Department of Energy
Republic of the Philippines

BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
RURAL ELECTRIFICATION
IN
NORTHERN LUZON
IN
REPUBLIC OF THE PHILIPPINES

June 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.
NEWJEC Inc.

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct a basic design study on the Project for Rural Electrification in Northern Luzon and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Philippines a study team from November 2 to December 13, 2005.

The team held discussions with the officials concerned of the Government of the Philippines, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to the Philippines in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the teams.

June 2007

Masafumi KUROKI
Vice-President
Japan International Cooperation Agency

June, 2007

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Rural Electrification in Northern Luzon in the Republic of the Philippines.

This study was conducted by the consortium of Nippon Koei Co., Ltd., and Newjec Inc. under a contract to JICA, during the period from October, 2006 to July 2007. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of the Philippines and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Michio HASEGAWA

Chief Consultant,
Basic design study team on
The Project for Rural Electrification
in Northern Luzon
The consortium of Nippon Koei Co., Ltd.,
and Newjec Inc.

Summary

SUMMARY

1. Background of the Project

The Republic of the Philippines (hereinafter referred to as "the Philippines") is an archipelagic country with islands extending about 1,850 km from north to south and about 1,100 km east to west. The total area of the Philippine is about 300,000 km^2. Manila, the capital of the Philippines, is situated in Luzon island, the largest of the country's islands followed by Mindanao (94,596km^2) and Palawan (14,896 km^2). The population of the Philippines is 83 million as of 2004 (Source: World Bank).

In 2005, the Philippines recorded a total GNP of 105.2 billion US dollars, and per capita GNP of 1,232 US dollars. The main industries are the overseas service industry and the agriculture, forestry and fisheries industry. Industry can be classified as 15% primary industries, 32% secondary industries, and 53% tertiary industries. Among these, the agriculture, forestry and fisheries industry employs about 37% of the total population, and the main commodities are domestic products such as rice and corn and export-purpose products such as coconuts, sugarcane, and bananas. Manufacturing accounts for the largest portion of secondary industries. Food processing also occupies a high proportion of manufacturing industries, followed by oil and coal products. Among the tertiary industries, particularly, information and communications services, outsourcing business, and tourist industries are rapidly growing, and income from overseas workers stands at 7% of GNP, which reveals the extent to which expatriate labor contributes to the GNP.

2. Description of the Project

The electrification rate currently stands at around 70%. This means that 20 million out of 83 million people have no access to electricity due to geographic disadvantage. As most of the un-electrified villages are scattered in mountainous areas or on remote islands, electrification by extending the power grid is extremely difficult. Consequently, renewable energy such as small or micro hydro-power and photovoltaic generation has been individually developed in the past.

Rural electrification has been one of the priority policies of the Philippine government as a means of improving the standard of living in remote agricultural villages and to reduce poverty by generating income sources, targeting "100% electrification of villages by 2008" and "90% electrification of households by 2017".

A total of 94% of villages, that is, 39,381 out of 41,945 villages, has been electrified as of the end of 2005. Progress is steadily being made towards the targets of "100% electrification of villages by 2008" and "90% electrification of households by 2017". However, as of 2005, although it was claimed that about 70% of households had been electrified, actually a lot of upland dwellers have not benefited from electricity. Under these circumstances, more sustainable investment from technical and financial aspect is expected in the future.

Northern Luzon, which contains the project sites, is located in precipitous mountain range and sparsely populated regions where more than 500 villages or 60,000 households are still un-electrified. The DOE has recognized this as a key factor to attain 100% electrification ratio at the barangay level. Barangay level electrification means that at least some of the households are electrified in the barangay. The DOE has been tackling electrification by employing micro hydro energy since 1999 in the Northern Luzon area which is rich in water resources. However, too few villages have been electrified so far and those that have experience chronic problems of frequent malfunctions of the equipment. These are caused by low quality equipment and improper operation and maintenance services due to a shortage of human or monetary resources.

Under such circumstances, the JICA Philippine office implemented a preliminary study for micro-hydropower development for non-electrified barangays in Northern Luzon in 2003. The JICA study revealed the feasibility of the project and performed the ranking of the priority of the potential sites. Consequently, in November 2005, the Philippine government made a request to the Japanese government as follows:

> "Construction of Micro-Hydro Facilities and Transmission line for 14 sites in Northern Luzon, Generation Capacity 490kW, and Transmission Length 48.7km"

The Philippine government requested a grant aid from the Government of Japan for construction of micro hydro generation facilities for 14 sites. In reply to the Philippines' request, the Government of Japan decided to conduct the basic design study for the Project. JICA sent a study team to the Philippines from November 2 to December 13, 2006. The study team had a series of discussions with the Philippine side. Through these discussions, the details of the request were confirmed and then the socioeconomic situation in the target area, electrical demand, conditions of the existing transmission/distribution system, and location of the micro hydro generation sites were surveyed. The study team continued the basic design in Japan based on the results of the study at the project site. The basic design in Japan confirmed that implementation of the grant aid was justified and confirmed the scope of the Project. From May 30 to June 8, 2007, JICA again dispatched the team to the Philippines to explain the draft basic design and the obligations of the Philippine side.

A total of 14 candidate sites for constructing micro-hydro power stations had been put forth by the Philippine government at first. However, two of the sites were eliminated by agreement during the discussions with DOE as it was found that those sites were to be electrified by extension of the power grid of other schemes.

Site surveys of the 12 sites were conducted by the Basic Design Study Team, of which five feasible sites were identified as having higher priority upon comprehensive evaluation of the survey results under a Japanese grant aid scheme. These five sites were finally selected for inclusion in the Project using a point system consisting of the criteria shown in the table below.

In parallel with the survey in non-electrified barangays, a survey of barangays which have been electrified by a Japanese grass-roots project was conducted. Through the survey and the results of a preliminary study made by the JICA office, the demand per household was determined as 200W provided that the targeted barangays are properly electrified.

Selection criteria:

1) Future grid extension plan to the targeted barangays from power utility company
2) The resident's willingness and/or awareness to participate in the Project
3) Potential supply power compared to barangay's demand
4) Confirmation of construction cost in per household
5) Confirmation of feasibility in transportation during construction periods
6) Feasibility study for the schedule under a grant aid scheme

Finally, the following are the main equipment and facilities for procurement and construction for the five selected sites under a Japanese grant aid scheme:

1) Procurement and Construction of Micro-Hydro Facilities Including Ancillary Facilities
2) Procurement and Construction of 13.2kV Transmission Line Facilities
3) Procurement of Low Voltage Distribution Line Equipment and Material; approx. 22km

The following table shows generation capacity and length of the transmission line for the five targeted sites.

Site Name	Nominal capacity of Major Generating Facilities		Length of 13.2kV Transmission Line (km)	Generating output (kW)
	Turbine (kW)	Generator (kVA)		
Maling-1	54	70	5.35	48
Maling-2	98	120	12.9	83
Maluksad	120	130	3.55	87
Cambulo	92	120	3.40	78
Liwo-2	42	60	5.55	38
Total			30.75	334

3. Implementation Schedule and Cost

Cost Estimate in the Basic Design Study will be shown in the event of the Exchange of Notes provided that this Project will be implemented under a Japanese Grant Aid Scheme. The estimated period of implementation of the Project is 20 months from the exchange of notes between Governments of both countries.

4. Project Evaluation and Recommendation

The agency responsible for implementation of this Project on the Philippines side is EUMB in DOE. Within EUMB, the department named REMD is in charge of project execution.

Operation and maintenance of the Project facilities after completion are to be undertaken by BAPA (Barangay Alternative Power Association), which are composed of the local residents who are the recipient of the facilities. The BAPA play a vital roll in the post project period. It is indispensable that they are assisted by LGUs and monitored by DOE. Part of the Project is to assist to establish BAPA by March 2008 in collaboration with an on-going Technical Cooperation Program Team. It is planned that BAPA will cooperate with the Team to obtain guidance to develop its own practical and appropriate organization and rules of operation. The Program is also expected to afford appropriate advice and guidance to BAPA throughout the construction period of the Project.

Because it is essential to have the BAPAs functioning properly, especially once the operation of the plants commences, preparation for establishing BAPAs commenced during the Basic Design Study. The Study Team urged DOE to duly beging preparing to establish the BAPAs and started monitoring the progress of establishment in collaboration with the Technical Cooperation Program Team.

In order for BAPA to conduct smooth management of the power supply, there is a common issue to tackle, that is, each local community must pay its power tariff regularly and fully, and collection and expenditure of money is to be conducted through a transparent accounting system. As there is a considerable disparity in income among the residents of the barangays and sitios, it will be crucial to establish a practical and equitable tariff system based on existing conditions.

However, micro hydro generating facilities have lower operating costs than diesel-powered electricity generation. Furthermore, the Project is planning to adapt durable and robust types of equipment. The costs for maintenance will not be high because the main expenses will be consumables. In this regard, most of the expenses in the operation will be personnel costs, which is a fixed cost.

To commence operation, it is expected that the BAPA will secure sufficient revenue and that local residents will save enough from their payments for working on the project to pay for the connection of wires to each house, so that the connection ratio of households will be high from the commencement.

By implementing the Project, the following direct and indirect effects are expected.

(1) Direct Effects

1,600 households with a total population of 8,000 in ten barangays will be supplied with electric power. The total output of electric power is planned to be 334 kW from the five power plants, and power of 200W can be allocated to each household for 24 hours a day throughout the year.

(2) Indirect Effects

1) Utilization of electric power by local residents will enable introduction of electric tools such as threshing machines for farming that will increase their income and eventually lead to poverty reduction in rural communities.

2) Electric lighting at home will enable children to study in the evening and improve the educational environment.

3) Access to radio and TV will be made possible by electrification, which will give access to real time information networks, to say nothing of the electric home appliances such as washing machines, refrigerators etc. The living environment of the rural communities will be greatly modernized.

4) A model of BAPA is expected to be formalized.

The following points are to be considered to ensure the Project is implemented effectively and efficiently.

1) It is very important to set forth a suitable power tariff system taking the actual livelihoods of residents into consideration. No less important, however, is to collect the full power tariff from residents and without delay to enable the BAPA to undertake smooth and sustained operation and maintenance of the Project facilities.
2) At the appropriate time in the Project schedule, low voltage distribution lines have to be installed so that the effects of the Project could be maximized.
3) Civil works need to be permanently located in existing paddy fields, so the understanding of the local residents for the Project will be an essential requirement of the implementation.

