outlet valves for irrigation.

Table 4.1 Maximum Discharge of Dam Intake facilities

Dam name	Max. Discharge	Outlet valve diameter
Bainges dam	0.7 cu.m/sec	600 mm
Pangasan dam	0.4 cu.m/sec	500 mm

(2) Outlet facilities

Additional outlet valves which aim to scour ash accumulated on the bottom of the reservoirs are installed for the reason that the existing valves for irrigation use are structurally not suitable for the aforementioned sand scouring. Sub-valves are also applied for the maintenance of the main valves.

(3) Structures to prevent ash from flowing into the reservoirs

As given in Paragraph 3.3.3, (3), the total storage capacity of the ash trapped by the structures is as follows:

Table 4.2 Storage Capacity of Structures

Bainges dam	640,000 cu.m
Pangasan dam	120,000 cu.m
Total	760,000 cu.m

(4) Dredging of ash deposited in the reservoir

As given in Paragraph 3.3.3, (4), the required volume of ash dredging is as follows:

Table 4.3 Volume of Ash Dredging

Balnges dam	80,000 cu.m
Pangasan dam	50,000 cu.m
Total	130,000 cu.m

(5) Vegetation

The proposed area for vegetation is as follows:

Table 4.4 Vegetation Area

Balnges dam	150 ha
Pangasan dam	50 ha
Total	200 ha

4.2.2 Plan for Intake Facilities

(1) Selection of type and location

a) Type of intake facilities

In general, inclined conduit type or intake tower type is selected. Inclined type intake conduit is recommended for both dam intake facilities. The following are the reasons to adopt inclined type intake conduit.

Table 4.5 Advantages and Disadvantages of Each Intake facility

	Intake tower type	Inclined conduit type
Foundation	A firm rock foundation is required for intake tower type. However, firm rock foundation exists about five (5) meters below from the existing ground surface at its proposed sites, so that the increase of the construction for its base is inevitable.	Inclined type requires a less firm foundation and also a low construction cost in comparison with that of the tower type.
Structure and cost	Intake tower type is in high repair costs for its appurtenant structures, such as operation bridge. Construction cost is generally higher and O&M is more difficult than inclined conduit type.	A topographic gradient of 1:3.0 of proposed site is suitable for inclined intake conduit in both dams.
Others	Regarding Pangasan dam, proposed site is too close to the approach channel leading to the spillway crest that intake tower is not adopted because of high suffering of damages by floating foreign materials and driftwood, as well.	Inclined intake conduit of Pangasan dam must be constructed on the dam embankment, however, the stability of dam embankment is not affected by its construction, because the foundation of the intake is on the original dam foundation.

Sluice gate with manual spindle operation is adopted considering its simple structure for operation and low maintenance cost. The sluice gate operation has many achievements on the adoption as a dam intake system in its intake capacity ranging from 0.5 to 2.0 cu.m/sec.

b) Location of intake facilities

The intake facilities of both dams shall be constructed adjacent to the existing inlets for the reason that the length of the water conduit pipe should be shortened to minimize the quantity of the ash accumulation inside.

As for the Bainges dam site, the right abutment of the dam embankment, where existing inlet is located, is recommended to construct intake facilities. Firm foundation exists one (1) to two (2) meters below the ground surface. While in the Pangasan dam site, the dam embankment adjacent to the existing inlet is selected for intake construction. In this case, the countermeasures to release displacement of the spindle alignment due to the settlement of dam embankment shall be considered.

(2) Water transmission

Inclined conduit (steel pipe. ø 600 mm) is connected to the existing bottom conduit (steel pipe. ø 1,000 mm).

(3) Number of intake gates

a) Water depth for irrigation use

Table 4.6 Features of Dam Storage Water Elevation

Dam name	Normal water surface	Low water level	Water depth
Balnges dam	NWL. 94.00 m	LWL. 84.30 m	9.70 m
Pangasan dam	NWL. 126.50 m	LWL. 120.10 m	6.40 m

b) Alignment of intake gates

Three (3) meters of the gate interval is applied. The diameters of intake gates are estimated as listed below. Relations between gate elevations and the sediment capacities are illustrated in Fig. 4.1,4.2.

Table 4.7 Intake Gate Alignment

Dam name	No. of gate	Diameter of gate
Balnges dam	3	No. 1 gate; ø 600 mm
		No. 2 gate; ø 400 mm
		No. 3 gate; ø 400 mm
Pangasan dam	2	No. 1 gate; ø 600 mm
		No. 2 gate; ø 400 mm

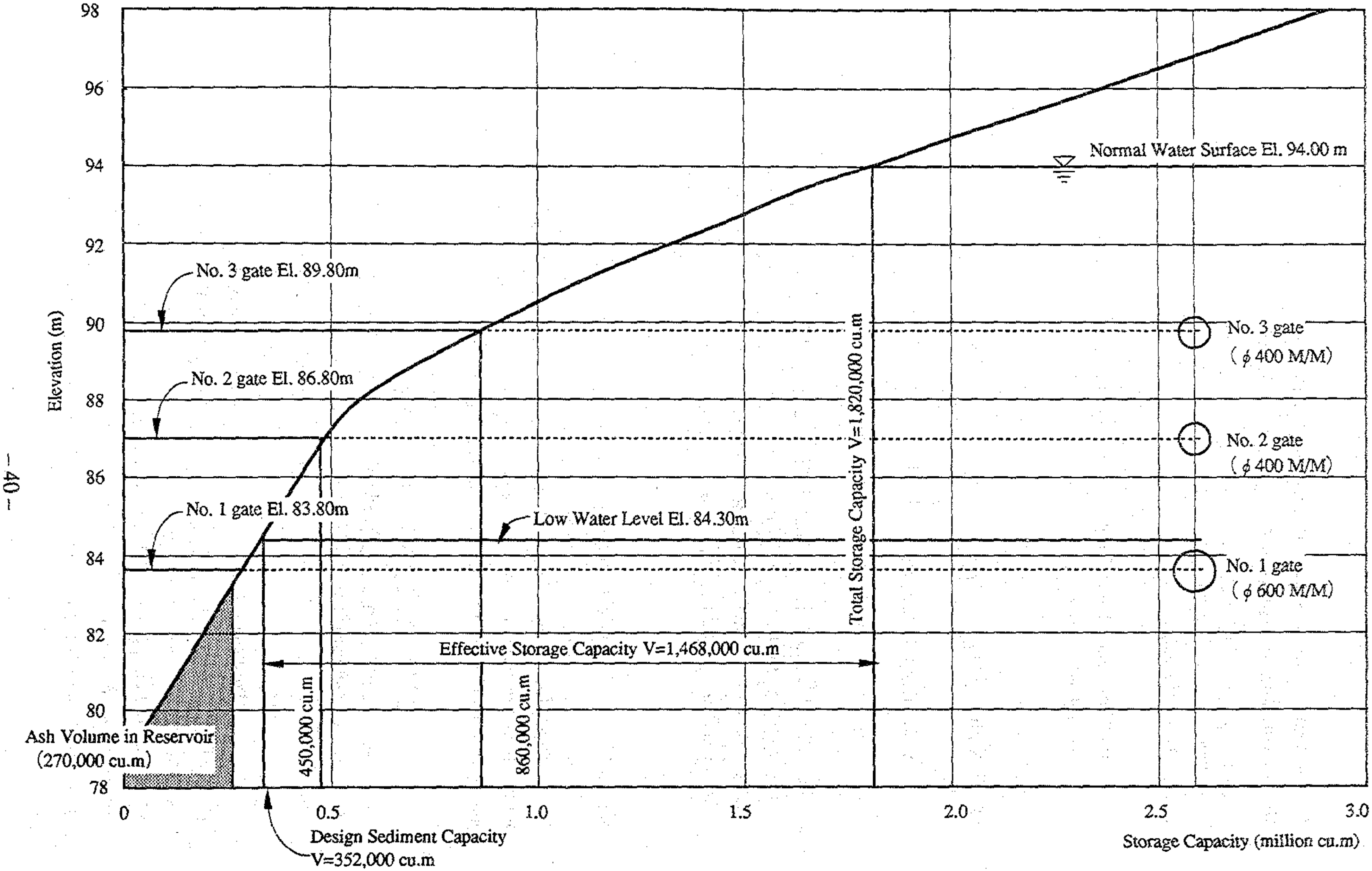


Fig. 4. 1 Elevation-Dam Storage Capacity and Gate Installation (Balnges Dam)

