CHAPTER 5

SURVEY FOR NEW HYDRO ELECTRIC POWER POTENTIAL SITES

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5.1 Survey for New Hydro Electric Power Potential Sites

5.1.1 Outline of Survey for New Hydro Electric Power Potential Sites

The Survey for New HEP (Hydro Electric Power) Potential Sites in this study serves to identify new HEP sites by map study, to conduct site verifications at selected prospective potential sites and to set priorities for potential projects to facilitate the promotion of yen loans, other official financing and also private investment. The selected sites are expected to be developed by LGUs (Local Government Units), ECs (Electric Cooperatives) and private developers.

5.1.2 Target Areas of Survey for Hydro Electric Power Potential Sites

HEP surveys have already been conducted and many potential sites have been identified on Luzon and Mindanao islands. On the other hand, there are many uninvestigated areas on the Visayas islands and North Luzon. These areas are recognized as undeveloped areas of HEP projects.

From the above background, HEP potential sites surveys to be conducted in Visayas and North Luzon areas as a part of this study are shown in Table 5.1-1. The map of the study areas is shown in Fig. 5.1-1.

Table 5.1-1 Target Areas of Surveys

Region		Island
CAR	CORDILLERA ADMINISTRATIVE REGION	Luzon
REGION 1	ILOCOS REGION	
REGION 2	CAGAYAN VALLEY	
REGION 4-B	MIMAROPA	Mindoro
		Marinduque
		Romblon
		Palawan
REGION 5	BICOL REGION	Masbate
REGION 6	WESTERN VISAYAS	Panay
		Negros
REGION 7	CENTRAL VISAYAS	Negros
		Bohol
REGION 8	EASTERN VISAYAS	Samal

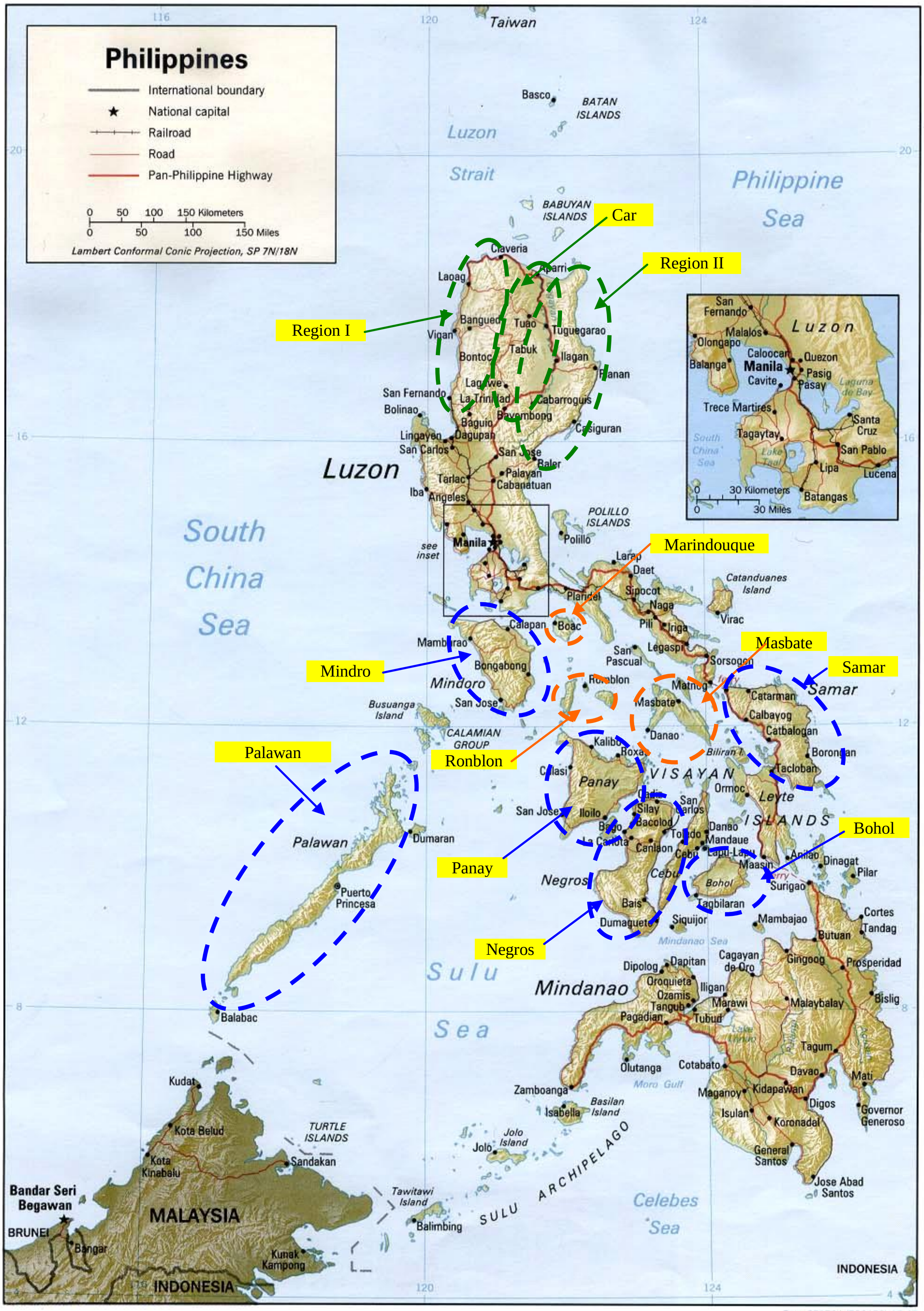


Fig 5.1-1 Map of Study Areas

5.2 Method of Hydro Electric Power Potential Sites Survey

5.2.1 Development Process of Hydro Electric Power Potential Sites Survey

The process from planning to operation of an HEP development project is classified into "Investigation and Planning," "Design," "Construction" and "Operation and Maintenance." The HEP potential survey is a preliminary study of the "Investigation and Planning" process.