Basic Design Report
on
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the Republic of the Philippines

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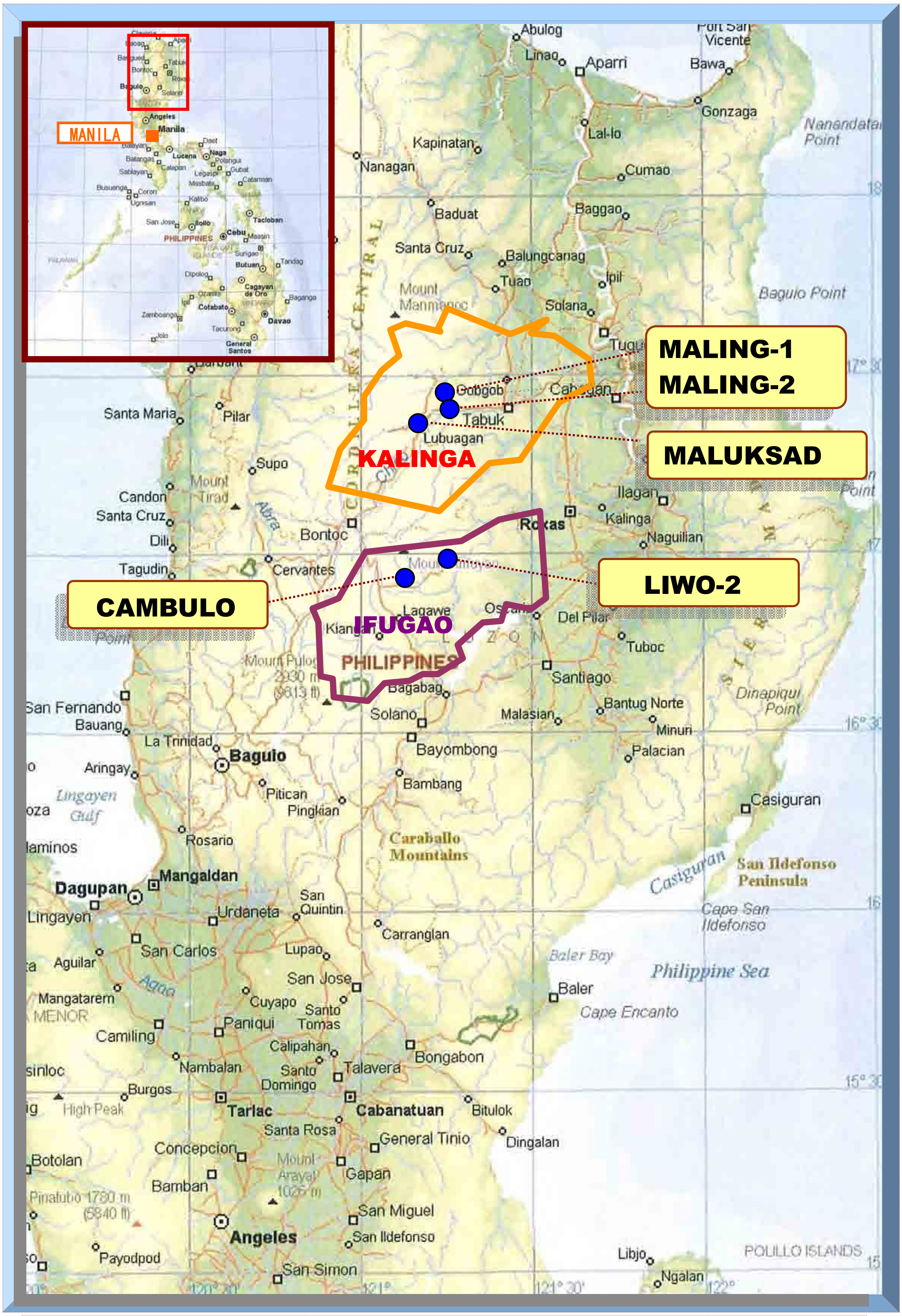

Location of Project Sites

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Abbreviations

ABEP	Accelerated Barangay Electrification Program
ANECs	Affiliated Non-Conventional Energy Center
BAPA	Barangay Alternative Power Association
BHN	Basic Human Needs
DOE	Department of Energy
EA	Electric Agency
EC	Electric Cooperative
ER Program	Expanded Rural Electrification Program
IEC	International Electro-technical Commission
ISO	International Organization For Standardization
JICA	Japan International Cooperation Agency
JEM	Japan Electric Machine Industry
JIS	Japan Industry Standard
LGU	Local Government Units
NEA	National Electric Administration
ODA	Official Development Assistance
PEC	Philippine Electric Code
PMO	Project Management Office
REMD	Renewable Energy Management Division
SI	The International System of Units
WB	World Bank

Units

length	mm	:	Millimeters
	cm	:	Centimeters (10.0 mm)
	m	:	Meters (100.0 cm)
	km	:	Kilometers (1,000.0 m)
Area	m^2	:	Square-meters (1.0 m x 1.0 m)
	km^2	:	Square-kilometers (1.0 km x 1.0 km)
Volume	m^3	:	Cubic-meters (1.0 m x 1.0 m x 1.0 m)
Time	sec.	:	Seconds
Currency	US$	:	United State Dollars
	PhP		Philippine Pesos
	JPY		Japanese Yen
Electricity	kV	:	Kilo volts (1,000 V)
	kA		Kilo-amperes
	W	:	Watts (active power) (J/s: Joule/second)
	VA		Volt-amperes
	kW	:	Kilo watts (10^3 W)
	kVA		Kilo volt-amperes
	MW		Mega watts (10^6 W)
	MVA	:	Mega volt-amperes (10^6 VA)

Chapter 1

Background of the Project

CHAPTER 1 Background of the Project

The Philippines, with a land area of 299,400km^2, about 80% that of Japan, is an archipelago nation comprised of more than 7,100 islands. Owing to such geographic disadvantage, the electrification rate currently stands at around 70%, 20 million out of 83 million people have no access to electricity.

Rural electrification has been one of the priority policies of the Philippine government as a means of improving the standard of living in remote agricultural villages and to reduce poverty by generating income sources, targeting "100% electrification of villages by 2008" and "90% electrification of households by 2017".

As most of these un-electrified villages are scattered in mountainous areas or on remote islands, electrification by extending the power grid is extremely difficult. Consequently, renewable energy such as small or micro hydro-power and photovoltaic generation has been individually developed in the past. In the future, 70% of rural electrifications are planned to be covered by grid line extension while 30% will be by renewable energy sources.

Northern Luzon, which contains the project sites, is located in mountainous and sparsely populated regions where more than 500 villages or 60,000 households are still un-electrified. The DOE has been developing micro-hydro power stations; however, too few villages have been electrified so far and those that have experience chronic problems of frequent malfunctions of the equipment. These are caused by low quality equipment and improper operation and maintenance services due to shortage of human or monetary resources.

The Japanese Government dispatched long term experts in 2001 to 2004, who selected potential candidate sites for micro-hydro power stations and conducted technical transfer services such as for project site selection/formulation and for operation and maintenance procedures. Since 2004 they have been rendering technical assistance under the "Rural Electrification Project" with the aim of establishing a tariff system for electricity generated by renewable energy development. In 2003, "The Study of Micro-Hydropower Development for Un-energized Barangays in Northern Luzon" was conducted by the JICA Manila office in which 50 potential sites were reconnoitered. This list of sites was eventually culled to 20 through a screening process that took into consideration hydro-power potential, power demand, ease of operation, and maintenance and site access.

The Government of the Philippines intended to execute all of the proposed projects on its own but was unable to because of financial difficulties. It therefore applied for Japanese Grant Aid to execute 14 micro-hydro power stations from among the foregoing 20 candidate sites in coordination with the above-mentioned technical assistance by JICA experts.

Chapter 2

Contents of the Project

Chapter 2 Contents of the Project

2.1 Basic Concept of the Project

(1) Overall Goal and Project Objectives

In the Philippines, rural electrification has been one of the priority policies to improve the standard of living and reduction of poverty in remote agricultural villages by generating income sources. The targets are “100% electrification of villages by 2008” and “90% electrification of households by 2017”. More than 1,000 villages have been electrified in recent years, resulting in a total of 94% of villages, or 39,381 out of 41,945 villages, having been electrified as of the end of 2005.

The overall goal of the Project is to help electrify the remaining un-electrified rural communities towards 100% through micro-hydro power generation.

(2) Outline of the Project

The objective of the Project is, as a part of the effort to electrify the remaining un-electrified areas, to electrify the rural communities in Northern Luzon, where electrification by extending the power distribution network is very difficult due to its remote and rugged terrain, through micro-hydropower generation at several stations for individual power supplies. The micro-hydropower generation taps the renewable energy of the streams that are abundant in the region.

The Project is intended to establish a community-based power generation and supply system through the activities of an electrification cooperative. It is intended to realize a user (rural community)-participation effort to the maximum extent possible and should go hand in hand with the ongoing Project Type Technical Cooperation Project by JICA (2004-2009) as a back up in the soft aspects. Among the candidate sites in the area, 5 power generation sites have been selected to cover 10 villages, primarily because of the high degree of willingness of the villagers to participate in the undertaking as was discovered during site reconnaissance and in consideration of other physical conditions such as accessibility and transportation.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

(1) Basic Policies

A total of 14 candidate sites for constructing micro-hydro power stations had been put forth by the Philippine government at first, however, 2 of them were agreed to be dropped during the discussion with DOE as it was found that those sites were to be electrified by extension of a power grid under other schemes.

Site surveys of the 12 sites have been conducted by the Basic Design Study Team, of which 8 feasible sites were selected as having higher priority upon comprehensive evaluation of the survey results, namely regarding 1) accessibility to the power grid, 2) willingness of the local community to participate in the undertaking, 3) generating power potential against demand (200W/households), 4) cost of construction per household.

Moreover, considering accessibility to the sites and expected construction period, 5 sites were finally picked for inclusion into the Project.

Table 2.1-1 Requested and Selected Sites

Five selected sites (highlighted)

	Site	Province	State	Generating Capacity (kW)	Comprehensive evaluation score	Accessibility Construction Period	Notes
1	Maling-1	Balbalan		40	17 OK	OK	
2	Maling-2			45	18 OK	OK	
3	Buaya		Karinga	12	6 NO		
4	Malkusad	Pasil		50	17 OK	OK	
5	Dakalan	Tanudan		45	17 OK	NO	
6	Lubo			no data	10 NO		
7	Cambulo	Banaue		55	19 OK	OK	
8	Pula			25	16 OK	NO	
~~9~~	~~Inwaloy~~		Ifugao	15			*1
10	Maga	Maoyao		20	12 OK	NO	
11	Liwo-2			20	18	OK	
12	Binalian			20	10 NO		
~~13~~	~~Babadi~~	Kayapa	Nueva	25			*1
14	Talicabcab		Viskaya	8	10 NO		

*1 Power grid will be extended within two years

(2) Natural Conditions

All equipment and materials will be designed and manufactured to comply with the conditions as outlined below.

1) The possible generating capacity will be determined by design water flow, which can be evaluated by flow duration curves based on measured discharge records, to secure stable power throughout the year.
2) Since construction of major hydraulic structures such as a weir and intake facility have to be conducted in the river and on the river bank, the construction schedule, particularly in the rainy season, shall be formulated carefully.
3) Such remote villages can not be approached by vehicle due to lack of developed roads. This condition will also have to be considered in planning transportation schemes.

(3) Applied Standards and Regulations

The following standards and regulations will be applied in design of the facilities to be constructed and equipment to be procured under the Project.

1) Civil Engineering Structures
There are no standards for civil engineering structures specifically for the micro-hydro power generation in either the Philippines or Japan. Functions of both micro-hydro power and larger scale hydro power facilities are basically the same. Therefore, Japanese standards for general civil engineering structures will be adopted in the Project.

2) Turbines, Generators and Control/Protection Equipment
In the Philippines, there are no standards for turbines, generators and control/protection equipment for micro-hydro power generation either, therefore, the pertinent parts of the international standards, IEC or Japanese standards JIS, JEC, will be applied.

3) Transmission and distribution systems
Equipment and materials that have been commonly used by a power utility company for Transmission and distribution systems can be procured in the Philippines, therefore Philippine standards NEA (National Electric Administration and PEC (Philippine Electric Code) will be employed.

The international system of units (SI) will be applied to the design and manufacture throughout.

(4) Use of Local Subcontractors

The 5 subject sites are scattered in remote regions, therefore, in order to complete the Project without delay, it is indispensable to engage local construction companies who have ample experience in working under harsh conditions as sub-contractors under the supervision of the Japanese firm who is engaged as the prime contractor under the Grant Aid program.

Moreover, to ensure quality of the works, to meet the target schedule and for safety control, design and construction supervision services are to be rendered by a Japanese engineer.

(5) Operation and Maintenance Capability of the Executing Agency

DOE is the executing agency in charge of the Project. Establishing a project office in charge of the Project execution in DOE, with at least two staff members, is considered indispensable for smooth implementation of the Project, particularly for coordination with LGUs and local communities.

After completion, operation and maintenance work will be undertaken by BAPA which will be organized by March, 2008 under the auspices of DOE.

Technical training of operation and maintenance staff of the facilities and training for management personnel is increasingly important for BAPA under the auspices of DOE and LGUs in charge. Those training services will proceed in coordination with the "Technical Assistance Program for Rural Electrification" by the Japanese Government.