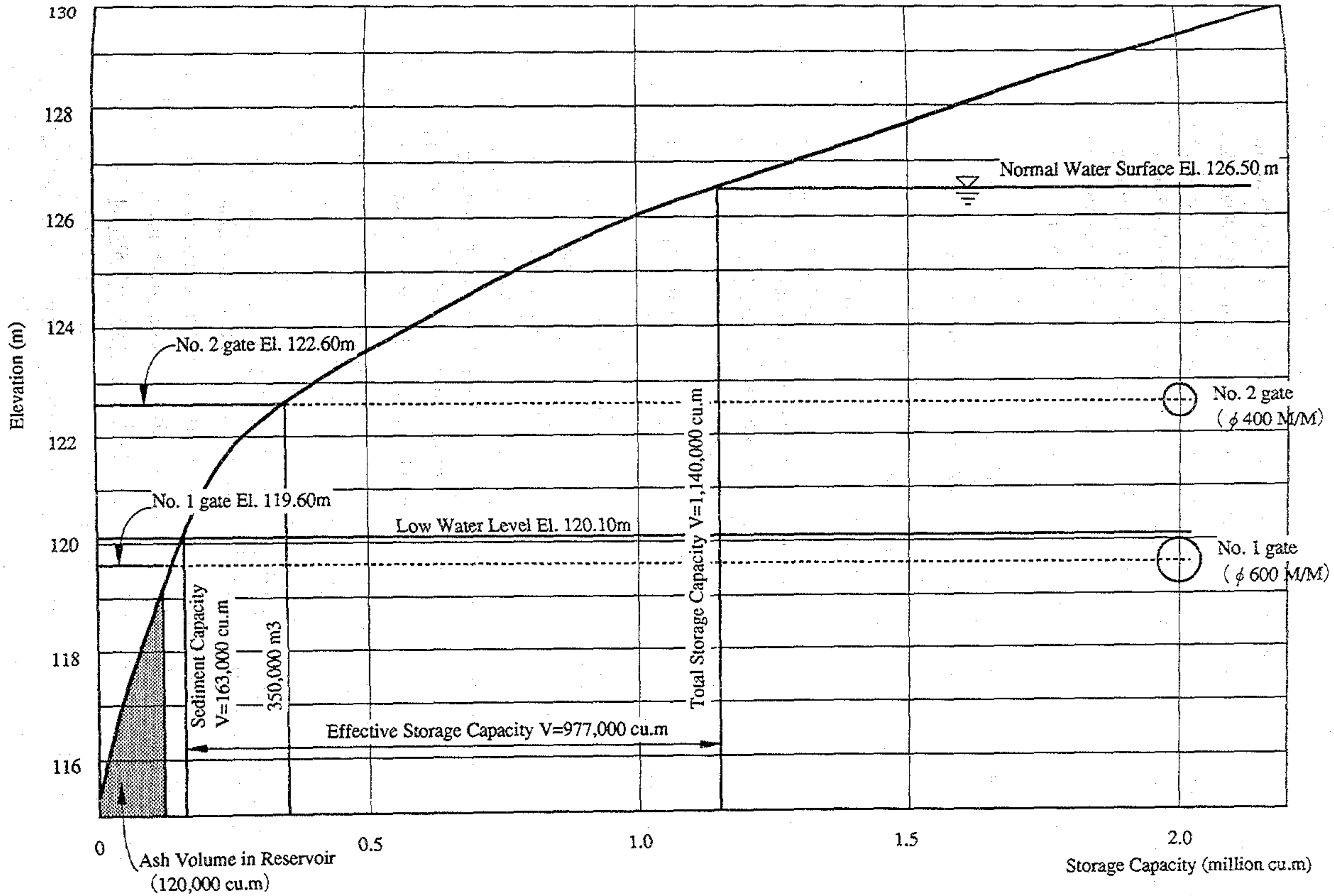


Fig. 4. 2 Elevation-Dam Storage Capacity and Gate Installation (Pangasan Dam)

c) Intake capacity

Head losses in the maximum intake discharge (Q) are 1.13 m in the Balnges dam and 0.69 m in the Pangasan dam as calculated below. The differences of water heads between the low water elevation of the reservoir and the center of the outlet valve are higher than head losses in both of the reservoirs, so that the maximum intake discharge can be diverted through the proposed water transmit conduits. (equations below are explained in calculation sheets of head losses, in the technical report (5), 5.1, 5.2)

Balnges dam: $H=(Q/0.659)^2$

$Q=0.7$ cu.m/sec: $H=1.13$ m

Pangasan dam $H=(Q/0.482)^2$

$Q=0.4$ cu.m/sec: $H=0.69$ m

where, H: Total head losses (m)

Q: Discharge (cu.m/sec)

4.2.3 Plan for Outlet Works

(1) Type and location

a) Type

Outlet facilities are composed of a discharge valve and energy dissipator. A sluice valve is available for the discharge valve. An energy dissipator consists of reinforced concrete canal. The following are the details of the gate facilities.

Table 4.8 Outlet Valves

Balnges dam	Main valve	: Sluice valve	(Dia. ø 500 mm)
	Sub valve	: Sluice valve	(Dia. ø 500 mm)
Pangasan dam	Main valve	: Sluice valve	(Dia. ø 500 mm)
	Sub valve	: Sluice valve	(Dia. ø 500 mm)

b) Allowance of sand scouring

Allowance of the grain size of sand to be scoured is dominated by the water velocity in the bottom conduit of a diameter of 1,000 mm, in which the velocity of flow is lowest. A maximum grain size of 16 mm in the Balnges dam, and 11 mm in the Pangasan dam can be scoured according to the results of the calculation stated in the technical report (3).

c) Energy dissipator

Table 4.9 Length of Energy Dissipator

Balnges dam	Concrete canal	9.0 m
Pangasan dam	Concrete canal	7.5 m

(see technical report (4))

4.2.4 Plan for Gabion Dams

(1) Type and location of gabion dams

a) Type of gabion dams

The gabion dam is substantially composed of 3 - 4 layers of steel net gabion filled with cobble stone. Sand bags are piled up in the steel net gabion to prevent the outflow of ash through the cobble stones. The top of the gabion dam is protected with plain concrete in the case of a flood.

b) Location of gabion dams

The location of the gabion dams is determined to satisfy its total trapping capacity of 640,000 cu.m in the Balnges reservoir and 120,000 cu.m in the Pangasan reservoir. Wider sections of the river are selected to minimize river bed scouring by floods.

The wider and gentler portion of the longitudinal slope of the river bed shall be selected for the construction of the gabion dams in consideration of the effective capacity for trapping ash. However, upstream of the dam storage area is unavoidably selected for the construction of the gabion dams in the Pangasan reservoir for the reason that an acceptable site is not found in the river due to its steep gradient of around 1:10 and narrow section of less than 10 meters of the river.

c) Dimension of gabion dams

Three (3) types of the gabion dams are planned as shown in drawing No. 7 and 8. Proposed locations and storage capacities of ash by the gabion dams are enumerated as follows:

Table 4.10 Proposed Location and Storage Capacity of Gabion Dams

Dam/Location	Station No.	Type	Dam length	Storage capacity
Balnges dam				
Right side river				
	STA.0+100	B	35 m	26,000 cu.m
	STA 0+300	B	50 m	30,300 cu.m
	STA.0+500	B	50 m	29,200 cu.m
	STA.1+700	A	25 m	21,700 cu.m
	STA.2+100	B	35 m	205,000 cu.m
	STA.3+400	B	50 m	121,900 cu.m
	STA.4+500	A	35 m	44,300 cu.m
	STA.5+300	A	30 m	31,600 cu.m
Total (1)				510,000 cu.m
Balnges dam				
Left side river				
	STA.0+100	B	25 m	24,800 cu.m
	STA.0+500	B	20 m	27,000 cu.m
	STA.0+900	B	25 m	22,700 cu.m
	STA.1+400	B	20 m	26,800 cu.m
	STA.1+700	B	20 m	28,700 cu.m
Total (2)				130,000 cu.m
Total (1)+(2)				**640,000** cu.m
Pangasan dam				
	STA.0+400	C	110 m	74,200 cu.m
	STA.2	C	95 m	45,800 cu.m
Total (3)				**120,000 cu.m**
Total (1)+(2)+3)				**760,000 cu.m**

4.2.5 Plan for Dredging of Ash

(1) Proposed dredging site

Upstream of the dam storage area, where huge amounts of ash have been deposited, is an efficient location for dredging in the Balnges reservoir site. While, the right side portion, where much of the ash is deposited among two streams of the tributaries, is selected in the Pangasan reservoir site.

(2) Method of dredging

Backhoes and dump trucks are available for the excavation and hauling of ash. Ash is disposed at disposal sites, which are located downstream from the dam embankment with 40,000 sq.m for the Balnges reservoir, and at the hill on the right side of the reservoir with 30,000 sq.m for the Pangasan reservoir. An embankment shall be constructed to secure the disposal capacity of ash in the Pangasan reservoir. The amount of ash to be dredged is estimated at around 80,000 cu.m in the Balnges reservoir and 50,000 cu.m in the Pangasan reservoir.

4.2.6 Plan for Vegetation

(1) Vegetation area

The vegetation area is illustrated in Fig. 4.3. Around 150 ha of the Balnges reservoir watershed and 50 ha of the Pangasan reservoir watershed are subjected to the vegetation out of the total vegetation area of 200 ha.

(2) Vegetation method

Vetiver grass is available for vegetation. The planting forms narrow strips following contour lines of around 800 m in length per one (1) ha with 20 meter intervals of adjacent strips. Planting intervals (slip and slip) of ten (10) cm are recommended to form continuous vegetative hedges as illustrated in Fig. 4.4.

Proposed facilities and construction works of the Project are shown in Table 4.11.

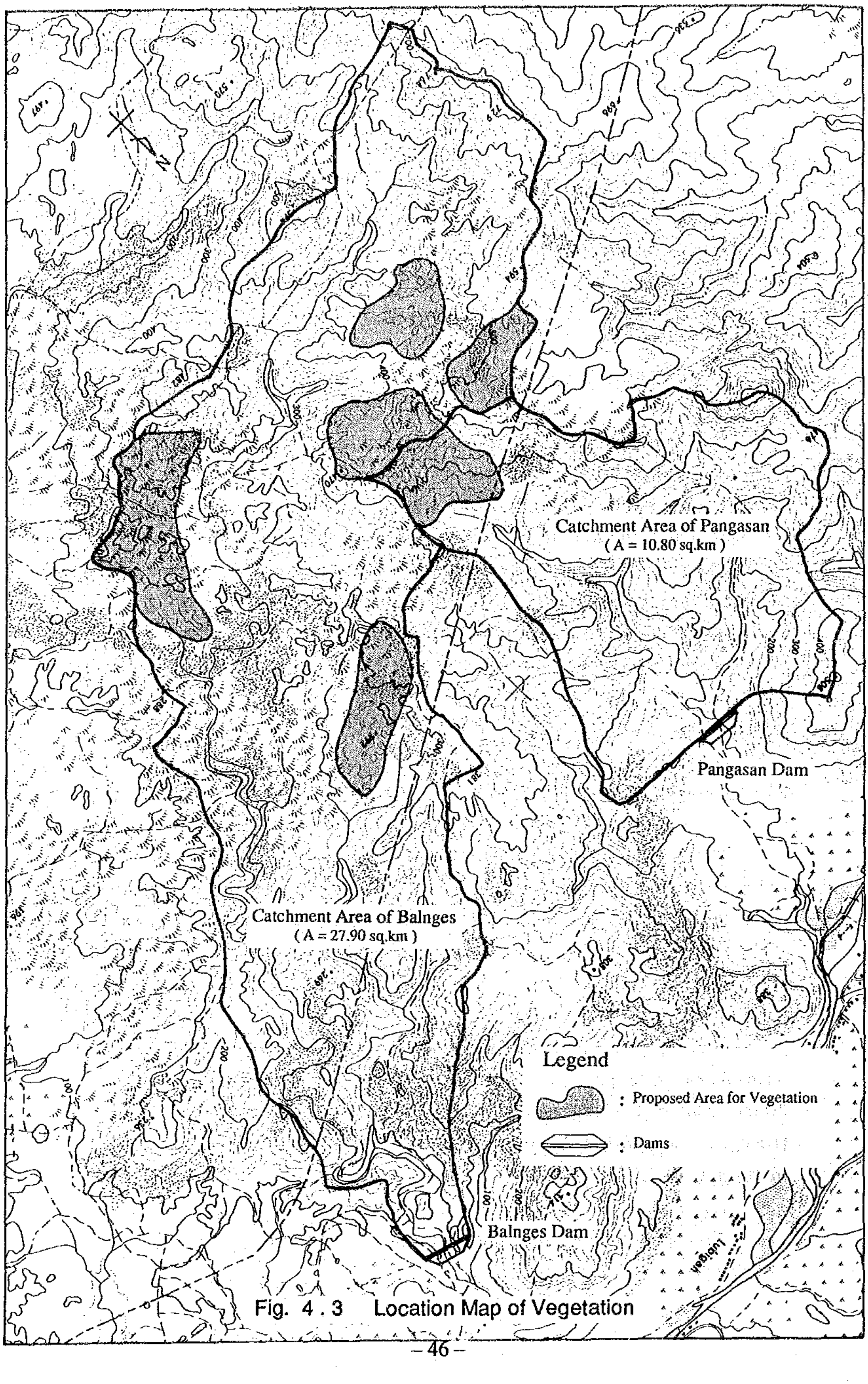
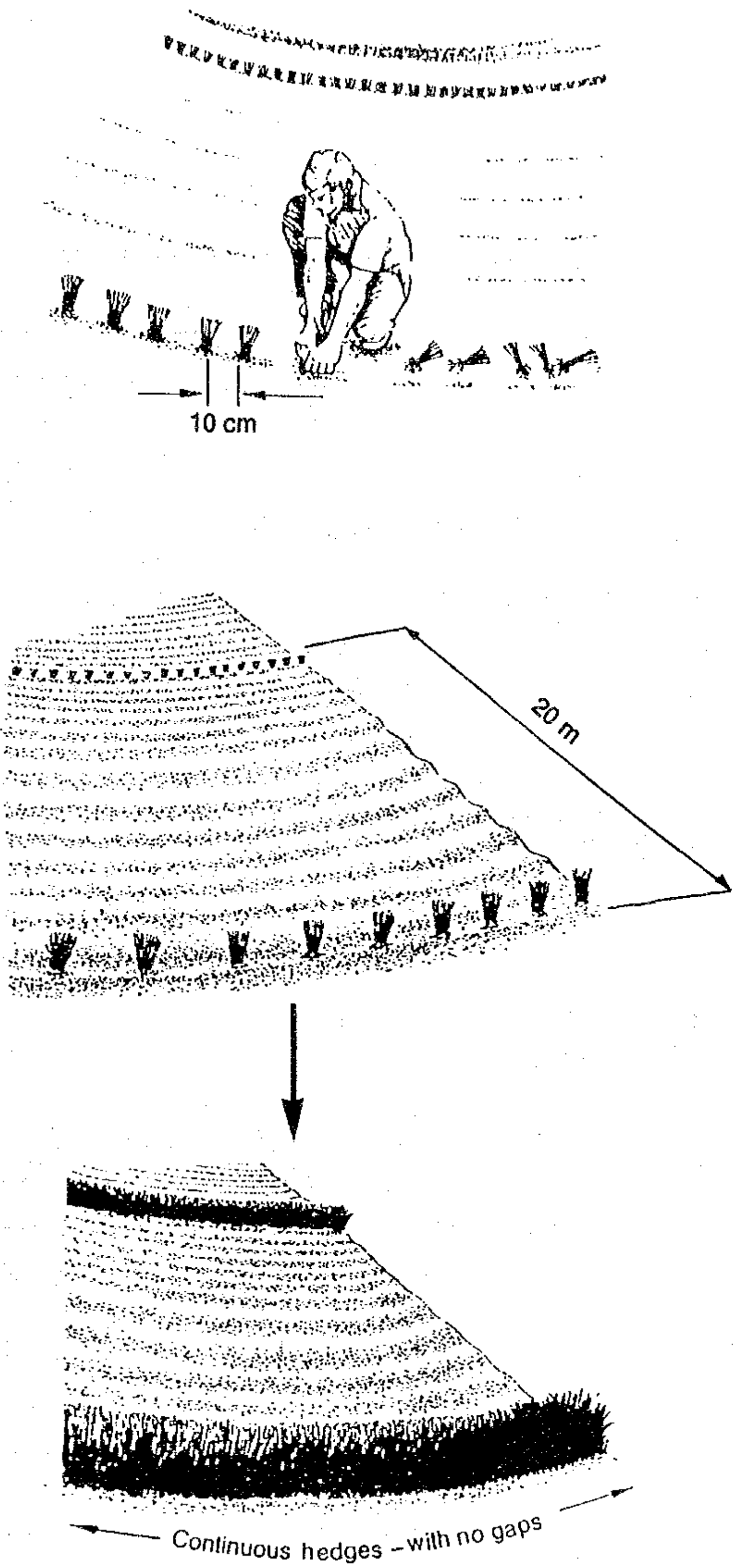


Fig. 4 . 3 Location Map of Vegetation



Source: Method of Vegetative Soil and Moisture Conservation
(World Bank)

Fig. 4 . 4 Planting of Vetiver Slips

Table 4.11 Proposed Facilities and Construction Works of the Project

Proposed Facilities	Bainges dam	Pangasan dam
a) For maintaining functional order of dam intake facilities		
1. Inclined intake conduit		
Intake gate installation	ø600mm: 1 gate ø400mm: 2 gates	ø600mm: 1 gate ø400mm: 1 gate
2. Outlet facilities		
Outlet valve installation and energy dissipator	ø500mm: 2 valves	ø500mm: 2 valves
b) For minimizing ash deposition in the reservoir and ensuring storage capacity		
3. Gabion dam	13 nos.	2 nos.
(Ash volume accumulated)	(640,000 m^3)	(120,000 m^3)
4. Dredging of ash	80,000 m^3	50,000 m^3
5. Vegetation	150 ha.	50 ha.

4.3 Implementation Plan

4.3.1 Construction Condition

(1) Executive agency of the Project

The NIA is assumed to be the executive agency for the Project implemented on the grant aid basis. The NIA is responsible for the project implementation and all of the affairs concerning the Project, such as the conclusion of the Consultant Services and Construction Agreement, Banking Arrangements, issue of Authorization to Pay, and the approval of Tender Documents, as well.

The NIA is the executing body for the irrigation project, carrying out project development and the construction and system operation of the prominent dam projects. During the construction period, the Project Development Department (PDD) of the NIA will take the leadership to form a project execution team, which consists of the project manager and irrigation engineer designating the operation and maintenance duties of the completed irrigation systems. The implementation organization is shown in Fig. 4.5.

(2) Scope of works

The scope of works of the Project includes the construction of the following facilities and related temporary works of access roads and others necessary for execution of the Project.

a. Intake facilities

1) Balnges dam inclined intake conduit works	:	1	L.S.
2) Pangasan dam inclined intake conduit works	:	1	L.S.

b. Outlet works

1) Balnges dam outlet works (valves, energy dissipator installation)	:	1	L.S.
2) Pangasan dam outlet works (valves, energy dissipator installation)	:	1	L.S.

c. Structures to prevent ash from flowing into the reservoirs

1) Balnges dam gabion dams	:	13 dams
2) Pangasan dam gabion dams	:	2 dams

d. Dredging of ash

1) Balnges reservoir site	:	80,000 cu.m
2) Pangasan reservoir site	:	50,000 cu.m

e. Vegetation works

1) Balnges reservoir watershed	:	150 ha
2) Pangasan reservoir watershed	:	50 ha

(3) Construction condition

The project site is not far from Manila, around 150 km. However, it is inevitable to take a detour of about 100 km to deliver the construction materials and equipment in case the bridges crossing the Abakan river in Pampanga Province, the Bamban river in Tarlac Province, and furthermore the Tarlac river, which is located close to the project site, all fall down due to a mud flow. Meanwhile, increasing the aggregate price (sand and gravel) may be attributed to the shortage of its production due to mudflows affected to the production sites adjacent to the rivers.

All barangays in the project area are not electrified, and potable water and telephone lines are not yet available. The existing roads located in the mountainous area are in poor condition. Maintenance of the access and temporary roads influences the whole construction progress, especially for transporting the materials of gabion dams and hauling the dredged ash in the dam and its watershed area.

In addition to the above, it is considerably important to make a construction plan considering an irrigation plan for farmers to avoid ineffective discharge of storage water due to the construction works.

Peculiarities regarding the execution of the construction works are enumerated as stated:

(a) Intake facilities

- to ensure drainage works, because the construction is carried out at the bottom of the reservoir with limited period
- to make a proper construction schedule, temporary work planning and procurement schedule of construction machineries and equipments considering a limited construction period, particularly for gate manufacturing and its installation

(b) Outlet facilities

- to consider drainage works of the dam storage water through the existing outlet facilities

(c) Structures to prevent ash from flowing into reservoirs (Gabion dams)

- to secure the temporary road connecting the quarry to the construction sites to smoothly transport the construction materials
- to determine the alignment and network of the temporary roads and its maintenance planning

(d) Ash dredging works

- to ensure the dredging schedule in full consideration to the fluctuations of the dam water stage influenced significantly on the water discharge for irrigation use and inflow of river water
- to determine the alignment and network of the temporary roads and its maintenance planning deliberating the numbers of the machineries and equipments for the construction
- to study the optimum combination of the numbers and capacity of the machineries and equipments

(e) Vegetation works

- to make a proper planting schedule of slips to commence planting in the beginning of the wet season

4.3.2 Supervisory Plan

Detailed design and construction supervision shall be rendered by a Japanese consultant firm under the agreement between the NIA and the said consultant firm in conformity with the Japan's grant system. Contents of the supervision are for the purpose of assisting the NIA to conclude a justifiable construction contract with a Japanese contractor, to realize the intention of the detailed design and to give the contractor technical guidance from a fair standpoint so that the construction may agree with the contract. The consultant services include the following:

a) Assistance in the conclusion of construction contract

Preparation of detailed design and tender document, qualification of the contractor for the tender, witnessing to tendering, awarding the contract, etc.

b) Approval of construction drawings

Inspection of construction materials and its specifications, approval of construction drawings proposed by the contractor, etc.

c) Supervision of construction

Examination of the construction schedule, advice for technical aspects to the contractor, reporting construction progress to the client, etc.

d) Assistance for arrangement of approval to pay

Examination of request for payment by the contractor during and after the construction, assistance for arrangement of the payment, etc.

e) Witnessing in the inspection

Examination of specifications of the construction facilities during and after the construction, advice to the contractor for technical matters, etc.

After confirming the complete execution of the construction, and witnessing the transfer of the implemented facilities, the consultant will make its services complete with the approval of the client with the receipt of the said facilities. The consultant is responsible for informing the requirements regarding construction progress, payments and transfer of the completed facilities to the Japanese government concerned.