(6) Grades of the Facilities and Equipment

As stated above, because the operation and maintenance will be undertaken by the local communities, the civil engineering facilities, turbines and generator equipment must be robust, durable, simple in operation and maintenance, trouble-free and must require the least possible amount of spare parts.

(7) Construction and Procurement Method and Schedule

At all the Project sites, construction works will have to be carried out by manpower alone, since heavy-construction equipment can not be mobilized due to undeveloped access roads.

Construction of such facilities as weirs and intakes in the rivers and on the river banks must be carried out when there is minimum water. Also, transportation of the large amount of construction equipment and materials must be conducted in the dry season. As a result, these works may largely have to be scheduled in the dry season. This is a very crucial requisite in planning the execution time schedule.

2.2.2 Basic Plan

2.2.2.1 Overall Plan

(1) Power Demand Survey of Electrified Barangay

To determine the power generating capacity of the Project, the Basic Design Study Team conducted a demand survey in Pantikian village that had been electrified by micro-hydropower generation funded by a Japanese grass-root grant aid.

As a result of the survey, it was found that the households can be classified into 4 groups based on their energy consumption. The categories and typical loads are shown in Table 2.2-1.

Table 2.2-1 Power Demand of Electrified Barangay.

	Load	Capacity (W)	Nos.	Large household (W)	Medium～large (W)	Medium～small (W)	Small (W)
1	Fluorescent 15W	15	2			30	30
2	-ditto-	15	3		45		
3	-ditto-	15	10	150			
4	Fluorescent 20W	20	1			20	
5	-ditto-	20	3		60		
6	-ditto-	20	5	100			
7	Television	105	1	105	105		
8	DVD	65	1	65	65		
9	Stereo	50	1	50		50	
10	Satellite tuner	100	1	100			
11	Washing machine	360	1	360			
12	Refrigerator	500	1	500			
I	Loads total			1,430	275	100	30
II	Demand factor			50%	70%	80%	100%
III	Power Consumption I x II			715	190	80	30

Based on the power consumption summarized for each type household in Table 2.2-1, assumed peak power demand per household is calculated percentage-wise as shown in Table 2.2-1. As the peak power demand in Pantikian Barangay is 135W at present, it can be said that this village belongs to pattern 2.

Table 2.2-2 Assumed Power Demand per Household

Patt-ern	Large Consumption	Medium-Large Consumption	Medium-Small Consumption	Small Consumption	Average Demand per Household (W)
1	5%	20%	50%	25%	121

2	5%	25%	50%	20%	129
3	10%	30%	45%	15%	169
4	10%	35%	45%	10%	177
5	10%	40%	40%	10%	183
6	10%	45%	40%	5%	191
7	10%	45%	45%	0%	193
8	10%	50%	40%	0%	199

Though a generally applicable power demand pattern can not be determined by one case study, as it may also depend on the financial situation of a village, a unit rate of 200W per household derived from table 2.2-2 above could safely be applied to a village that has a similar power demand distribution to this barangay, whose power consumption is distributed 10% in large, 50% in medium-large, 40% in medium-small scales.

The power demand for public facilities, such as schools, hospitals and churches, were excluded from the above demand, since those demands are mainly in daytime, which is off peak of households.

(2) Power Demand Forecast

Unless the system is integrated in a gird power distribution system, a power demand forecast is an essential requirement for micro hydropower generation to be able to supply constant power throughout the year whether in the rainy or dry season.

Unlike diesel power generation, the micro-hydro power generation can be operated without daily running cost such as for costly fuel, but only if appropriate maintenance is exercised.

It is expected that power demand in the beginning operation stage of the Project may accrue from small loads such as for lighting and radios/TV.

To determine the scale of the power generating facilities, the power demand at a household is assumed to be 200W in consideration of the following items.

- Long-term growth of power demand
- Increase of activities brought about by the improved living standards
- Growth in population, natural or by inflow
- Use of new electric appliances related to the improved living standards

In the preliminary basic design study in 2003 funded by the JICA Manila Office, the scale of power generation was also determined on an assumed power consumption rate of 200W/household.

2.2.2.2 Supply Areas

In the sitios belonging to barangays 1-5 listed below, each household is planned to be supplied with 200W power. Table 2.2-3 shows the barangays to be covered by the Project.

The Basic Design Survey Team confirmed that the Maling-2 site could generate 83kW, which can supply power to Balantoy (49kW), a part of Maling (3kW), and also a part of Publacion (remaining 31kW). In Publacion approximately 60% of the households have been supplied by the diesel generator owned by the municipal office which is put in operation from the evening to night time. However, the diesel generator is aged and consumes expensive diesel fuel that costs 15Php/kWh, which is higher than the 11Php/kWh for grid power. This cost has been shouldered by the users.

Therefore, the generating facility is designed to develop the full potential of 83kW to satisfy the demand in a part of Publacion of about 31kW for 150 households. However, the provision of transmission and distribution lines is up to the neighbor barangay of Balantoy.

Table 2.2-3 Supply Barangay to be Planned in This Project

No	Site Name	Targeted Barangay	No. of Households to be Supplied	Required Demand (kW)
1.	Maling-1	1) Maling	54	
		2) Balbalan Proper	163	
	(Subtotal)		**217**	**43.4**
2	Maling-2	3) Balantoy	244	
		1) Maling	16	
		4) (Publacion)	(150)	
	(Subtotal)		**410**	**82.0**
3	Maluksad	5) Maluksad	80	
		6) Pugong	120	
		7) Guinaang	156	
		8) Galdang	60	
	(Subtotal)		**416**	**83.2**
4	Cambulo	9) Purok 1	90	
		9) Purok 2	78	
		9) Purok 3	87	
		9) Purok 4	80	
	(Subtotal)		**335**	**67.0**
5	Liwo-2	10) Liwo-2	**152**	**30.4**
	Total	10 barangays	**1,530**	**306.0**

2.2.2.3 Civil Structure Design

In the Philippines, hydropower generation of less than 100kW output is defined as micro hydropower. The layout and main components of the micro hydropower stations are basically almost identical to those of large scale hydro power stations, only their scales are different.

Hydropower stations are usually composed of civil engineering structures such as intake weirs, headrace channels, settling basins, head tanks, penstocks, power houses and tailraces.

The micro hydropower station is usually a run-of-river type without a reservoir. River water is taken in at the intake weir at a height of 2 to 3 meters, led to the head tank through the open headrace channel, and then dropped to the generator through the penstock. Power output "P" is obtained by the product of discharge "Q" and effective head "He" as follows.

$$P = 9.8 * \eta * Q * He$$

where "η" is the efficiency of the turbine and generator, normally around 0.6

The design discharge Q is determined based on the measured water flow at nearby river gauging stations (normally the river flow rate during over 90% of the year is taken as dependable).

(1) Intake Weirs

Intake weir structures are either of concrete gravity type partially replaced with boulders inside the weir to reduce construction cost or Tyrolean type. The former is to be adopted at the sites of Maling-2, Maluksad and Cambulo, and the latter at the sites of Maling-1 and Liwo-2.

The height of the weirs is about 2 to 3 meters (weirs higher than 15 meters are called dams). The shape of the weirs is decided by the structural stability calculations under the assumed flood condition. Intake mouths and flushing channels are provided with manual gates for operation and maintenance purposes. The width of the flushing channels is 1.5 to 2 meters in consideration of the large amount of sand generated under flood conditions. The intake mouths for gravity type weirs are provided on the river banks at a 90 degree angle to the river flow.

(2) Headrace Channels

Open channels are basically applied to the headrace channels for easy construction and low cost. Non-pressure pipes are adopted for steep slopes and exposed rock slopes to minimize earthwork as much as possible, and to secure the stability of the excavated earth slope.

The channel gradient is basically at 1/1000 so that the water flow velocity is kept at about 1m/sec, to reduce the head loss and to prevent scouring of the channel structures.

The shape of the channel section is decided based on economic considerations and to minimize the friction loss and in consideration of topographic and geological features at the sites.

The depth of the channel is decided so that freeboard of about 30% of the channel depth is secured; the range of freeboard is about 20 to 30cm.

The channels to be adopted for given topographic and geological features at the sites are shown in Table2.2-4

Table2.2-4 Channel Type for Headrace

	Type	Structure	Conditions in which to be Applied
1	Culvert (Rectangular section)	Reinforced concrete	• Near intakes where the channel is likely to be inundated by flood and a flood protection wall is difficult to construct. • Where existing streams or waterways cross the channel.
2	Conduit pipe (Spherical section)	Half-buried or Underground Hard vinyl chloride pipe or Steel pipe	Over exposed rock slopes or steep slopes where an open channel is impractical or the slope would become unstable with excessive excavation.
3	Open channel (Rectangular section)	Reinforced concrete	Where topographic features are gentle and steady. A concrete cap to protect against falling debris, such as from slope collapse or fallen leaves and branches should be installed where deemed necessary.
4	Open channel (Trapezoidal section)	Mortar masonry concrete	Where topographic features are gentle and steady and land space can be secured.

(3) Settling Basins

A settling basin is provide in the middle of the headrace channel at Cambulo site where the headrace channel is 500 m or more in length and detritus from the slope slides is expected to fall in.

Width of the settling basin is decided so that the water velocity in the basin slows to less than 0.3m/sec.

The settling basin is made of reinforced concrete and equipped with a flushing gate and spillway.

Head tanks will also serve as settling basins for sand and silt at all sites except Cambulo.

(4) Head Tanks

A head tank is to be provided at the junction between the headrace channel and the penstock.

Capacity of the head tank is decided to enable supply of the design discharge to the penstock for two minutes or more, even if there is no water from the headrace channel. Moreover, the width of a head tank is decided so that the water velocity in the head tank is less than 0.3m/sec, to add the function of a settling basin as well.

The head tank is made of reinforced concrete and equipped with a flushing gate and spillway.

At Cambulo site, the head tank is also designed as a settling basin to remove the last of the sediments.

(5) Penstocks

Short steel pipes are connected with flange joints, because quality welding work is difficult in the field and access to the sites is generally bad for hauling lengthy pieces

A unit length for pipes of 6 meters is adopted at the sites of Maling-1, Maling-2 and Maluksad where the access is comparatively good. A unit pipe length of 3 meters is adopted at the sites of Cambulo and Liwo-2 because there are narrow or steep slopes in the access foot paths to these sites.

The anchor blocks and saddles are made of reinforced concrete, and the interval between saddles is basically 6 meters.

For the exposed pipe, expansion joints will be installed in consideration of temperature variation while for the underground pipe no expansion joints are provided.

(6) Power Houses

Ordinary above ground type structures will be used for the power houses, where enough space for the generators and control panels etc. will be provided.

The width and length of the power houses will be around 5 to 6 meters, and the height about 3 meters. The maximum depth of the outlet pit is to be about 3 meters from the ground floor of the power house.

The floor and columns will be made of reinforced concrete and the walls of cement mortar finished concrete blocks. The roofs are to be made of galvanized iron sheets that are supported by timber beams. Storage space for maintenance tools and spare parts is also to be provided in the power houses.

Open channels made of reinforced concrete will be provided for the tailrace channels.

(7) Others

Gabion or masonry retaining walls will be adopted for slope protection works over steep excavated slopes (except rock slopes) and in collapse-prone slopes. Near the intake, gabions or retaining walls are to be provided protect river banks from scour. It is noted that blasting work will have to be executed where large boulder removal or rock excavation is needed for the structures or slopes.

In Cambulo site, the planned location of the headrace channel, settling basin and head tank encroaches upon existing rice terraces in some portions. In these places, reinforcement of existing masonry walls or securing of drainage for the rice terraces will be exercised to minimize the influence on the rice terraces.

For access to the power stations and the safe patrolling of civil engineering structures, footpaths with a width of about 50 cm will be constructed at all sites.

Features of the five micro-hydropower stations are shown in Table2.2-5.