4.3.3 Procurement Plan

The proposed facilities are composed of (1) earth works, (2) concrete works, (3) steel structural works, and (4) gabion dam works. The principal construction materials are listed below:

Table 4.12 Construction Materials, Machinery and Equipment

Item	Materials	Machinery/Equipment
(1) Earth works	-	Bulldozer, Backhoe, etc., Dump truck, etc., Vibration compactor, etc., Air compressor
(2) Concrete works	Cement Aggregates Reinforcing bar Scaffolding	Potable concrete mixer, Generator, Submersible pump
(3) Steel structural works	Steel gate, Control valve	Truck crane, etc, Welding machine, Generator, Submersible pump, etc.
(4) Gabion works	Cobble stone Reinforcing bar	Bulldozer, Backhoe, Tractor shovel, etc., Dump truck, etc., Air compressor, Welding machine, Generator, etc.

Principal construction materials, machineries and equipments can be commonly procured in the Philippines. Specified materials and machineries provided from Japan are shown as below in consideration to the particular conditions of the construction sites and the requirement of a highly precise finishing of the steel structures.

(a) Construction materials

The following steel structures shall be manufactured in Japan to secure its water tightness and durability. There are few achievements in the Philippines in the use of inclined type conduit gates for dam intake facilities.

1)	Intake facilities:	Conduit gates(ø600mm x 2 gates, ø400mm x 3 gates) Gate operation device (includes spindle) Screen
2)	Outlet facilities:	Outlet valves (ø500mm x 2 valves) Flexible joint (ø500mm x 2 valves)

(b) Construction machineries and equipments

The following construction machineries and equipments shall be procured in Japan because of their insufficient supply for construction use in the Philippines.

1) Submersible pump (5.5 kW x 10 nos.)
2) Generator (35 kVA x 2 nos.)
3) Welding machine (200A x 2 nos.)
4) Air compressor (5 cu.m/min x 2 nos.)

4.3.4 Implementation Schedule

The Project will be completed after undertaking the processes described below:

<u>Consultant Contract</u>

The NIA will conclude the consultant service agreement with a Japanese consulting firm. The consultant will proceed upon the verification of the agreement by the Government of Japan.

<u>Detailed Design</u>

Detailed design will be carried out in conformity with the description in the basic design study report. A detailed design report and tender documents will be prepared in two (2) months.

<u>Tender and Construction Contract</u>

After the approval of the tender documents by the NIA, the consultant will explain the contract documents and the bidding to the Japanese contractor. Tendering is composed of public notice, pre-qualification of the contractor, assessment of tenders, and awarding the contract. This takes approximately one (1) month.

<u>Construction</u>

After the conclusion of the construction contract, the construction work will be commenced with the verification by the Government of Japan. The construction work will be completed in eight (8) months.

Detailed design and construction works are scheduled as shown in Fig. 4.6.

4.3.5 Undertaking by the Philippines Government for the Project Implementation

The necessary amount of budget for the project implementation to be undertaken by the Government of the Philippines has been estimated as below:

1.	Land acquisition		
	Disposal area for dredging of ash	3 ha.	600,000 pesos
2.	Maintenance fee for irrigation canals	8,000 m	400,000 pesos
3.	Personnel and office requirements	1 LS.	750,000 pesos
	Total		1,750,000 pesos

4.4 Implementation Plan and Agency

The System consists of the dam facilities and irrigation canals. The System is being well operated and maintained by the NIA and Irrigators associations (IAs), respectively. It is recommended that the NIA be responsible for the operation and maintenance of the facilities constructed in the Project for the reason that the said facilities are connected the dam facilities.

Presently, the project manager in the NIA Central Office is responsible for the management of the irrigation activities of the irrigation systems. Furthermore, the NIA has established the Project office at the project site, and the staff, comprised of the chief engineer and four (4) engineers designated to the constructed dams substantially carried out the operational works with the cooperation of the IAs. The IAs activities are under the direction of the project office. The IAs, named Vamastic IA for the Mangillog and the Bulelatin canals, Badamia IA for the Pangasan canals and the Morisa IA for the Bainges canals can afford to maintain irrigation canals individually. The IA designates one (1) representative for the said works. The IAs are responsible for payment to the NIA of an equivalent amount not to exceed 1.5 cavans per hectare per year for the O& M of dams and reservoirs. Meanwhile, the members constituted by farmers are responsible for payment to the IAs of an equivalent amount not to exceed 0.5 cavan per hectare, per year for the O& M of the irrigation canals.

The authority regarding dam operation and maintenance will eventually be transferred to the NIA Region III Office after several years. (see Fig. 3.5 in Chapter 3)

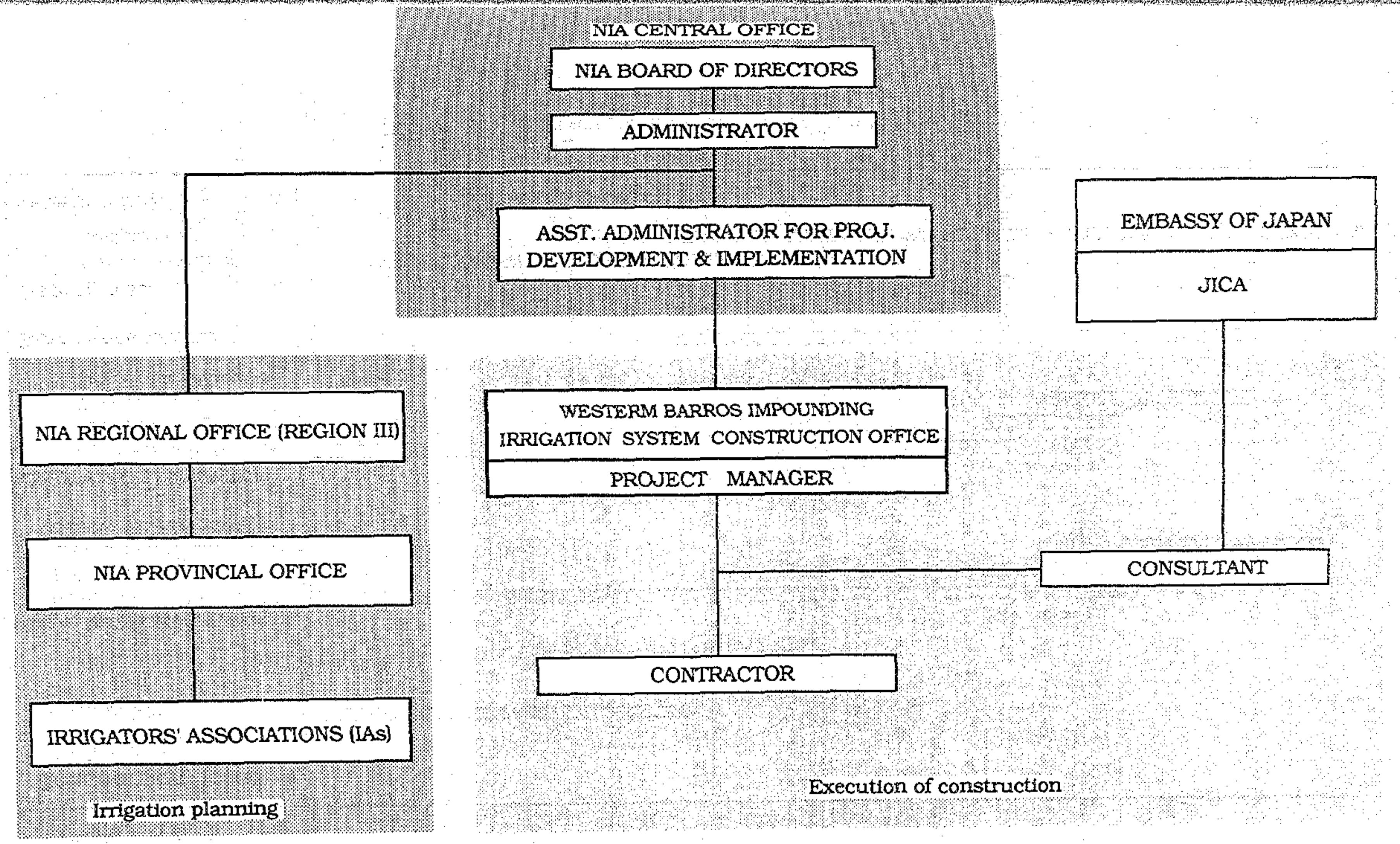


Fig. 4. 5 Implementation Organization of the Project

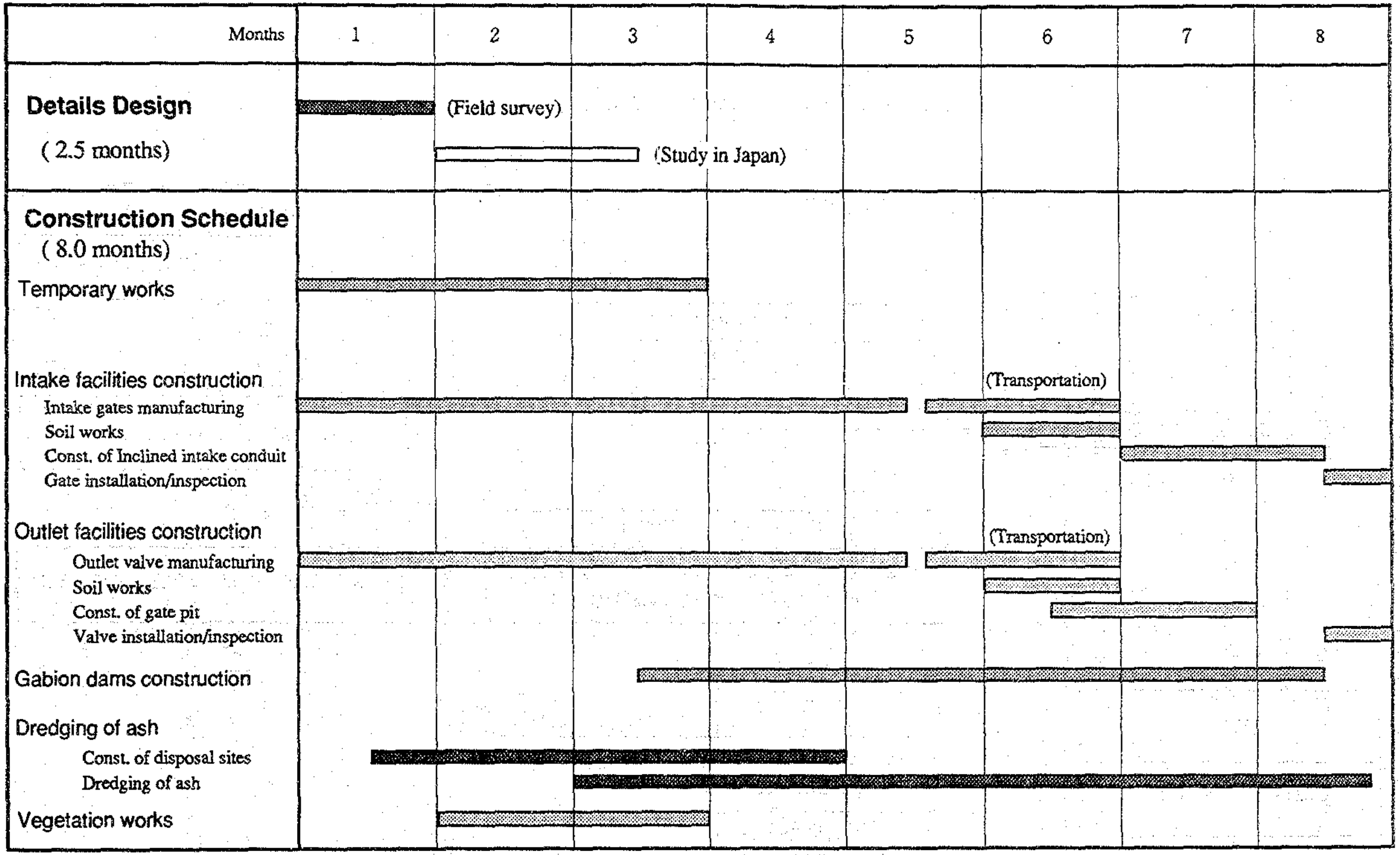


Fig. 4. 6 Implementation Schedule of the Project

Chapter 5 Project Evaluation and Conclusion

5.1 Effects of the Project

The expected and intended effects of, and the degree of solving problems by this Project are examined as follows:

(1) Problems confronting

The Balnges and the Pangasan dams and reservoirs are the major water resource facilities of the Western Barrios Impounding Irrigation System, which were completed in March 1991. The heavy ashfalls expelled from Mt. Pinatubo piled up on the watersheds of the Balnges and the Pangasan reservoirs in June 1991, and voluminous ashfalls were re-mobilized by the following monsoon rains to be silted into the rivers and reservoirs. While the deposited ash discharges from the watersheds in the future, problems such as the reservoir filling up by ash deposition, disorder of dam intake function, reduced irrigable area corresponding to decreased storage water capacity, difficulties in dam management especially for emergency release, etc. are certainly expected.

(2) Proposed countermeasures

The proposed countermeasures against the problems mentioned and their intended effects are as follows:

Table 5.1 Proposed Facilities

Proposed Facilities	Balnges dam	Pangasan dam
a) For maintaining functional order of dam intake facilities		
1. Inclined intake conduit		
Intake gate installation	3 gates	2 gates
2. Outlet facilities		
Outlet valve installation and energy dissipator	2 valves	2 valves

(continued)

Proposed Facilities	Balnges dam	Pangasan dam
b) For minimizing ash deposition in the reservoir and ensuring storage capacity		
3. Gabion dam	13 nos.	2 nos.
4. Dredging of ash	80,000 m^3	50,000 m^3
5. Vegetation	150 ha.	50 ha.

(3) Effects and degree of solving problems

The effects of the proposed countermeasures, and the degree of solving the problems mentioned are studied as follows:

a) Beneficiaries

The original irrigation areas of the Balnges and the Pangasan dams are 350 ha and 200 ha respectively, thus 550 ha in total is the benefit farm area of the Project. In line with these irrigation areas, the number of beneficiaries as of 1990 is summarized as follows (for details, refer to Table 6.1 in the technical report (6)):

Table 5.2 Number of Beneficiaries (as of 1990)

Dam	Barangay	Beneficiary	No.of Farm Household
Balnges dam	Moriones	1,150 persons	213 nos.
Pangasan dam	Iba, San Pedoro	490 persons	91 nos.
Total		1,640 persons	304 nos.

On the other hand, a great number of farmers will have a employment opportunity at the construction works of the Project. This can be the financial benefit to the farmers employed. This will be of financial benefit to the approximately 8,400 farmers employed as shown in Table 5.3.

Table 5.3 Total Number of Beneficiaries

Barangay	Population (persons)
Iba	2,771
Moriones	1,542
Pao	1,111
Villa Agripay	2,993
Total	8,417

b) Technical effects

The technical effects of this Project are studied from the viewpoints of the future ashfall distribution among the proposed countermeasures in relation to the future storage capacity (refer to Table 5.4, 5.5). This study concluded that all the aforementioned problems will be solved by the Project. It is worthy to keep in mind that the required functions of the dams and reservoirs in question can be realized by the integrated effects of every countermeasure.

c) Economic effects

With project conditions, the dams and reservoirs will function originally as planned, and a stable irrigation farming system will continue in their irrigation areas. While, without project conditions, their functions would be lost after experiencing five wet seasons, from October 1997, and the rainfed farming would take place again. Therefore, the major economic effects of the Project are derived from saving agricultural production losses caused by the volcanic calamity to the irrigation systems. The salient features of these economic effects are computed as follows (refer to Table 6.3 in the technical report (6)):

Table 5.4 Ash-fall Distribution and Dam Storage Capacity (Without Project Conditions)

(Unit: '000m3)

Item	Balnges	Pangasan	Total
a. Deposited Ash-fall (as of Apr. 1992)	1,850	510	2,360
b. Future Ash-fall Distribution			
- On watershed	820	200	1,020
- In reservoir	1,030	310	1,340
Sub-total	1,850	510	2,360
c. Storage Capacity			
- Original total storage capacity	1,820	1,140	2,960
- Original dead storage capacity	350	160	510
- Original effective storage capacity	1,470	980	2,450
- Future effective storage capacity*/			0

Note: Without project conditions will take place after the wet-season-end of Oct. 1995.
*/ Future effective storage capacity should be 0 (zero) substantially because of the disorder of dam intake facilities.

Table 5.5 Ash-fall Distribution and Dam Storage Capacity (With Project Conditions)

(Unit: '000m3)

Item	Balnges	Pangasan	Total
a. Deposited Ash-fall (as of Apr. 1992)	1,850	510	2,360
b. Future Ash-fall Distribution			
# Vegetation	lower-watershed's-ash-outflow		
# Gabion dams	640	120	760
# Dredging of ash-fall in reservoir	80	50	130
# Inclined intake facilities	obtain-dam-intake-function		
# Sand discharge valve*/	60	20	80
Sub-total	780	190	970
- On watershed	800	200	1,000
- In reservoir	270	120	390
Total	1,850	510	2,360
c. Storage Capacity			
- Original total storage capacity	1,820	1,140	2,960
- Original dead storage capacity	350	160	510
- Original effective storage capacity	1,470	980	2,450
- Future dead storage capacity	350>270	160>120	510
- Future effective storage capacity	1,470	980	2,450

#: Proposed countermeasures of this Project.
*/ Volume of silt discharged through this valve.

Table 5.6 Financial Value of Agricultural Production Losses

Item	Balnges	Pangasan	Total
1. Damaged (Irrigation) Area (ha)	350	200	550
2. Annual Saved Production Loss			
Paddy (tons)	735	420	1,155
Corn (tons)	1,400	800	2,200
3. Financial Value			
Paddy ('000 Pesos)	2,353	1,345	3,698
Corn ('000 Pesos)	1,480	846	2,325
Total	3,833	2,191	6,023

Note) Above figures are estimated as differences between future with and without project conditions.

d) Farm income effects

The farm income effects on the typical farm household model are studied on the small tenant farmers (farm size 1.0 ha) as a model, whose lands are located in the irrigation areas of the dams. Without project conditions, the annual net farm income is estimated at about 7,900 pesos. On the other hand, with project conditions, it will increase to about 13,800 pesos, or 1.75 times of the income in without project conditions. As for the annual disposable income, it is expected to increase by about 5,500 pesos. This incremental disposable income will contribute toward upgrading the living standards of the beneficial farmers and also in the creation of employment opportunities in the rural area through active agricultural productivity (refer to Table 6.4 in the technical report (6)).

Table 5. 7 Summary of Project Effects

Item	Effects	Scope of Benefit	Amount of Effects
1. Economic effects (Irrigation benefits)	Stability of crop production and high crop productivity are expected in the beneficial areas of the Balnges and Pangasan reservoirs. The running of inland fisheries in the reservoirs, which is a source of supplementary income for the farmers, will be able to continue.	i) Beneficial area · Wet season (Rice) Balnges dam : 350 ha Pangasan dam : 200 ha · Dry season (Corn) Balnges dam : 350 ha Pangasan dam : 200 ha ii) Beneficiaries · Farm households Balnges dam : 213 Pangasan dam : 91 Total 304 · Population Balnges dam : 1,150 persons Pangasan dam : 490 persons Total 1,640 persons	i) Irrigation benefits (see table 5.3) · Increase of crop production (Annual saved production loss) Rice : 1,155 tons Corn : 2,200 tons · Financial value of annual saved production loss Rice : 3,698,000 pesos Corn : 2,325,000 pesos Total : 6,023,000 pesos ii) Farm income effects · Income on farmer, which has 1.0 ha of a tenant Annual net farm income (with project) 7,900 pesos Annual net farm income (without project) 13,800 pesos Balance (increase of income) 5,900 pesos Annual incremental disposal income 5,500 pesos iii) Total number of beneficiaries including Farmers employed at construction of Project : 8,400 persons
2. Social effects a. Improvement of living standards	Improvement of living standards in rural areas is accomplished through stable farm management due to the high agricultural productivity brought about by the Project.	Farm households : 2,100 Population : 11,000 persons	
b. Improvement of living conditions	Farming in the dry season contributes to the increase of the income of farmers, which enables them to remain at their farms year-round rather than having to relocate and find work else where during the dry season.		

5.2 Conclusion and Recommendation

As described above, the Project is expected to create direct and indirect effects and contribute greatly to the enhancement of the lives of inhabitants over a wide range. Meanwhile, the nationwide SWIM Project whose implementation has been rapidly promoted since 1991 by the Government of the Philippines, aims to attain 1) acceleration of economic growth in less developed regions and enhancement of living standards of farmers in these regions, 2) creation of employment opportunity for rural people through construction activities as well as operation and maintenance of the projects, 3) promotion of effective development and utilization of land and water resources, and so on. Whereas, the System will contribute by extending its valuable demonstrative effects over the country in serving as a pilot model project prior to the SWIM Project. In this connection, it is recommended that the Project will be executed under a grant aid program by the Government of Japan to minimize the damages of the ash deposition and to take urgent countermeasures to secure the reservoirs functions. In order to ensure smooth implementation, operation and maintenance of the Project, it is recommended that the following shall be undertaken by the Government of the Philippines.

-- to secure the land for construction and temporary roads.

-- to hold explanatory meeting in advance for the farmers. The aim would be to confirm the planting periods and to escape from the problems caused by the construction works on their irrigation and farming activities.

Furthermore, realization of effective operation after construction will depend considerably upon the self-help efforts of farmers as well as the efforts of the Philippine officials and the NIA. It is therefore recommended that the concerned Philippine personnel conduct their activities with due attention to the following points.