Table2.2-5 Features of the Five Micro Hydropower Stations

		Unit	Maling-1	Maling-2	Malksad	Cambulo	Liwo-2
Catchment Area		km^2	16.56	30.39	52.35	51.10	13.54
Available discharge		m^3/sec	0.30	0.50	0.87	0.82	0.26
Design discharge*		m^3/sec	0.31	0.52	0.68	0.65	0.29
Gross head		m	25.520	26.450	20.240	19.785	22.180
Effective head		m	22.930	23.880	19.310	18.145	20.840
Generator output		kW	47.8	83.3	86.8	77.9	38.1
Number of turbine generator		pc	1	1	1	1	1
Type of turbine			Reversal pump/ Cross-flow	Reversal pump/ Cross-flow	Reversal pump/ Cross-flow	Reversal pump/ Cross-flow	Reversal pump/ Cross-flow
Intake weir							
	Type		Tyloean	Concrete gravity	Concrete gravity	Concrete gravity	Tyloean
	Structure		Concrete	Boulder core concrete	Boulder core concrete	Boulder core concrete	Concrete
	Length	m	16.5	27.0	25.0	20.0	14.0
	Height	m	2.0	2.5	2.5	2.5	2.0
Settling basin							
	Structure					Reinforced concrete	
	Inside dimension	m				B3.5×H1.8 (t=0.2)	
	Length	m				10.0	
Headrace channel							
Culvert	Structure				Reinforced concrete		
	Inside dimension	m			B1.4 x H1.4		
	Length	m			40.0		
Open channel	Structure		Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete
(Square shape)	Inside dimension	m	B0.7×H0.7 (t=0.2)	B0.9×H0.9 (t=0.2)	B1.0×H1.0 (t=0.2)	B1.0×H1.0 (t=0.2)	B0.75× H0.75 (t=0.2)
	Length	m	103.0	11.0	277.0	142.0	388.0
Open channel	Structure					Mortar masonry concrete	
(Trapezoidal	Inside dimension	m				B2.0×H1.0 (t=0.3)	
section)	Length	m				290.0	
Conducting pipe	Structure		Steel pipe		Steel pipe	Steel pipe	Steel pipe
	Inside dimension	m	D=650mm (t=4mm)		D=700mm (t=4mm)	D=700mm (t=4mm)	D=650mm (t=6mm)
	Length	m	32.0		67.0	123.0	6.0
Head tank							
	Structure		Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete
	Inside dimension	m	B4.0×H2.5 (t=0.2)	B2.5×H2.7 (t=0.2)	B3.0×H3.0 (t=0.2)	B4.0×H3.4 (t=0.2)	B2.75×H2.9 (t=0.2)
	Length	m	7.0	20.0	20.5	14.0	9.0
Penstock							
	Type		Underground	Buried & Underground	Underground	Buried & Underground	Buried & Underground
	Structure		Steel pipe	Steel pipe	Steel pipe	Steel pipe	Steel pipe
	Inside diameter	m	D=400mm (t=6mm)	D=600mm (t=6mm)	D=600mm (t=6mm)	D=500mm (t=6mm)	D=400mm (t=6mm)
	Length	m	135.0	172.0	31.0	29.0	47.0
	Anchor block	pc	5	7	2	2	3
	Saddle	pc	1	1	1	2	3
Power house							
	Type		Above ground	Above ground	Above ground	Above ground	Above ground
	Structure		Base: Concrete Wall: Concrete block + Mortar Roof: Galvanized iron + Timber	Base: Concrete Wall: Concrete block + Mortar Roof: Galvanized iron + Timber	Base: Concrete Wall: Concrete block + Mortar Roof: Galvanized iron + Timber	Base: Concrete Wall: Concrete block + Mortar Roof: Galvanized iron + Timber	Base: Concrete Wall: Concrete block + Mortar Roof: Galvanized iron + Timber
	Inside diameter	m	B4.4×L4.4 (t=0.3)	B5.7×L4.7 (t=0.3)	B5.7×L5.7 (t=0.3)	B5.4×L5.4 (t=0.3)	B4.4×L4.4 (t=0.3)
	Height of house	m	3.0	3.0	3.0	3.0	3.0
	Pit depth	m	2.5	3.0	3.5	3.4	1.2
Tailrace							
Open channel	Structure		Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete
(Square shape)	Inside dimension	m	B1.2×H0.5	B1.4×H0.5	B1.4×H0.5	B1.5×H0.5	B1.0 x H0.5
	Length	m	6.0	7.0	10.0	15.0	6.0

*:The efficiency of reversal pump greatly depends on effective head and design discharge. Due to the design condition of using the reversal pump of the standard product, the design discharges for Maling-1, Maling-2 and Liwo-2 are a little bigger than their available discharge respectively as a result.

2.2.2.4 Basic Design of Hydro Power Plants

Power output of the hydropower plants is estimated by available water flow and water column pressure at the candidate sites. Potential available water at respective sites is obtained from the hydrologic and meteorological data. The water flow at a weir site is obtained by catchment area and runoff data. Referring to this data, the flow duration curve is prepared for determining turbine discharge. In this study, 90%～95% dependable flow rate is taken for the turbine discharge. Acting turbine head is obtained by level differences between intake and tailrace water levels, which produces the optimum design of waterway structures according to the site conditions. Effective head for the turbines is obtained by reduction of head loss in the waterways. Based on such available water and head and power demand at respective project sites and with an aim at meeting the consumer demand to the maximum extent, installation capacity of each power plant is finally decided.

(1) Selection of hydraulic turbine type

Design head in this Project is in a range from 18m to 24m and available water flow rate is from 0.29 m^3/s to 0.68m^3/s.

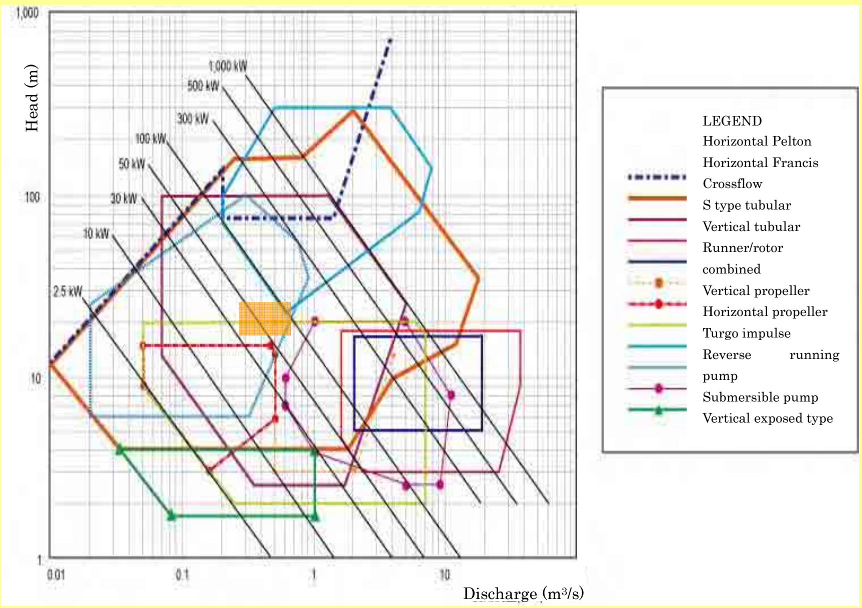


Figure 2.2-1 Selection of Turbine

The applicable turbine type is decided by the selection chart for hydraulic turbines. For this Project, turbine type will be selected from among the horizontal Francis type, cross-flow type, horizontal propeller type and reverse running pump type based on the design head and discharge. The turbine type is also chosen based on ease of maintenance and spare parts procurement. In the Project, most power plants are located in isolated regions; hence this factor is increasingly important. It means that the turbine should be of robust, durable and of trouble-free construction for minimum maintenance. The horizontal propeller and Francis type turbines have guide vane operation mechanism and tend to require sophisticated maintenance service which would be reflected in higher operation costs. The reverse running pump is fabricated of castings which produces metals strong enough to withstand severe operation conditions. However, it has a disadvantage that the pump tends to get less efficient under low load operation. In case of a load shutdown, on the other hand, the reverse running pump can withstand runaway speed operation continuously even if the speed rises to over 150% of the rated speed, that is another advantage over the other types. It is also expected that the pump can be selected from the standard model pumps, which means there is no need to design the specific new manufacture. This fact would certainly contribute to reduction of the cost

Cross flow turbines are commonly used for micro-hydro power stations in the Philippines due to their advantage of simple operation and maintenance.

In consequence of the above discussion, it is judged that the reverse running pump turbine and cross flow turbines are the most suitable types for these micro power plants.

Turbine load change and speed control are generally adjusted by guide vane opening/closing in normal hydraulic turbines, but the reverse running pumps can not follow the system load change due to its construction features. So, in order to correspond to the load change, dummy loads will be placed in the powerhouse tailraces so that the generator output is always kept under constant load. A main inlet valve will be provided in each unit so that it can be started and stopped manually.

(2) Selection of Generators

There are two possible generator types for micro power plants; one is the synchronous generator and the other is the induction generator. The micro power plants in the Project are to be constructed in remote areas where extension of the grid distribution line is not practical. The induction generator generally requires supply of exciting current to kick in. The synchronous generator can be adopted as it is independent of power distribution system.

The generator terminal voltage will be selected from its capacity and speed. Planned capacities of the generators in the Project are in a range from 30kW to 90kW and considering the fact that the standard voltage in the Philippines is 415V for low tension circuits, the applied voltage should also be 415V, and in a 3-phase and 3-wire system. Dimensions of generators with higher speed are generally smaller and become more economical. For the generators of the above range capacity, characteristics are generally of speed 1,800rpm with 4-poles or of 1,200 rpm with 6-poles. In this Project, 1, 200 rpm is recommended considering the runaway speed of the turbine at the time of load shut-down. Turbine speed will be decided based on the available turbine discharge and water head but this speed is not always consistent with that of the generator. To counter this situation, a speed reduction gear is to be provided so that the turbine and generator speed 1,200 rpm is maintained.

(3) Control of generating power plants

Operation of generation equipment will be supervised and controlled by a resident operator. The operation system will, in principle, be of continuous operation.

1) Generator Control Systems :

Each generating plant is to be controlled by an automatic control system. Output voltage is to be automatically controlled by a voltage regulator.

2) Load Control

Generator output will be controlled by a dummy load governor to eliminate the effect of fluctuation of the demand side. Operation mechanism is such that the gap between generator output and demand load is automatically compensated for by means of frequency variation by the Electrical Load Controller (ELC).

(4) Design of hydropower plants

Installation capacity of the five (5) power plants is determined to be in a range from 30kW~90kW based on the following considerations.

- Each respective power plant should produce a constant output throughout the year based on civil engineering structural design and study of the available water discharge.

- Available water discharge will fluctuate enormously in the dry and wet seasons, therefore, the required water for the power generation will be confined within 90% dependable water flow discharge from the duration curve.

Outline of the generating equipment is as follows.

1) Design of Generating Equipment

i) Hydraulic turbine

Type	: Horizontal double suction reverse running pump or Cross flow
Governor	: Dummy load governor
Inlet valve	: Manually operated butterfly valve
Rating	: Refer to table 2-2-6

ii) Generator

Type	: 3-phase brushless synchronous generator

Frequency	: 60Hz
Connection	: 3 phase 3 wire
Insulation class	: F class on stator and rotor windings
Rating	: Refer to table 2-2-6

iii) Control panels

Type	: Indoor, enclosed self-standing type
Control and protection equipment	: Annunciator for status indicator, measuring instruments, protection relays, AVR, Auxiliary relays, 400V switchgears, voltage and current transformers etc.

Table-2-2-6 Basic Design of Generating Equipment

Equipment	Specification	Name of plant site				
		Maling -1	Maling -2	Maluksad	Cambulo	Liwo-2
Turbine	Effective head (m)	22.93	23.98	19.31	18.145	20.84
	Discharge (m^3/s)	0.31	0.52	0.68	0.65	0.26
	Efficiency	0.78	0.82	0.79	0.79	0.78
	Max. output (kW)	54	98	102	92	42
	Speed (rpm)	1,200	700	800	800	1,200
Speed increaser	Flat gear (ratio)	-	7/12	3/4	3/4	-
Generator	Rated capacity (kVA)	70	120	130	120	60
	Rated voltage (V)	415	415	415	415	415
	Efficiency	88.0	87.0	88.0	88.0	87.0
	Power factor	0.8	0.8	0.8	0.8	0.8
	Speed (rpm)	1,200	1,200	1,200	1,200	1,200

2) Operation and control systems

Control and operation will be supervised by a resident operator. Start and stop operation of the generator is effected by manual operation of the main inlet valve.