-- to designate specialized engineers to manage the operation and maintenance related to the dam facilities and water distribution, and to carry out cleaning of ash deposited in the irrigation canals. In addition to this, the engineers shall conduct periodical monitoring of ash development in the reservoir and appropriately operate the outlet valves to scour ash on the bottom of the reservoirs when necessary.

-- to enhance cooperative relations between the NIA and IAs. The NIA is responsible for the establishment of legislation and undertaking for operation and maintenance of reservoirs and irrigation canals, and the collection of irrigation fees.

Furthermore, the resettlement and the reclamation by the landless farmers evacuated from the Mt. Pinatubo eruption are taking place in the watersheds of the Bainges and Pangasan reservoirs. It is expected that the outflow of remaining ash and erosion of soil resulting from rainfalls will be accelerated owing to their excessive reclamation, as well as felling trees. The survey shows that the outflow of ash remaining in the watersheds and soil erosion are refrained by herbaceous plants naturally growing in these watersheds. For this reason, it is necessary to promote "vegetation work" on a wide area as a measure not only for the protection from ash flowing and soil erosion, but for the comprehensive soil conservation in the watershed of the reservoirs. If a guidance concerning vegetation work is organized by the Department of Agriculture and other relevant agencies for the resettling farmers, the Project can be expected to have more sustainable effects.

TECHNICAL REPORT

TECHNICAL REPORT

(1) Calculation for Intake Gates Diameters

The diameter of the intake gates is calculated by the following equation:

$$Q = C \times A \times \sqrt{(2 \times g \times H)}$$

where Q: Intake discharge (m^3/sec)
A: Area of intake pipe (m^2)
C: Coefficient of discharge (C=0.62)
H: Water depth (m)

i) No. 1 gate (ø600 mm)

$$Q = 0.62 \times \pi / 4 \times 0.6^2 \times \sqrt{(19.6 \times 1.0)}$$
$$= 0.78 \ (m^3/sec)$$

Maximum intake discharges of the Balnges and the Pangasan dams are 0.7 m^3/sec, 0.4 m^3/sec, respectively. The diameter 600 mm of intake gate pipe satisfies the required intake discharge in condition that the water head is around one meter as calculated above.

ii) No. 2, 3 gate (ø400 mm)

$$Q = 0.62 \times \pi / 4 \times 0.4^2 \times \sqrt{(19.6 \times 3.0)}$$
$$= 0.60 \ (m^3/sec)$$

Incase that the No.1 gate at low water level is disordered by ash deposition, the diameter 400 mm of intake gate located at elevated portion is used for intake. The discharge around 0.60 m^3/sec can be discharged in condition that the water head is around three meters as calculated above.

(2) Calculation for Inclined Intake Conduit Pipe

A size twice the cross section of the inlet hole is standard not to hinder flow from the inlet.

$D_1 = \sqrt{(2 \times D_2^2)}$

$D_1 = \sqrt{(2 \times 0.4^2)}$

$= 0.56 < 600$ mm

The diameter of 600 mm of inclined intake conduit pipe is applied.

(3) Capacity of Sand Scouring

Capacity of sand scouring is determined by the following equation:

--Balnges dam

$Q = 0.608\sqrt{H}$ $= 1.9\ (m^3/sec)$

$H = (WL.\ 94.00 - WL.\ 84.30 = 9.70\ m)$

$V_{1000} = Q/A = 1.9 / (\pi / 4/x\ 1.0^2)$ $= 2.42\ (m/sec)$

$I = f / D \times V^2 / 2g = 12.7 \times g \times n^2 / D^{(1/3)}$

$I_1 = 12.7 \times 9.8 \times 0.013^2 \times 2.42^2 / 19.6$ $= 0.0062$

$\tau_0 = 1000 \times 1.0 / 4 \times 0.0062$ $= 1.55\ (kg/m^2)$

$U_* = \sqrt{(1.55 / 100)} = 0.12$ m/sec $= 12$ cm/sec

$U_*^2 = 12.0^2 = 89 \times d$: $d = 12.0^2 / 89 = 1.6$ cm $= 16$ mm

--Pangasan dam

$Q = 0.612\sqrt{H}$ $= 1.5\ (m^3/sec)$

$H = (WL.\ 126.50 - WL.\ 120.10 = 6.40\ m)$

$V_{1000} = Q/A = 1.5 / (\pi / 4/x\ 1.0^2)$ $= 1.91\ (m/sec)$

$I = f / D \times V^2 / 2g = 12.7 \times g \times n^2 / D^{(1/3)}$

$I_1 = 12.7 \times 9.8 \times 0.013^2 \times 1.91^2 / 19.6$ $= 0.0039$

$\tau_0 = 1000 \times 1.0 / 4 \times 0.0039$ $= 0.98\ (kg/m^2)$

$U_* = \sqrt{(0.98 / 100)} = 0.10$ m/sec $= 10$ cm/sec

$U_*^2 = 10.0^2 = 89 \times d$: $d = 10.0^2 / 89 = 1.1$ cm $= 11$ mm

(4) Energy Dissipator Length

Velocity (v):	Balnges dam	9.67 m/sec
	Pangasan dam	7.64 m/sec

Energy dissipator length(L):		$L = 1.2 + v\sqrt{h}$
	Balnges dam	8.21 m -------9.0 m
	Pangasan dam	6.48 m -------7.5 m

(5) Calculation Sheet of Head Losses of Intake Facilities

Calculation sheets of the inlet and outlet facilities of the both dams are shown in following sheets (5.1), (5.2), (5.3), and (5.4).

(6) Tables related to Project Evaluation

Table 6.1	Land Holding Area by Dam
Table 6.2	Crop Budget
Table 6.3	Financial Value of Saved Crop Production
Table 6.4	Financial Analysis

(5.1) Calculation sheet of head losses (Intake, Balnges dam)

Losses	Pipe dia. (mm)	Flow area Ai(m2)	Ai^2(m4)	Coefficient of losses Calculations	fi	fi/Ai^2
1 Inflow	600	0.283	0.0801		0.100	1.248
2 Rapid exp.	600	0.283	0.0801	D1/D2=0.6/1.0=0.6	0.410	5.119
3 Bend (1)	1000	0.785	0.6162	45°	0.183	0.297
4 Bend (2)	1000	0.785	0.6162	45°	0.183	0.297
5 Friction	1000	0.785	0.6162	124.5x0.013^2x120/1.0^(4/3)	2.525	4.098
6 Rapid con.	600	0.283	0.0801	D2/D1=0.60/1.0=0.60	0.380	4.744
7 Friction	600	0.283	0.0801	124.5x0.013^2x10/0.60^(4/3)	0.416	5.194
8 Bend (3)	600	0.283	0.0801	45°	0.183	2.285
9 Sub gate	600	0.283	0.0801	C=0.90	0.235	2.934
10 Main gate	600	0.283	0.0801	C=0.90	0.520	6.492
11 Outlet	600	0.283	0.0801		1.000	12.484
Total					6.135	45.192

K=1/(fi/Ai^2)^0.5= 0.1488 Q=K*√(2gh)= 0.659 √H

(5.2) Calculation sheet of head losses (Intake, Pangasan dam)

Losses	Pipe dia. (mm)	Flow area Ai(m2)	Ai^2(m4)	Coefficient of losses Calculations	fi	fi/Ai^2
1 Inflow	600	0.283	0.0801		0.100	1.248
2 Rapid exp.	600	0.283	0.0801	D1/D2=0.6/1.0=0.6	0.410	5.119
3 Bend (1)	1000	0.785	0.6162	45°	0.183	0.297
4 Bend (2)	1000	0.785	0.6162	45°	0.183	0.297
5 Friction	1000	0.785	0.6162	124.5x0.013^2x100/1.0^(4/3)	2.104	3.414
6 Rapid con.	500	0.196	0.0384	D2/D1=0.60/1.0=0.60	0.380	9.896
7 Friction	500	0.196	0.0384	124.5x0.013^2x10/0.50^(4/3)	0.530	13.802
8 Bend (3)	500	0.196	0.0384	45°	0.183	4.766
9 Sub gate	500	0.196	0.0384	C=0.90	0.235	6.120
10 Main gate	500	0.196	0.0384	C=0.90	0.520	13.542
11 Outlet	500	0.196	0.0384		1.000	26.042
Total					5.828	84.543

K=1/(fi/Ai^2)^0.5= 0.1088 Q=K*√(2gh)= 0.482 √H

(5.3) Calculation sheet of head losses (Outlet, Balnges dam)

	Losses	Pipe dia. (mm)	Flow area Ai(m2)	Ai^2(m4)	Coefficient of losses Calculations	fi	fi/Ai^2
1	Inflow	600	0.283	0.0801		0.100	1.248
2	Rapid exp.	600	0.283	0.0801	D1/D2=0.6/1.0=0.6	0.410	5.119
3	Bend (1)	1000	0.785	0.6162	45°	0.183	0.297
4	Bend (2)	1000	0.785	0.6162	45°	0.183	0.297
5	Friction	1000	0.785	0.6162	124.5x0.013^2x120/1.0^(4/3)	2.525	4.098
6	Rapid con.	750	0.442	0.1954	D2/D1=0.75/1.0=0.75	0.235	1.203
7	Friction	750	0.442	0.1954	124.5x0.013^2x10/0.75^(4/3)	0.309	1.581
8	Bend (3)	750	0.442	0.1954	45°	0.183	0.937
9	Sub gate	500	0.196	0.0384	C=0.90	0.235	6.120
10	Main gate	500	0.196	0.0384	C=0.90	0.235	6.120
11	Outlet	500	0.196	0.0384		1.000	26.042
	Total					5.598	53.062
	K=1/(fi/Ai^2)^0.5=		0.1373		Q=K*√(2gh)=	0.608 √H	

(5.4) Calculation sheet of head losses (Outlet, Pangasan dam)

	Losses	Pipe dia. (mm)	Flow area Ai(m2)	Ai^2(m4)	Coefficient of losses Calculations	fi	fi/Ai^2
1	Inflow	600	0.283	0.0801		0.100	1.248
2	Rapid exp.	600	0.283	0.0801	D1/D2=0.6/1.0=0.6	0.410	5.119
3	Bend (1)	1000	0.785	0.6162	45°	0.183	0.297
4	Bend (2)	1000	0.785	0.6162	45°	0.183	0.297
5	Friction	1000	0.785	0.6162	124.5x0.013^2x100/1.0^(4/3)	2.104	3.414
6	Rapid con.	750	0.442	0.1954	D2/D1=0.75/1.0=0.75	0.235	1.203
7	Friction	750	0.442	0.1954	124.5x0.013^2x10/0.75^(4/3)	0.309	1.581
8	Bend (3)	750	0.442	0.1954	45°	0.183	0.937
9	Sub gate	500	0.196	0.0384	C=0.90	0.235	6.120
10	Main gate	500	0.196	0.0384	C=0.90	0.235	6.120
11	Outlet	500	0.196	0.0384		1.000	26.042
	Total					5.177	52.378
	K=1/(fi/Ai^2)^0.5=		0.1382		Q=K*√(2gh)=	0.612 √H	

Table 6.1 Land Holding Area by Dam

Dam	Farm Size (ha)								
	0.5	1	1.5	2	2.5	3	3.5	4	4.5
Balnges									
HH No.	16	89	32	43	8	11	6	5	0
HH No.(%)	7.5	41.8	15.0	20.2	3.8	5.2	2.8	2.3	0.0
Area(ha)	8	89	48	86	20	33	21	20	0
Pangasan									
HH No.	4	30	8	22	3	8	3	5	1
HH No.(%)	4.4	33.0	8.8	24.2	3.3	8.8	3.3	5.5	1.1
Area(ha)	2	30	12	44	7.5	24	10.5	20	4.5
Total									
HH No.	20	119	40	65	11	19	9	10	1
HH No.(%)	6.6	39.1	13.2	21.4	3.6	6.3	3.0	3.3	0.3
Area(ha)	10	119	60	130	27.5	57	31.5	40	4.5

Dam	Farm Size (ha)							
	5	5.5	6	6.5	7	7.5	12	15
Balnges								
HH No.	2	0	0	0	0	0	0	1
HH No.(%)	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Area(ha)	10	0	0	0	0	0	0	15
Pangasan								
HH No.	4	0	1	0	0	1	1	0
HH No.(%)	4.4	0.0	1.1	0.0	0.0	1.1	1.1	0.0
Area(ha)	20	0	6	0	0	7.5	12	0
Total								
HH No.	6	0	1	0	0	1	1	1
HH No.(%)	2.0	0.0	0.3	0.0	0.0	0.3	0.3	0.3
Area(ha)	30	0	6	0	0	7.5	12	15

Dam	Total	Ave.(ha)
Balnges		
HH No.	213	
HH No.(%)	100	
Area(ha)	350	1.6
Pangasan		
HH No.	91	
HH No.(%)	100	
Area(ha)	200	2.2
Total		
HH No.	304	
HH No.(%)	100	
Area(ha)	550	1.8

Note: HH No. --- Number of farm households benefited by dams.
Source: "Individual Farmers Landholding in Pangasan CIP" and
"Masterlist of Farmers Beneficiaries" from Moriones Irrigators' Service Association.
a. Adjustment are made by Study Team.

Table 6.2 Crop Budget

- Rainfed Palay in Wet Season -

Future Without Project Condition (Unit: Pesos)

Item	Input Quantity	Unit Value	Production Cost
I. Cash Costs			
1. Hired Farm Labor	40 Md	65	2,600
2. Material Inputs			
-Seeds			282
-Fertilizer			565
-Chemicals			611
3. Others			812
4. Sub-total			4,870
II. Non-cash Costs			
1. Family Farm Labor	29 Md	65	1,885
2. Others			94
3. Sub-total			1,979
III. Total Production Costs			6,849
IV. Total Returns	2,400 Kg	4.0	9,600
V. Cash Costs			4,870
VI. Cash Balance			4,730

- Irrigated Palay in Wet Season -

Future With Project Condition (Unit: Pesos)

Item	Input Quantity	Unit Value	Production Cost
I. Cash Costs			
1. Hired Farm Labor	61 Md	65	3,965
2. Material Inputs			
-Seeds			226
-Fertilizer			1,153
-Chemicals			940
3. Others			2,513
4. Sub-total			8,797
II. Non-cash Costs			
1. Family Farm Labor	51 Md	65	3,315
2. Others			166
3. Sub-total			3,481
III. Total Production Costs			12,278
IV. Total Returns	4,500 Kg	4.5	20,250
V. Cash Costs			8,797
VI. Cash Balance			11,454

- Irrigated Corn in Wet Season -

Future With Project Condition (Unit: Pesos)

Item	Input Quantity	Unit Value	Production Cost
I. Cash Costs			
1. Hired Farm Labor	71 Md	65	4,615
2. Material Inputs			
-Seeds			130
-Fertilizer			1,335
-Chemicals			900
3. Others			2,792
4. Sub-total			9,772
II. Non-cash Costs			
1. Family Farm Labor	56 Md	65	3,640
2. Others			182
3. Sub-total			3,822
III. Total Production Costs			13,594
IV. Total Returns	4,000 Kg	3.5	14,000
V. Cash Costs			9,772
VI. Cash Balance			4,228

Source) Survey Team's estimate using the following data:
- Farm Economy Survey conducted by Study Team,
- Existing data collected by Study Team.

Table 6.3 Financial Value of Saved Crop Production

- Balnges Dam -

Item	Planted Area (ha)	Unit Yield (ton/ha)	Production (ton)	Net Return per ha (Peso/ha)	Annual Profit ('000Peso)
I. Without Project					
1. Rainfed Palay	350	2.4	840	4,730	1,656
II. With Project					
1. Irrigated Palay	350	4.5	1,575	11,454	4,009
2. Irrigated Corn	350	4.0	1,400	4,228	1,480
3. Total	700				5,489
III. Net Benefit					
1. Palay	0	2.1	735	6,724	2,353
2. Corn	350	4.0	1,400	4,228	1,480
3. Total	350				3,833

- Pangasan Dam -

Item	Planted Area (ha)	Unit Yield (ton/ha)	Production (ton)	Net Return per ha (Peso/ha)	Annual Profit ('000Peso)
I. Without Project					
1. Rainfed Palay	200	2.4	480	4,730	946
II. With Project					
1. Irrigated Palay	200	4.5	900	11,454	2,291
2. Irrigated Corn	200	4.0	800	4,228	846
3. Total	400				3,137
III. Net Benefit					
1. Palay	0	2.1	420	6,724	1,345
2. Corn	200	4.0	800	4,228	846
3. Total	200				2,191

- Whole Area -

Item	Planted Area (ha)	Unit Yield (ton/ha)	Production (ton)	Net Return per ha (Peso/ha)	Annual Profit ('000Peso)
I. Without Project					
1. Rainfed Palay	550	2.4	1,320	4,730	2,602
II. With Project					
1. Irrigated Palay	550	4.5	2,475	11,454	6,300
2. Irrigated Corn	550	4.0	2,200	4,228	2,325
3. Total	1100				8,625
III. Net Benefit					
1. Palay	0	2.1	1,155	6,724	3,698
2. Corn	550	4.0	2,200	4,228	2,325
3. Total	550				6,023

Farm Size: 1 ha
Tenure: Tenant

Table 6.4 Financial Analysis

Farm HH Size: 5.4

Item	Without Project			With Project		
	Q'ty	Unit(P/kg)	Value(P)	Q'ty	Unit(P/kg)	Value(P)
1. Marketable Production						
- Palay (Rainfed)	1,470 kg	4.0	5,880	0 kg	4.0	0
- Palay (Irrigated)	0 kg	4.5	0	3,570 kg	4.5	16,065
- Corn	0 kg	3.5	0	4,000 kg	3.5	14,000
(Sub-total)			5,880			30,065
2. Family Consumption						
- Palay (Rainfed)	930 kg	4.0	3,720	0 kg	4.0	0
- Palay (Irrigated)	0 kg	4.5	0	930 kg	4.5	4,185
(Sub-total)			3,720			4,185
3. Payment to Land Owner			2,130			7,150
4. Production Cost						
- Palay (Rainfed)	1 ha		4,870	0 ha		0
- Palay (Irrigated)	0 ha		0	1 ha		8,797
- Corn	0 ha		0	1 ha		9,772
(Sub-total)			4,870			18,569
5. Net Farm Income						
- Crops			2,600			8,531
- Livestocks			3,700			3,700
- Other Crops			1,590			1,590
(Sub-total)			7,890			13,821
6. Cash Income						
- Crops			5,880			30,065
- Net Livestock Income			3,700			3,700
- Net Other Crops Income			1,590			1,590
- Off Farm			3,870			3,870
(Sub-total)			15,040			39,225
7. Cash Expenditure						
- Crops Production			7,000			25,719
- Others			8,000			8,000
(Sub-total)			15,000			33,719
8. Farm Cash Balance			40			5,506

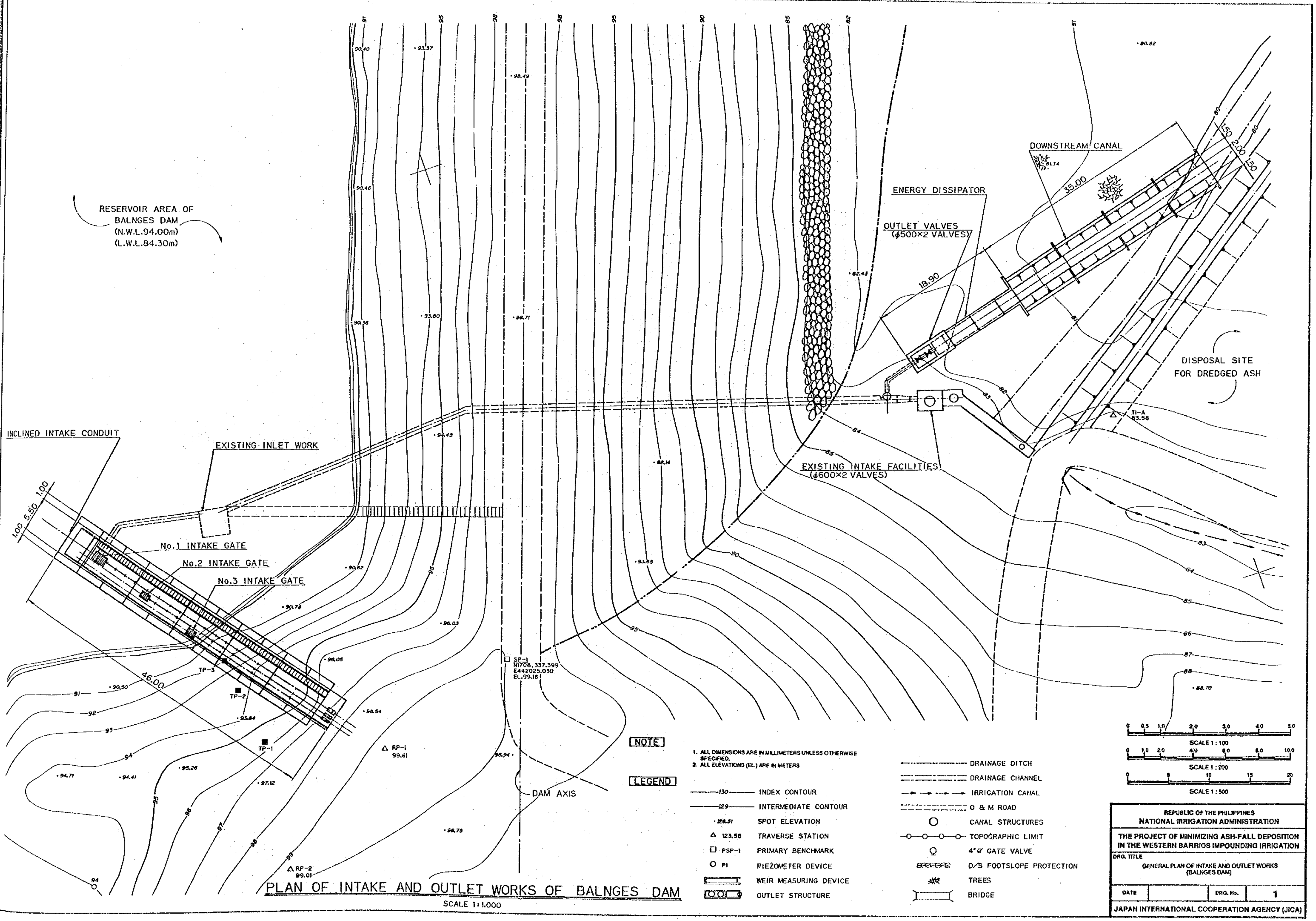
Note: Net income of livestocks and other crops, annual off farm income and home expenditure are derived from adjusting the results of Farm Economy Survey.