3) Protection system

i) Emergency stop

Emergency stop will be initiated by the protective relays and a generator main circuit breaker will be opened to isolate the generator from the power distribution system. At the same time, the operator will close the main inlet valve by hand to stop the turbine safely.

Heavy fault alarm will be given by a bell furnished on the generator control panel and the operator will close the main inlet valve immediately. Status of operation and kind of heavy fault will also be indicated on the annunciator in the control panel.

On serious fault conditions, a lock-out relay will be kicked in so that the generator could not be re-started until after confirmation of removal of the cause of the fault.

ii) Alarms

Light fault alarm will be given by a buzzer on the generator control panel. The operator will take the proper action corresponding to the kind of fault and its extent to protect the generator from any damage.

A bell and buzzer alarm can be reset after some period by the operator, but in case of serious fault, the lamp indication is made so that it can not be reset until removal of the cause of fault by way of a lock-out relay.

2.2.2.5 Transmission and Distribution Facilities

(1) Design Policy

There are several kinds of specifications for the transmission/distribution facilities and equipment, which have been standardized in the PEC (Philippine Electric Code) and NEA (National Electric Administration). In the Project, the design of transmission and distribution lines will follow these standards in principle. Because the selected barangays and sitios are not planned to be integrated into the power company's existing grids, the hydro-power generating facilities are to be operated individually and independently. Once the micro generating facilities are completed, residents in the barangays are supposed to undertake the operation and maintenance of them by establishing an organization to this end. Therefore, the installed equipment has to be designed and manufactured for reliability and durability because the residents have to determine the causes of the problems that have occurred and solve them on their own. In addition, the design must take into account availability of spare parts and consumables in the Philippines for easy maintenance service.

1) Applicable criteria and standards

For the equipment and materials for transmission and distribution facilities, the specifications of PEC and NEA will generally be followed. When not stipulated in those standards, IEC shall be adapted.

(a) Philippine Electric Code (PEC)
(b) National Electric Administration (NEA)
(c) International Electrotechnical Commission（IEC）

2) Supply Demarcation

For those who reside near the five Project sites, power will be supplied with a voltage that is determined by weighing the balance between the design generating capacity of the power stations and the communities' (barangay, sitio) power demand.

As a result, at the power station, the primary voltage of the generator 400-440V is stepped up by a transformer to 13.2kV for transmission of power over the transmission lines.

In Japan, the transmission and distribution systems normally comprise supply and construction up to single phase transformer (7.62/0.24kV). For further lower voltage power distribution (240V), supply of materials only such as electric poles, cables and accessories is included in the scope of the transmission/distribution work. Drop wires and Watt-hour meters are not included. The same principle will be employed in the Project as well.

3) Applicable Frequency and Voltage

In the Philippines, a frequency of 60Hz is being used throughout, and for medium voltage transmission lines, rated voltage is 13.2/7.62kV. Rated voltage for lower power distribution is 415/240V.

4) Supply System

Generally, weight of conductor for three (3)-phase, three(3)-wire supply systems is about 75% that for single-phase, two-wire systems, the former being more economical and reasonable from an economic point of view.

In the Philippines, however, use of a neutral line on the secondary side of the transformer is often exercised to materialize single-phase, two (2)-wire distribution due to absence of three-phase power use at the consumer side. There are a number of cases in the Philippines's own undertaking as well as in Japan's development assistance projects that have employed three (3)-phase, four (4)-wire supply systems from the secondary side of the transformer at the power station to enable single-phase, two (2)-wire distribution for this type of power demand at the consumer side. Balancing the loads on R, S and T phases is the critical factor in these cases.

Taking these facts into consideration, transmission system characteristics are determined to be as summarized in the following table.

Table 2.2-7 Power Supplying System of the Project

Type	Transmission Rated Voltage	Supplying System
Middle Voltage Transmission Line	13.2/7.6kV	Three(3) Phase Four(4) Wire (Neutral Grounded)
Low Voltage Distribution Line	240V	Single Phase Two(2) Wire

Voltage drop is in proportion to the length of transmission conductor and its resistance but inversely proportional to voltage. Size of the conductors has to be determined economically balancing these factors such that voltage drop stays within the allowable limit.

Table 2.2-8 shows allowable voltage drop ratio for the medium voltage transmission lines and distribution lines.

Table 2.2-8 Allowable Voltage Drop Ratio

Type	Voltage Drop Ratio	
Medium Voltage	Primary	±1%～2%
Low Voltage	Secondary	±3%～5%

5) Selection of Transmission Line Routes

Transmission line routes for the target five (5) micro power generation sites are determined principally to minimize adverse effects to the rural communities from the view point of environmental protection, such as evacuation of residents, cutting down trees etc. The route selection will also be influenced by physical conditions such as poor subsoil conditions to support electric towers or poles, existence of unstable soil slopes or trees likely to fall over the cable lines at the time of typhoons etc.. Obviously, a route along the existing road is preferred for easy inspection and maintenance but this will not necessarily be economical. All in all, power line routes will be finalized taking all things into consideration.

6) Specifications for Transmission Equipment

i) Conductors for Transmission Lines

Generally, conductors have a tendency that electric current can not easily flow in the center (core) as the frequency of the current goes up. For this reason, composite cables that have a steel core inside that is stronger but less electrically conductive and an outer sheath made of aluminum that has higher conductivity have come into use. Typical of this kind is the bare ACSR cable. This cable, although slightly less conductive than copper cable, is nowadays widely used, particularly for long spanned hanging cables owing to the high tensile strength.

The Project decided to use the ACSR cable for the above reason. Concurrently, size of the cable was determined to be ACSR 1/0 (50mm2) or over in compliance with the voltage drop limitation. Where neutral lines are employed, their cable size should also correspond to the main cables in order to maintain consistency of strength of cable lines.

Table 2.2-9 and 2.2-10 shows the electric characteristics and length of the medium voltage transmission lines for each Project site.

Table 2.2-9 Length of Transmission Line for Each Site

Site / Supply System	Length of Transmission Line(km)				
	Maling-1	Maling-2	Maluksad	Cambulo	Liwo-2
Three Phase Four Wire	2.40	3.00	1.20	0.75	0.45
Two Phase Three Wire	2.30	1.15	0.90	0.40	1.45
Single Phase 2wire	0.65	8.75	1.45	2.25	3.65
Total	5.35	12.9	3.55	3.40	5.55
5 sites total	30.75				

Table 2.2-10 Total Length of Conductors for Each Site

Supply System \ Site	Required Length of Conductors (km)				
	Maling-1	Maling-2	Maluksad	Cambulo	Liwo-2
ACSR 1/0	18.69	34.6	10.92	9.14	8.9
Total	87.45				

In this Project, procuring 13.2kV transmission equipment and materials and also those of low voltage distribution line are to be planned as mentioned below. The equipment and materials are planned to be transported to the end point of the 2nd transportation by the Japanese Side. Construction to string low voltage distribution lines shall be conducted by the Philippine side.

Table 2.2-11 Length of Low Voltage Distribution Line for Each Site

Supply System \ Site	Length of Low Voltage Distribution Line (km)				
	Maling-1	Maling-2	Maluksad	Cambulo	Liwo-2
Single Phase 2wire	3.67	4.69	5.56	4.66	3.55
5 sites total	22.13				

ii) Support Poles for Transmission Lines

For supporting the 13.2kV transmission lines, hollow core steel poles will be used in this Project because of easy availability in the Philippines.

Length of the poles will be determined to secure the required minimum clearance to the surrounding structures and nearby trees. Basically, 30(ft) standard poles will be used because of the constraints in transportation. Length of poles will further be examined from the view point of clearance from the ground as the case may be. Given that the clearance from the poles is not sufficient, 40(ft) or 50(ft) poles will be adopted. Embedding length of pole in the ground will comply with the minimum embedding length prescribed by NEA as summarized in the table below. Span of hanging cables will generally be 40-50m. For other matters, reference is made to the NEW ENGINEERING BULLETIN DX1320 of NEA.

Table 2.2-12 Embedding depth of poles

Length of Pole(ft)	Embedding depth(ft)
30	5.5
40	6.0
50	7.0

iii) Pole-mounted transformers

Pole-mounted transformers will be installed at the center of load at each barangay or sitio where voltage is to be stepped down to 240V. Table 2.2-13 shows the specifications of the standard pole-mounted transformers of NEA. Capacity of the transformers to be installed is determined by picking adequate models from this table in consideration of the demand and utilization factors of the barangay. Selected transformer capacities for the Project sites are illustrated in the attached drawings.

Table 2.2-13 Specification of Pole-mounted Transformer

Type	Single Phase、Outdoor Type Oil-immersed Transformer（±5%、5 steps）
Capacity	5kVA,10kVA,15kVA,20kVA,25kVA,35kVA
Rated Voltage	Primary：7.62kV、Secondary：240V (Single Phase Two Wire)
Cooling System	Self-cooling

iv) Cross arms and fittings for poles

Types of cross arms and fittings are determined according to horizontal and vertical angles along the planned transmission route. They are selected from Table 2.2-14 Type of Cross Arms and Fittings for Poles, standard of NEA

Table 2.2-14 Cross Arms and Fittings for Pole

Type	Type for Cross Arms and Fittings for Pole
Single Phase	A1, A1A A2 A5-1 A7 A7-1
Two Phase	B1 B1A B1-1 B1-1A B2 B3 B4-1 B4-1A B7 B7-1 B8 B14 B15
Three Phase	C1-1 C1-1A C1-2 C1-4 C2-2 C3-1 C7 C14 C15

v) Insulators for poles

Regardless of single phase, two phase or three phase, pin insulators are applied for straight line hanging conductor and suspension insulators, in pairs for angled lines, each 6” diameter.

vi）Fuse cut-out switches

On the primary side of the pole-mounted transformers, a fuse cut-out switch is to be installed for protection of the transformer. Rated voltage and amperage is not to be less than 15kV and 100A respectively. Installed fuses are determined according to the capacity of the transformers.

vii）Lightning arresters

Lightning arresters are to be valve type, rated at not less than 9kV. They are to be installed at the terminal points of the transmission lines or the load side of the cut out switches.

viii) Grounding devices

Grounding devices are to be installed on the distribution transformers, lightning arresters, metal encasements of electric equipment and other required devices for protection of the transmission system. The grounding devices will generally comply with NEA standards.

2.2.3 Basic Design Drawings

The basic design drawings for the Project are listed in Table 2.2-15.