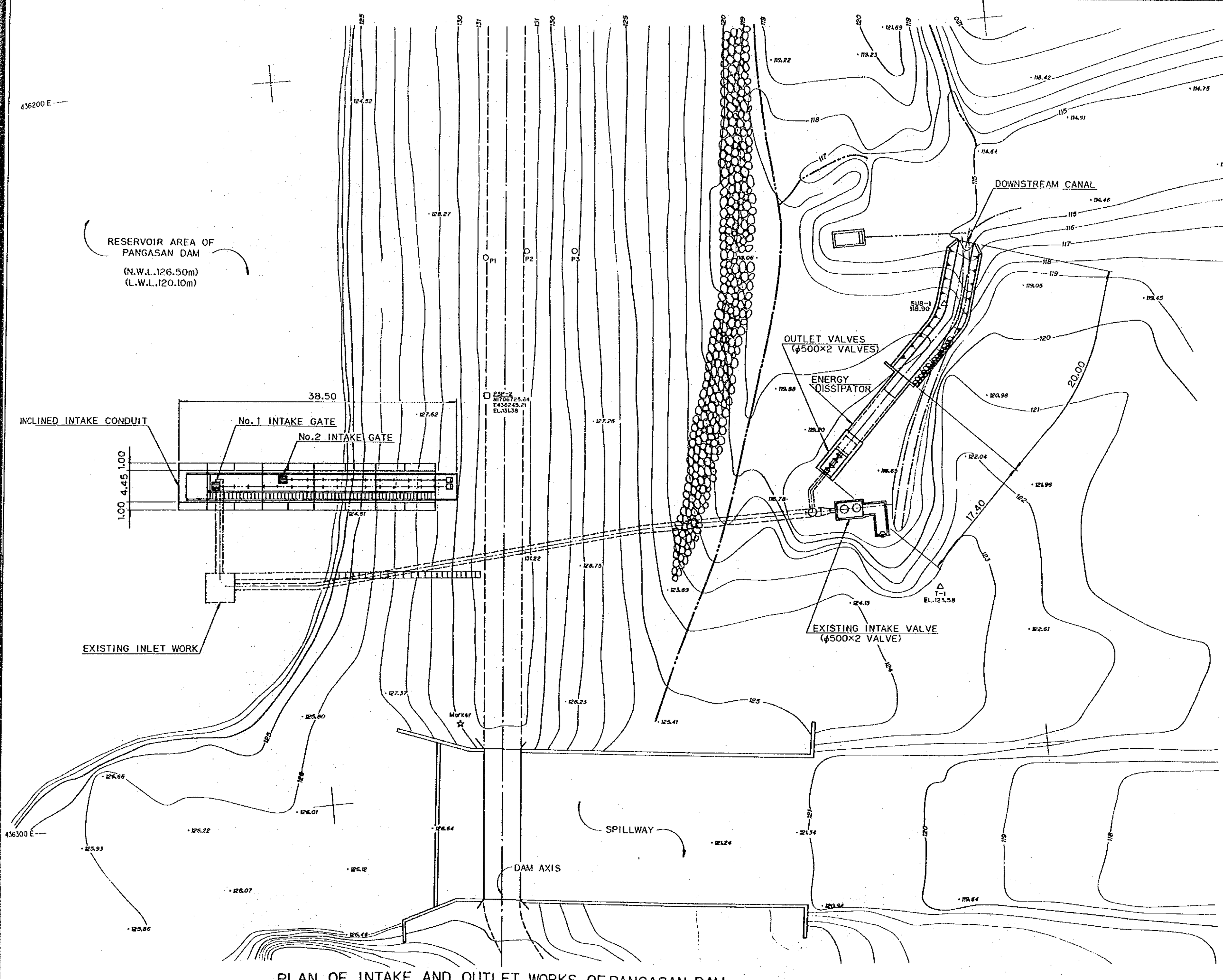
(7) Features of Dams and Reservoirs

Items		Mangillog dam	Bulelatin dam	Bainges dam	Pangasan dam
Drainage area	(km^2)	8.1	2.0	27.9	10.8
Mean annual rainfall	(km^2)	1,931.0	1,931.0	1,931.0	1,931.0
Mean annual run-off	(MCM)	14.0	3.6	50.4	23.8
Dam height	(m)	19.3	10.0	24.2	17.3
Crest elevation	(El.m)	111.3	98.0	98.2	130.8
Dam length	(m)	704.5	215.0	252.0	245.0
Crest width	(m)	6.0	6.0	6.0	6.0
Volume of embankment	(m^3)	363,000	37,000	158,000	81,000
Type of spillway		Ungated chute	Ungated chute	Ungated chute	Ungated chute
Design flood capacity	(m^3/sec)	127.0	26.0	266.0	210.0
Crest length	(m)	25.0	18.0	40.0	25.0
Crest elevation	(El.m)	108.0	96.0	94.0	126.5
Max. water surface	(El.m)	109.2	96.5	96.3	128.6
Normal water surface	(El.m)	108.0	96.0	94.0	126.5
Low water level	(El.m)	99.0	91.3	84.3	120.1
Total storage capacity	(MCM)	3.21	0.73	1.82	1.14
Effective storage capacity	(MCM)	3.11	0.70	1.47	0.98
Sediment capacity	(MCM)	0.10	0.03	0.35	0.16
Type of inlet		Drop inlet	Drop inlet	Inclined intake conduit	Inclined intake conduit
Max. intake capacity	(m^3/sec)	0.72	0.20	0.70	0.40

DRAWINGS

DRAWINGS


RESERVOIR AREA OF
BALNGES DAM
(N.W.L.94.00m)
(L.W.L.84.30m)
INCLINED INTAKE CONDUIT
EXISTING INLET WORK
No.1 INTAKE GATE
No.2 INTAKE GATE
No.3 INTAKE GATE
46.00
1.00 5.50 1.00
TP-1
TP-2
TP-3
RP-1
99.61
RP-2
99.01
SP-1
N1708,337.399
E442025.030
EL.99.16
DAM AXIS
DOWNSTREAM CANAL
ENERGY DISSIPATOR
OUTLET VALVES
(ϕ500×2 VALVES)
EXISTING INTAKE FACILITIES
(ϕ600×2 VALVES)
35.00
18.90
1.50 2.00 1.50
DISPOSAL SITE
FOR DREDGED ASH
TI-A
83.58
PLAN OF INTAKE AND OUTLET WORKS OF BALNGES DAM
SCALE 1:1,000
NOTE
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. ALL ELEVATIONS (EL.) ARE IN METERS.
LEGEND
130 INDEX CONTOUR
129 INTERMEDIATE CONTOUR
126.51 SPOT ELEVATION
123.58 TRAVERSE STATION
PSP-1 PRIMARY BENCHMARK
PI PIEZOMETER DEVICE
WEIR MEASURING DEVICE
OUTLET STRUCTURE
DRAINAGE DITCH
DRAINAGE CHANNEL
IRRIGATION CANAL
O & M ROAD
CANAL STRUCTURES
TOPOGRAPHIC LIMIT
4"Ø GATE VALVE
D/S FOOTSLOPE PROTECTION
TREES
BRIDGE
SCALE 1:100
SCALE 1:200
SCALE 1:500
REPUBLIC OF THE PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION
THE PROJECT OF MINIMIZING ASH-FALL DEPOSITION IN THE WESTERN BARRIOS IMPOUNDING IRRIGATION
DRG. TITLE
GENERAL PLAN OF INTAKE AND OUTLET WORKS (BALNGES DAM)
DATE
DRG. No. 1
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)



PLAN OF INTAKE AND OUTLET WORKS OF PANGASAN DAM

SCALE 1:1,000

NOTE

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. ALL ELEVATIONS (EL.) ARE IN METERS.

LEGEND

130	INDEX CONTOUR
129	INTERMEDIATE CONTOUR
· 126.51	SPOT ELEVATION
△ 123.58	TRAVERSE STATION
□ PSP-1	PRIMARY BENCHMARK
O P1	PIEZOMETER DEVICE
	WEIR MEASURING DEVICE
	OUTLET STRUCTURE
	DRAINAGE DITCH
	DRAINAGE CHANNEL
	IRRIGATION CANAL
	O & M ROAD
	CANAL STRUCTURES
	TOPOGRAPHIC LIMIT
	4"ϕ GATE VALVE
	D/S FOOTSLOPE PROTECTION
	TREES
	BRIDGE

SCALE 1 : 100 (0, 0.5, 1.0, 2.0, 3.0, 4.0, 5.0)

SCALE 1 : 200 (0, 1.0, 2.0, 4.0, 6.0, 8.0, 10.0)

SCALE 1 : 500 (0, 5, 10, 15, 20)

REPUBLIC OF THE PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION

THE PROJECT OF MINIMIZING ASH-FALL DEPOSITION IN THE WESTERN BARRIOS IMPOUNDING IRRIGATION

DRG. TITLE: GENERAL PLAN OF INTAKE AND OUTLET WORKS (PANGASAN DAM)

DATE		DRG. No.	2

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)