Table 2.2-15 List of basic design drawings

Draw. No.	Title
	(Maling-1)
MMS-001	Maling-1, Malign-2, Malkusad Micro Hydro Power Station Access Plan
M1-C-001	Maling-1 Micro Hydro Power Station General Plan
M1-C-002	Maling-1 Micro Hydro Power Station Waterway Profile and Sections
M1-C-003	Maling-1 Micro Hydro Power Station Intake Weir (Plan & Sections)
M1-C-004	Maling-1 Micro Hydro Power Station Head Tank (Plan & Sections)
M1-C-005	Maling-1 Micro Hydro Power Station Power House (Plan & Sections)
M1-E-001	Maling-1 Micro Hydro Power Station Plan
M1-E-002	Maling-1 Transmission Line Plan
M1-E-003	Maling-1 Transmission Single Line Diagram
	(Maling-2)
M2-C-001	Maling-2 Micro Hydro Power Station General Plan
M2-C-002	Maling-2 Micro Hydro Power Station Waterway Profile and Sections
M2-C-003	Maling-1 Micro Hydro Power Station Intake Weir (Plan & Sections)
M2-C-004	Maling-1 Micro Hydro Power Station Head Tank (Plan & Sections)
M2-C-005	Maling-1 Micro Hydro Power Station Power House (Plan & Sections)
M2-E-001	Maling-2 Micro Hydro Power Station Plan
M2-E-002	Maling-2 Transmission Line Plan
M2-E-003	Maling-2 Transmission Single Line Diagram
	(Maluksad)
MS-C-001	Maluksad Micro Hydro Power Station General Plan
MS-C-002	Maluksad Micro Hydro Power Station Waterway Profile and Sections (1/2)
MS-C-003	Maluksad Micro Hydro Power Station Waterway Profile and Sections (2/2)
MS-C-004	Maluksad Micro Hydro Power Station Intake Weir (Plan & Sections)
MS-C-005	Maluksad Micro Hydro Power Station Head Tank (Plan & Sections)
MS-C-006	Maluksad Micro Hydro Power Station Penstock & Powerhouse (Plan & Sections)
MS-E-001	Maluksad Micro Hydro Power Station Plan
MS-E-002	Maluksad Transmission Line Plan
MS-E-003	Maluksad Transmission Single Line Diagram
	(Cambulo)
CB-G-001	Cambulo Micro Hydro Power Station Access Plan
CB-C-001	Cambulo Micro Hydro Power Station General Plan(1/2)
CB-C-002	Cambulo Micro Hydro Power Station General Plan(2/2)
CB-C-003	Cambulo Micro Hydro Power Station Waterway and Headrace Sections (1/2)
CB-C-004	Cambulo Micro Hydro Power Station Waterway and Headrace Sections (2/2)
CB-C-005	Cambulo Micro Hydro Power Station Intake Weir (Plan & Sections)
CB-C-006	Cambulo Micro Hydro Power Station Settling Basin (Plan & Sections)
CB-C-007	Cambulo Micro Hydro Power Station Head Tank (Plan & Sections)
CB-C-008	Cambulo Micro Hydro Power Station Penstock & Powerhouse (Plan & Sections)
CB-E-001	Cambulo Micro Hydro Power Station Plan

CB-E-002	Cambulo Transmission Line Plan
CB-E-003	Cambulo Transmission Single Line Diagram
	(Liwo-2)
LW-G-001	Liwo-2 Micro Hydro Power Station Access Plan
LW-C-001	Liwo-2 Micro Hydro Power Station General Plan
LW-C002	Liwo-2 Micro Hydro Power Station Waterway Profile and Headrace Sections (1/2)
LW-C003	Liwo-2 Micro Hydro Power Station Waterway Profile and Headrace Sections (2/2)
LW-C-004	Liwo-2 Micro Hydro Power Station Intake Weir (Plan & Sections)
LW-C-005	Liwo-2 Micro Hydro Power Station Head Tank (Plan & Sections)
LW-C-006	Liwo-2 Micro Hydro Power Station Penstock & Powerhouse (Plan & Sections)
LW-E-001	Liwo-2 Micro Hydro Power Station Plan
LW-E-002	Liwo-2 Transmission Line Plan
LW-E-003	Liwo-2Transmission Single Line Diagram
FP-E-001	Support Fitting Types for Single Phase
FP-E-002	Support Fitting Types for Two Phase
FP-E-003	Support Fitting Types for Three Phase

2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

The Project will be implemented in the framework of Japan's Grant Aid Scheme. Therefore, it will be put into practice after approval of the Japanese Government, and the Exchange of Notes (E/N) is conducted between the Governments of both countries.

(1) Project Execution Body

The agency responsible for implementation of this Project on the Philippines side is EUMB in DOE. REMD in EUMB is in charge of the project execution. It is considered necessary to establish an office in charge of the Project in REMD, with at least two full time staff for close communication and coordination with the consultant and contractor from Japan and for smooth progress and completion.

The appointed person in the said project office will explain the details of the Project to the concerned government officials and also to the LGUs and local communities of the barangay. In addition, he will call for attention of the concerned parties to ensure security during construction and installation and also for sustained operation and maintenance of the Project after completion.

(2) The Consultant

In order to work out the design of facility, construction plans, equipment and material procurement and installation, a Japanese consultant will be engaged by the Philippine Government who will carry out the said works along with construction supervision services. The Consultant also is to prepare bid documents and assist DOE in examination of bidder prequalification and bids.

As there are 5 subject sites in the Project, local engineers will be engaged by the Japanese Consultant who will dispatch resident supervisors from the local engineers at each site for quality, security and schedule control.

(3) The Contractor and Local Contractors

The Contractor will be a Japanese corporation selected by the Government of the Philippines through competitive bidding in accordance with Japan's Grant Aid Scheme. The Contractor will construct facilities, procure equipment/material and install, test and commission the equipment procured under the Project.

In order to incorporate local resources as much as possible into execution of the Project, local construction company(s) with ample experience in the field of hydraulic civil engineering structures, installation of transmission lines, etc. will be engaged as subcontractor(s) by the Japanese Contractor.

(4) Necessity to Dispatch Japanese Engineers

Since the work planned under the Project consists of several major components such as civil engineering structure construction, hydro-mechanical and electrical facilities such as gates and penstocks, turbines, generators and control/protection equipment, construction of transmission lines, and testing and commissioning the equipment, coordination among these components is crucial for successful completion of the Project as a whole under the given physical and time constraints.

Dispatch of a site manager from the Japanese Consultant in this regard is considered vital to ensure the quality of the work, safe operation and timely completion.

2.2.4.2 Implementation Conditions

(1) Points to be Considered in Execution of the Work

As Northern Luzon is located under the route of typhoons, people suffer from disastrous damage such as to bridges by floods and traffic disruption by landslides almost every year. As local roads, which are a great distance from trunk national roads are not well maintained, it takes a long time to restore the bridges and roads once they are damaged.

As the subject sites of the Project are located in the mountains and far from trunk roads, the equipment and materials for the Project will certainly have be transported during the season free of typhoons, that is any time of the year except July thru October.

Equipment and materials will have to be transported by man power from the end points of vehicular delivery along the rural roads around the barangay to the power station sites. As these access roads run along steep mountain slopes, transportation of equipment and materials will have to be scheduled in the dry season to ensure safety of goods as well as people. When transportation in rainy season is unavoidable, special safety precautions must be exercised.

Even transportation of heavy equipment such as turbines, generators, transformers or over-size equipment such as penstocks and transmission/distribution poles will have to depend on man power to a large extent, therefore route selection and weather forecasts will have to be very carefully done and watched.

Catchment areas of Maling-2, Maluksad and Cambulo sites are so large that there are huge volumes of water flow in the rainy season. Construction work on such hydraulic structures as weirs and intakes, which will be in the river water permanently after completion must be scheduled during low river water flow periods, namely from the end of the dry season thru the early rainy season, so that temporary water diversion works can be minimized.

To accelerate construction in the dry season, ample construction materials must have been delivered on time at the site. That will in turn require large temporary stock yards around the sites. Timely rescheduling to cope with sudden inclement weather or soil conditions will be called for. These will be important tasks of the engineer dispatched from the Japanese Consultant.

When dynamite blasting, which will certainly be needed for some of the weirs, intakes and headrace construction works, special safety measures for labors and also for the local community will have to be exercised according to applicable safety standards and regulations in the country.

(2) Points to be Considered for Procurement

1) Equipment Design

The five Project sites are scattered in remote regions. To maintain the planned schedule, well organized plans for procurement and transportation of equipment and materials to the sites are very important.

Moreover, considering the fact that BAPA organized by the barangay residents will operate and maintain the equipment after completion, the entire generating system must be simple and trouble-free.

As for the turbines and generators, the ones made in the Philippines could not be used judging from the fact that existing micro-hydro power plants are prone to frequent malfunction. Speaking about the equipment made in the third countries, malfunction of turbines occurred in a micro-hydro power plant in Layte Island. After two years operation, it was replaced with ones made in Japan. In view of these incidents, long-term reliable equipment from Japan is strongly recommended.

On the other hand, equipment and materials for transmission and distribution lines such as aluminum conductors, cables, poles, and transformers and mechanical assemblies such as penstocks and gates that are available in the Philippines have satisfactory records with domestic power companies and industries and have proven their reliability. As a consequence, these local goods are recommended.

The Basic Design Study Team visited factories manufacturing aluminum conductors, power and control cables during the basic design study period and confirmed that they have good manufacturing capacity and their products meet the requirements of the Project.

2) Procurement Control

For smooth execution within the defined period of field work, it is absolutely necessary to deliver the equipment and materials to the sites in a timely manner. Since the period of marine transportation from Japan plus inland vehicular transportation to as near the sites as possible is expected to be about 20 days, the Contractor must undertake procurement in advance paying due attention to this factor. For example, all necessary documents for transportation and customs clearance must be expertly prepared so as not to cause set backs to the progress of the Project.

3) After-sales Service

As it is necessary for the Contractor to provide after-sales service in terms of supply of spare parts and repair of breakdowns associated with the new equipment, he must be able to keep uninterrupted liaison with the concerned parties in the Philippines after the completion of the Project.

2.2.4.3 Scope of Works

Regarding the various undertakings that are necessary to implement the Project's procurement and installation, the Japanese and the Philippine sides are in agreement with the following demarcations in Table 2.2-16, that are self-explanatory.

Table 2.2-16 Scope of Works

No.	Items	Japan	Philippine
1)	To secure land for permanent facilities		○
2)	To secure land for temporary use and eliminate obstacles		○
3)	To maintain and rehabilitate any existing access roads used for the construction work of the project		○
4)	To construct the intake structure for five hydro-power stations	○	
5)	To construct water way structures for five hydro-power stations	○	
6)	To construct powerhouse facilities for five hydro-power stations	○	
7)	To construct transmission lines between the power station and the center of the barangay	○	
8)	To procure the equipment for distribution line after secondary of pole mounted transformer to nearby houses	○	
9)	To install the distribution equipment mentioned in item 8)		○
10)	To procure and install household wiring		○
11)	To procure and install Watt-hour meters		○
12)	Formulation and operation of BAPA		○

A transmission line between the power station to a defined point in the barangay is to be procured and installed by the Japanese side. As for the distribution line, equipment is to be procured by the Japanese side but installed by the Philippine side.

2.2.4.4 Consultant's Supervision

(1) Basic Policy

The basic policy of the Consultant's supervision of the Project is as outlined below:

1) In accordance with Japan's Grant Aid Scheme, the Consultant will organize a project supervision team to enable smooth implementation of the Project based on the detailed design.

2) The Consultant will supervise the Contractor's operation to ensure quality construction works and erection of the equipment indicated in the Contract and completion of the Project as a whole within the scheduled period. The Consultant will also supervise the Contractor's safety measures taken in field works.

(2) Consulting Services

DOE of the Philippines side's execution office and the Japanese Consultants will enter into a contract and the latter will carry out the following tasks.

1) Detailed Design and Preparation of Bidding Documents
i) Detailed Design

Based on the results of the Basic Design Study, the execution costs are to be explained to and confirmed by the Philippine side. At the same time, the responsibilities of the Philippine side are to be confirmed for timely work execution. Prior to the preparation of bidding documents, detailed design will be performed, the execution cost precisely estimated and construction plans worked out.

ii) Preparation of Bidding Documents

The bidding documents will be prepared based on the results of the detailed design and the construction plans conforming to the requirements of the Grand Aid Scheme.

2) Procurement and Construction Supervision

i) Bidding Process

The process includes the bid calling, questions and answers, attendance to bid closing and opening, evaluation of bids, assistance in negotiation and conclusion of execution contract.

ii) Site Supervision Process

This process comprises meetings among concerned parties before commencing site works, approval of shop drawings, factory inspection before shipment, supervision of site erection works, preparation of progress reports during site construction, issue of interim certificates, and attendance to site tests before taking over.

iii) Process after Completion of Construction and Erection

This process comprises issue of completion certificates, processing for taking over, preparation of completion reports and defect liability tests to be carried out one year after taking over.

(3) Members of the Consultant

To smoothly execute the necessary services itemized in Item (2), it is required that a senior engineer with ample experience in similar kinds of services and full understanding of the contents of the Project will be nominated as Project Manager and an effective organization consisting of staffs for detailed design, bidding procedures, review and approval of design, factory inspection, and site supervision will be established.

1) Members for Detailed Design

Table2.2-17 Members for Detailed Design

Title	Contents of Assigned Work
Project Manager	Based on full understanding of the background and purposes of the Project, the Project Manager will manage the overall execution of the Project. He will review and monitor progress of the Project and current problems, control the work progress, and instruct and provide advice to subordinate members. He will carry out bid calling, questions and answers, bid acceptance, evaluation of submitted bids, and assist negotiation and conclusion of contract
Engineers for Civil Facility Design A and B	Based on the established basic design criteria, engineers will determine specifications of civil engineering structures, detailed design, drawings for the five micro-hydropower plants taking into account the natural and physical constraints. Engineer A will carry out bid calling, questions and answers, bid acceptance, evaluation of

	submitted bids, and assist with negotiations and conclusion of contract
Engineer for Gates and Penstock	Based on the established basic design criteria, the engineer will determine the specifications for the Gates and Penstock and execute the detailed design and drawings for the five micro-hydropower plants taking into account natural and physical constraints.
Engineer for Turbine and Generator	Based on the established basic design criteria, the engineer will determine the specifications for the Turbine and Generator, and execute the detailed design for the five micro-hydropower plants taking into account natural and physical constraints.
Engineers for Transmission/ Distribution Line A and B	Based on the established basic design criteria, these engineers will determine the specifications for the Transmission/ Distribution Line, and execute the detailed design, drawings for the five micro-hydropower plants taking into account the natural and physical constraints. As for the distribution line, Quantity of the material to be procure will be checked through site surveys.
Engineer for Construction Program/ Cost Estimate (Civil)	Based on the established basic design, the engineer will prepare the construction schedule and estimate the project cost for the five micro-hydropower plants taking into account the natural and physical constraints based on necessary data from each engineer
Engineers for Bidding Documents	An engineer will collect the required technical information from each engineer and prepare the bidding documents for the five micro-hydropower plants.

2) Members for Construction Supervision

Table 2.2-18 Members for Construction Supervision

Title	Contents of Assigned Work
Chief Engineer for Site Supervision	Based on a full understanding of the background and purposes of the Project, the Chief Engineer will manage the overall execution of the Project. He will review and monitor the progress of the project and current problems, control the progress of the works, and instruct and provide advice to subordinate members. He will support training for formation, operation and management of BAPA and assist to establish a supporting system in cooperation with Technical Cooperation Project in order to enhance BAPA.
Resident Engineer for Civil Facilities	The resident supervising engineer will supervise the entire site works from commencement of construction up to completion of the Project (5 micro-hydropower plants).
Engineer for Civil Facilities	The civil engineer will supervise the civil and building works for the micro-hydropower plants and will be dispatched to the site to perform necessary supervision services during the dry season.
Gates and Penstock Engineer	The Gates and Penstock engineer will be in charge of drawing approval, fabrication, factory inspection and site tests, and installation of gates and penstocks for the micro-hydropower plants and will be dispatched to the site to perform necessary supervising works.
Inspector for Turbines and Generators	The Inspector will examine Turbines and Generators drawings for which Contractor apply for approval and check the quality and function of the equipment at factory prior to the shipment.
Inspector for Transmission/Distribution Line	The Inspector will examine Transmission/Distribution Line facilities' drawings for which Contractor apply for approval.
Procurement Engineer	Procurement Engineer will assist to take over constructed facilities as completion.
Procurement Management Engineer for Turbines and Generators	The electrical engineer will be in charge of turbines, generators, control devices and electrical facilities for the five micro-hydropower plants and will be dispatched to the site to perform necessary supervising works.
Procurement Management Engineer for Transmission/Distribution Line	The engineer in charge of high voltage transmission and distribution line facilities for the five micro-hydropower plants will be dispatched to the site to perform necessary supervising works
Operation Examiner	During commissioning of the facilities, the examiner will operate, examine and test whole facilities.

The Project is unique in that transmission line extension is prohibitive. However, there is great difficulty to access the sites where even cell phones can not be used. The only communication with the outside world will be by satellite phone.

Moreover, the Consultant as well as the Contractor in the sites will face another barrier, communication with the local communities; often it is virtually impossible to use the English language as a medium. In this regard, engagement of local consultants is indispensable.

2.2.4.5 Quality Control Plan

A quality assurance plan is summarized in Table 2.2-19 for the subject works that constitute the Project, civil works i.e. weirs, intakes, water ways, settling basin head tanks, penstocks, gates, turbines and generators and transmission and distribution lines.

Table 2.2-19 Quality Control Plan

Control Item	Tests	Method
1. Civil (concrete) works	Slump test Compressive strength test	Two times for each structure Once for weir, headrace and power house （28 days strength）
2. Gate and Penstock works	Water flow test Water seal test	-Penstock：Water filling and dewatering test at site -Gate：Water seal and operation test at site
3. Turbine and Generator	As mentioned at right	-Check of shop drawings -Review of factory inspection procedure -Attendance to factory inspection or review of factory inspection report -Pre-shipping inspection -Review of packing, transportation and site storage procedure -Review of installation manual and site inspection procedure -Attendance to trial operation, adjustment, and commissioning
4. Transmission /Distribution lines		-Quality and quantity check

2.2.4.6 Procurement Plan

The countries from which equipment and materials are to be procured are as shown in Table 2.2-20

Table 2.2-20 Procurement Plan

No.	Items	Local	Japan	Third Countries
	Materials for Construction			
1)	Sand, Gravel, Cobble stone	○		
2)	Cement	○		
3)	Reinforcement bar, Steel	○		
4)	Power station building materials	○		
5)	Penstock	○		
6)	Gate	○		
	Generating Equipment			
7)	Turbine, Generator		○	
8)	Control and Protection Panel		○	
	Transmission/Distribution Line			

9)	Steel Poles	○		
10)	Wire, Cable	○		
11)	Transformer, Switchgear	○		

2.2.4.7 Operational Guidance Plan

Operation and maintenance of the Project facilities after completion are to be undertaken by BAPA as the recipient of facilities and they are to play a vital roll in the post project period. It is indispensable that they are assisted by LGUs and monitored by DOE.

In the event of getting approval of the Project, it is quite important that BAPA cooperate with the on-going Technical Cooperation Program to obtain guidance from it to work out his own practical and appropriate organization and rules of operation. The Program is also expected to afford appropriate advice and guidance to BAPA throughout the construction period of the Project.

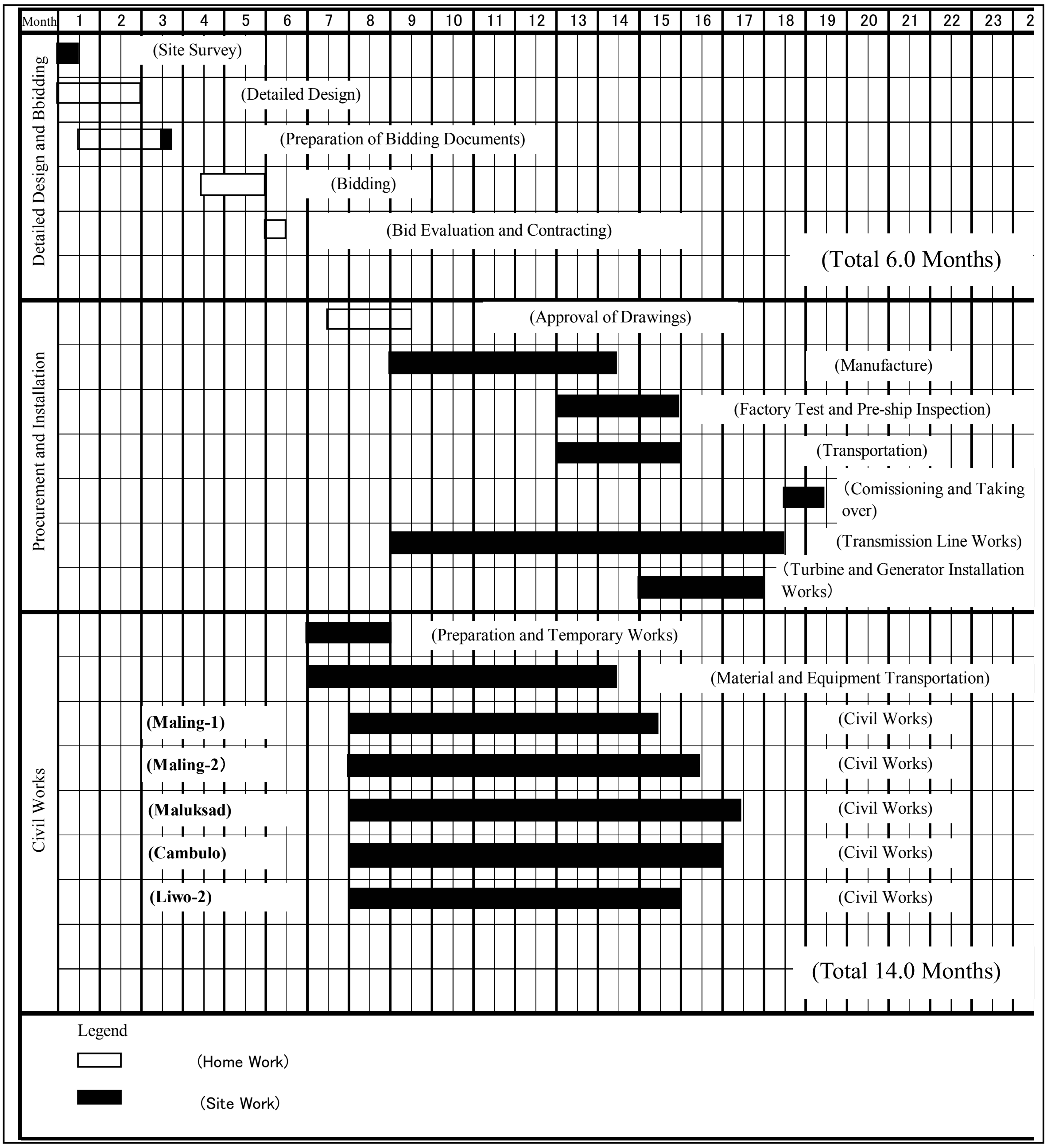
As regards the technical aspect, it is unlikely that hydro-electric engineers are resident in any of the local communities. Therefore, to counter an emergency such as electric trouble or turbine generator related accident it is essential that the local government has established a supporting service system from a regional power utility company for such cases.

In order for BAPA to conduct smooth management of the power supply, there is a common issue to tackle, that is, each local community must pay its power tariff regularly and fully and collection and expending the money is to be conducted in a transparent accounting system. As there is a considerable disparity in income among the residents of the barangays and sitios where some of them are substantially poorer than the others, it may be crucial to establish a practical and well balanced tariff system based on these existing conditions.

2.2.4.8 Implementation Schedule

Execution of this Project will require 20 months from the conclusion of the Exchange of Notes up to completion. The Exchange of Notes will cover both detailed design service and project construction and installation. Table 2.2-21 shows the overall Implementation Time Schedule.

Table 2.2-21 Implementation Schedule



2.3 Obligation of Recipient Country

The following tasks for the Project are to be within the scope of the Philippine side:

(1) Payment of Value Added Tax (VAT)

(2) Installation of Distribution Lines

Installation of distribution line, the materials for which are to be procured by the Japanese side, between secondary of step down transformer to be installed load center of sitio by Japanese side and nearby households

(3) Repair of Access Roads to the Barangays

Because there is inadequate slope protection for the roads to the barangays they tend to suffer from slope collapse, especially in rainy seasons, which make the roads impassable. The access roads are indispensable for transportation of materials and equipment for the Project. Any necessary repair of the roads is to be conducted by the Philippine side.

(4) Securing of land for the generating facilities and transmission lines to be utilized permanently

The Philippine government will secure land for Intake weirs, Headrace channels, Settling basins, Head tanks, Penstocks, Power house; and sites where Transmission Line poles will be laid, and aerial utilization right over the lines.

(5) Securing of land for the Temporary facilities for the construction and eliminate obstacles

The Philippine government will secure land for temporary facilities such as stock yards for materials and equipment and temporary access roads to the site, and eliminate obstacles when needed.

(6) Salary for DOE's staff and their direct costs

(7) Other Expenses

- Commissions to the Japanese bank for banking services based on the Banking Arrangement
- Tax exemption and customs clearance of the products at the port of disembarkation.
- Tax exemption of Japanese nationals from customs duties, internal taxes and other fiscal levies.
- Expenses for application or approval for relevant Authorities in the Philippines.
- All expenses other than those to be borne by the Grant Aid.

2.4 Project Operation Plan

After completion of the Project, to ensure uninterrupted operation and maintenance of the facilities, the following measures are expected to be implemented:

(1) Cooperation on the Project Execution by the Local Communities

Since residents of the selected barangays for the Project will play an important role in the management, operation and maintenance, their firm commitment to the Project is increasingly important. In this regard, effort was strenuously made to confirm this aspect during the site surveys by the Basic Design Study Team. In order to implement this Project smoothly, cooperation from barangay residents should be afforded to the construction and installation parties as well, especially installation of the hydro-electric equipment and transmission lines will need their understanding during the construction periods.

(2) Establishment of O&M Framework

(a) Cooperation with On–going Technical Cooperation Team

It is actually impossible for the local residents to envisage the concept and process of the Project implementation through detailed design and to make themselves ready for actual operation and maintenance activities. So cooperation with the on-going Technical Cooperation Project Team is very much encouraged.

(b) Appropriate Income and Power Tariff

In order to ensure sustainable operation, BAPA has to depend on the power tariff as the major source of income. The power tariff needs be determined in consideration of the required expenditures and income levels of each barangay. BAPA shall conduct fair and transparent accounting and report to the users.

(c) Formulation of BAPA and Drafting the Articles of Incorporation

On formulating BAPA, the articles of incorporation and supply terms and conditions have to be drafted.

(3) Cooperation from DOE and LGU

(a) Dispatching DOE to Initial Technical Transfer Training

It is quite unlikely that there are any electrical engineers resident in any of the barangays.

Consequently, at the initial stage, participation in the training programs from DOE and LGU is considered mandatory.

(b) Financial Assistance from DOE and LGU

BAPA will have to allocate some portion of the collected tariff for maintenance purposes. As a matter of fact, it is actually impossible for them to bear the entire cost of expensive spare parts for repair and maintenance. As a result, it is recommended that a loan system from DOE or LGU for costly spare parts be established.

(4) Acquisition of Operation and Maintenance Skill

(a) Participation by the barangay residents in on-the-job training from the construction stage

It is recommended that participation in on-the-job training offered by the Contractor in order to acquire operation and maintenance skill should be an obligation for concerned residents. This training could consolidate commitment to the Project and also enhance the sense of belonging to the electrified communities, and eventually lead to smooth implementation of the Project.

(b) Guidance service contract with equipment suppliers or manufacturers

It is recommended that a guidance service contract be made between BAPA and the manufacturers because overhaul work if needed is difficult to be carried out by BAPA on their own.

2.5 Project Cost Estimation

2.5.1 Initial Cost Estimation

Cost estimate in the Basic Design Study will be shown in the event of the Exchange of Notes provided that this Project will be implemented under a Japanese Grant Aid Scheme. Based on the conditions mentioned in paragraph (2), estimated cost to be borne by the Japanese side is shown in Annex -4 of Appendix 5.

This cost estimate is provisional and will be further examined by the Government of Japan for the approval of the Grant.

(1) Estimate of Cost to be Borne by the Philippine Side

1)	VAT (Value Added Tax)	Php 34.3 mil. (App. 83.8 mil. Yen)
2)	Installation cost of distribution line	Php 2.2 mil. (App. 5.4 mil. Yen)
3)	Maintenance of road side walls and access roads to sites	Php 1.3 mil. (App. 3.2 mil. Yen)
4)	Secure land	Php 0.4 mil. (App. 1.0 mil. Yen)
5)	Removal of existing trees, etc.	Php 0.2 mil. (App. 0.5 mil. Yen)
6)	Transportation expense of DOE staff	Php 0.5 mil. (App. 1.2 mil. Yen)
7)	B/A and A/P（0.1% of Expenditure）	Php 0.3 mil. (App. 0.7 mil. Yen)
	Total	Php 39.2 mil. (App. 95.8 mil. Yen)

(2) Estimating Conditions

1) Date of Estimate： December, 2006
2) Exchange Rate: 1 US$ = 117.55Yen、1Php=2.44Yen
3) Period of Construction: Detailed design and period of construction are shown in Table 2.2-21
4) Others: The Project will be implemented under a Japanese Grant Aid Scheme.

2.5.2 Operation and Maintenance Cost

The barangay residents have no experience managing the power generation or distribution related work of the Project sites because these sites have not been electrified so far.

Given that this Project is being implemented under a Japanese Grant Aid Scheme, initial investment by the residents in the micro hydro-electric facilities is not necessary. But to permanently manage the power generation and distribution business, it is recommended that a system to save money be established for renewal of the facilities after the current Project's life has lapsed. The activity to build a framework in this aspect is one of the important on-going undertakings of the Technical Assistance Team.

Table2.5-1 Items of Major Expenditure

Items for Major Expenditure	
1)	Allowance for BAPA executives
2)	Labor cost (Operator、Tariff collector、Patrol staff)
3)	Cost to purchase spare parts and maintenance cost
4)	Reserved fund for newel of facilities
5)	Expenses on office
6)	Other（Savings、expenses to purchase batteries）

It is natural that the various Project sites will have different tariff rates because each site has a different length of transmission lines, and a different number of households are to be connected to the transmission line. Moreover, there is considerable variation in income among the barangays. Power tariff is basically to be determined considering the balance between revenue and expenditures; however, because of the said different conditions there will inevitably be different tariffs among the barangays.

(1) Necessary Staff for Management of BAPA

Table 2.5-2 estimates necessary staff for management of BAPA

Table 2.5-2 Necessary Staff for Management for BAPA

	Required personnel	Number of personnel (per one site)	Estimated Salary	Remarks
1)	BAPA Executives	More than 3people in one barangay	1000p/month	
2)	Operator	3 person	200p/day	3shifts
3)	Tariff collector	2～5 people	500p/100H/H	Up to site
4)	Patrol staff	1～3 people	300p/day	4km for 1 person every week

Table 2.5-3 shows required personnel for management of BAPA

Table 2.5-3 Required Personnel for Management of BAPA (day)

Required personnel)	Maling－1	Malimg－2	Maluksad	Cambulo	Liwo-2
① BAPA executives	3	3	4	4	3
② Operator	3	3	3	3	3
③ Tariff collector	3	4	5	4	2
④ Patrol staff	2	3	1	1	2
Total	11	13	13	12	10

(2) Operation and Maintenance Cost

1) Estimated Personnel Cost

Operation and maintenance costs include several kinds of expenditures, but except for depreciation cost of the generating facilities, the major one would be personnel cost. Table 2.5-4 shows estimated personnel costs.

Table 2.5-4 Estimated Labor Cost (Month)

Estimated Labor Cost (Php)	Maling－1	Malimg－2	Maluksad	Cambulo	Liwo-2
① BAPA Executives	3,000	3,000	4,000	4,000	3,000
② Operator	18,000	18,000	18,000	18,000	18,000
③ Tariff collector	1,500	2,000	2,500	2,000	1,000
④ Patrol staff	2400	3,600	1,200	1,200	2,400
Total	24,900	26,600	25,700	25,200	24,400

2) Cost of Spare Parts

Since the Project facilities are primarily designed for robustness and reliability, the main spare parts will, therefore, be consumables. The Project guarantees supply of spare parts for the power generating facilities for 7 years. Upon expiration of that period and thenceforth, the expense for spare parts will have to be covered by the tariff paid by the consumers. Therefore, adequate forecast cycles for change of parts should be carefully worked out.

For repair of a major breakdown of the equipment after expiration of the “defect liability period” of the Project contract, the amount of money required would be so enormous that it could not be included in the tariff. It is recommended that DOE and/or LGU should provide a loan to BAPA for this purpose.

3) Cost for Renewal of Facilities after Project Life

Funds for renewal of the facilities in the future may not be needed if there is a good prospect of grid extension to the pertinent barangays by a power utilities company. It is in fact not a practical idea to entirely renew a micro hydro power generating facility with a unit of the same capacity and include the cost of doing so in the tariff, because it is a standard practice to utilize their full service lives, normally 30 years, with extra careful maintenance services.

4) Other Expenses

There may be some other miscellaneous expenses for office and car rental, office supplies, PCs etc., but existing public facilities and equipment can be utilized in common with other agencies. For example school class rooms can be utilized for BAPA’s meetings, and the cost of PCs and printers can be shared by installing them in schools for common use.

Chapter 3

Project Evaluation and Recommendations

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3.1 Project Effects

(1) Direct Effects

By implementing the Project, 1,600 households with a total population of 8,000 in ten (10) barangays will be supplied with electric power. The total output of electric power is planned to be 334 kW from the five power plants, and power of 200W can be allocated to each household for 24 hours a day throughout the year.

(2) Indirect Effects

The following indirect effects are expected by implementing the Project.

1) Poverty Reduction

Utilization of electric power by local residents will enable introduction of electric equipment such as threshing machine for farming that will increase their income and eventually lead to poverty reduction in rural communities.

2) Improvement of Educational Environment

Electric lighting at home would enable children to study in the evening that will improve educational environment.

3) Improvement of Living Environment

Access to and TV and radio will be made possible by the electrification, which will give access to real time information networks, to say nothing of the electric home appliances such as washing machines, refrigerators etc.. The living environment of the rural communities will be greatly modernized.

4) Formulation of BAPA

A model of BAPA is expected to be formalized

3.2 Recommendations

3.2.1 Recommendations

In order to realize the foregoing effects through uninterrupted and sustained operation of the Project facilities, it is recommended that the Philippines side tackles the following issues in a timely manner.

1) It is very important to set forth a suitable power tariff system taking the actual resident's livelihood into consideration. No less important, however, is to collect the full power tariff from the residents and without delay to enable smooth and sustained operation and maintenance of the Project facilities.

2) The operators and maintenance staff as well as accountants and administrators should not fail to participate in the training programs given by the Project to acquire as much knowledge and skill as possible for the Project facilities. It should be ensured that these people thereafter are actually engaged in their respective jobs after commissioning of the facilities.

3) DOE staff and relevant LGUs should be engaged in technical and financial assistance for BAPA on their own outside the scope of the Project

4) The operators and maintenance staff and accounting and administrative personnel should continue to participate in the training programs that will be conducted in the future in an effort to improve their own skills.

5) BAPA will have to report to LGUs, and LGUs in turn should monitor their activities and provide appropriate guidance and advice. In case of need, LGUs should support them in technical and financial matters.

6) The concerned offices of the Philippine government should give appropriate technical and financial support to the residents of BAPA whenever they attempt to improve their livelihoods.

3.2.2 Cooperation with Technical Assistance

Operation and maintenance of the Project facilities after completion are to be undertaken by BAPA (Barangay Alternative Power Association), which are composed of the local residents who are the recipient of the facilities. The BAPA play a vital roll in the post project period. It is indispensable that they are assisted by LGUs and monitored by DOE. Part of the Project is to assist to establish BAPA by March 2008 in collaboration with an on-going Technical Cooperation Program Team. It is planned that BAPA will cooperate with the Team to obtain guidance to develop its own practical and appropriate organization and rules of operation. The Program is also expected to afford appropriate advice and guidance to BAPA throughout the construction period of the Project.