In advancing an investigation and study, the general method is to upgrade the quality of the work gradually while considering the work efficiency and its cost efficiency. The "Investigation and Planning" process is roughly classified into a preliminary study and a F/S (Feasibility Study). Easily obtainable 1/50,000 to 100,000 scale topographic maps and existing runoff data are used in the preliminary study stage to make plans for several sites. Highly accurate topographic maps of 1/1,000 to 1/5,000 scales are then produced for those promising sites from economic and technical points of view. Geologic surveys by drilling, etc. and stream flow gauging at dam sites are done accordingly. An F/S is executed based on the results of these investigations. An F/S serves to consider the viability of the project based on power generation plans and layout, project cost estimations, economic and financial evaluations, etc.

Generally, the preliminary study is conducted for the purpose of HEP potential survey and part of preparing a master plan.

(1) Hydro Electric Power Potential Survey

HEP potential is the amount of potential energy that exists in a river or area. An HEP potential survey is done to investigate the potential and conducted from the following viewpoints.

- The available river head is utilized as much as possible in consideration of the present technological and economic level of hydro power development.
- The power generation method which is suitable for the local conditions is determined by the river topography and stream flow conditions.
- The locations of the reservoirs and regulating ponds are selected so that the river stream conditions are improved in ways that produce as much energy as possible by utilizing river flow effectively.

Many sites are planned in this survey, for which the preliminary study method was used.

(2) Master Plan Study

A master plan for river basin development is generally made before conducting an F/S of individual projects. The HEP potential survey is conducted to take inventory of the potential energy existing in a river. On the other hand, the master plan study is conducted to develop a river basin most effectively. As for the procedure, a study of HEP potential similar to that mentioned above is done. Then, priority is given to each project considering the project economics, access roads, transmission lines and other factors. Key projects identified by priority ranking lead to an F/S.

5.2.2 Basic Condition on Hydro Electric Power Potential Sites Survey

(1) Duplication with Existing Facilities and Existing Potential Sites

It is necessary towards identifying new HEP potential sites by map study to avoid duplication with the existing facilities and existing potential sites mentioned in Chapter 4. Some existing potential sites data is incomplete and missing information or old survey dates disqualify them from consideration for investment.

Therefore, even in the case of duplication, existing facilities and other existing potential sites than the (1) Potential sites by private sector (Approved) and (2) Potential sites by private sector (Not Approved) shown in Table 4.3-1, are identified as new HEP potential sites in this survey.

(2) Hydro Electric Power Generation Type

The 1) Run-of-River, 2) Pondage and 3) Reservoir types of HEP generation are adopted from the viewpoint of “power supply capability.”

1) Run-of-river type

This type takes in water within the range of the natural flow to generate electricity, and normally responds to the base load in the daily power demand curve. It is frequently applied to small scale HEP plants.

2) Pondage type

As power demand fluctuates significantly during the course of a single day, power supply must be carried out in response to demand. The pondage type has a pond that enables regulation of the river flow for one to several days. When the river flow is small, it is regulated so that head is built to allow a high power output in a short time in response to the peak load.

3) Reservoir type

As river flow changes by season, a natural lake or artificially constructed reservoir that stores water in the wet season can release it in the dry season to provide even flow throughout the year. While the pondage type has a pond that enables the regulation of river flow for one to several days, a power plant having a reservoir that enables annual or seasonal regulation of river flow is termed a “reservoir type.”

Generally, this type takes charge of peak load since it can supply relatively uniform power output throughout the year, as well as enable instantaneous response to peak demand. This type is widely adopted in large scale HEP plants.

(3) Scale of Power Generation

Republic Act (RA) No. 7156 (Act Granting Incentives to Mini-HEP Developers and for Other Purposes) defines a mini-HEP plant as having 101 kW to 10 MW output and a micro-HEP plant having less than 100 kW output.

The DOE (Department of Energy) promotes the construction of mini-HEP plants and provides tax incentives for these projects in RA No. 9513 (Renewable Energy Act of 2008).

As the DOE requires mini-HEP potential sites for preliminary studies, the target scale of power generation is mainly mini-HEP potential sites of 101 kW to 10 MW. However, promising sites, even if having the scale over 10 MW, shall be the target of this study.

(4) Topographic Map

1/50,000 topographic maps established by the NAMRIA (National Mapping and Resource Information Authority, DENR) is used for the map study. Catchment area, waterway length, etc. required for preliminary studies will be plotted from them.

(5) Discharge Survey

Duration curves of river run-off and regional zones shown in Fig 4.7-8 are used for preliminary studies.

5.2.3 Method of Preliminary Study

The method of preliminary study with regard to map study will reference that in the “Guide Manual for Development Aid Programs and Studies of Hydroelectric Power Projects (New Energy Foundation: 1997)” and the “Report on the Hydroelectric Power Development Planning Survey (Ministry of Economy: 1986).”

A planning flow chart for the preliminary study is shown in Fig 5.2-1.

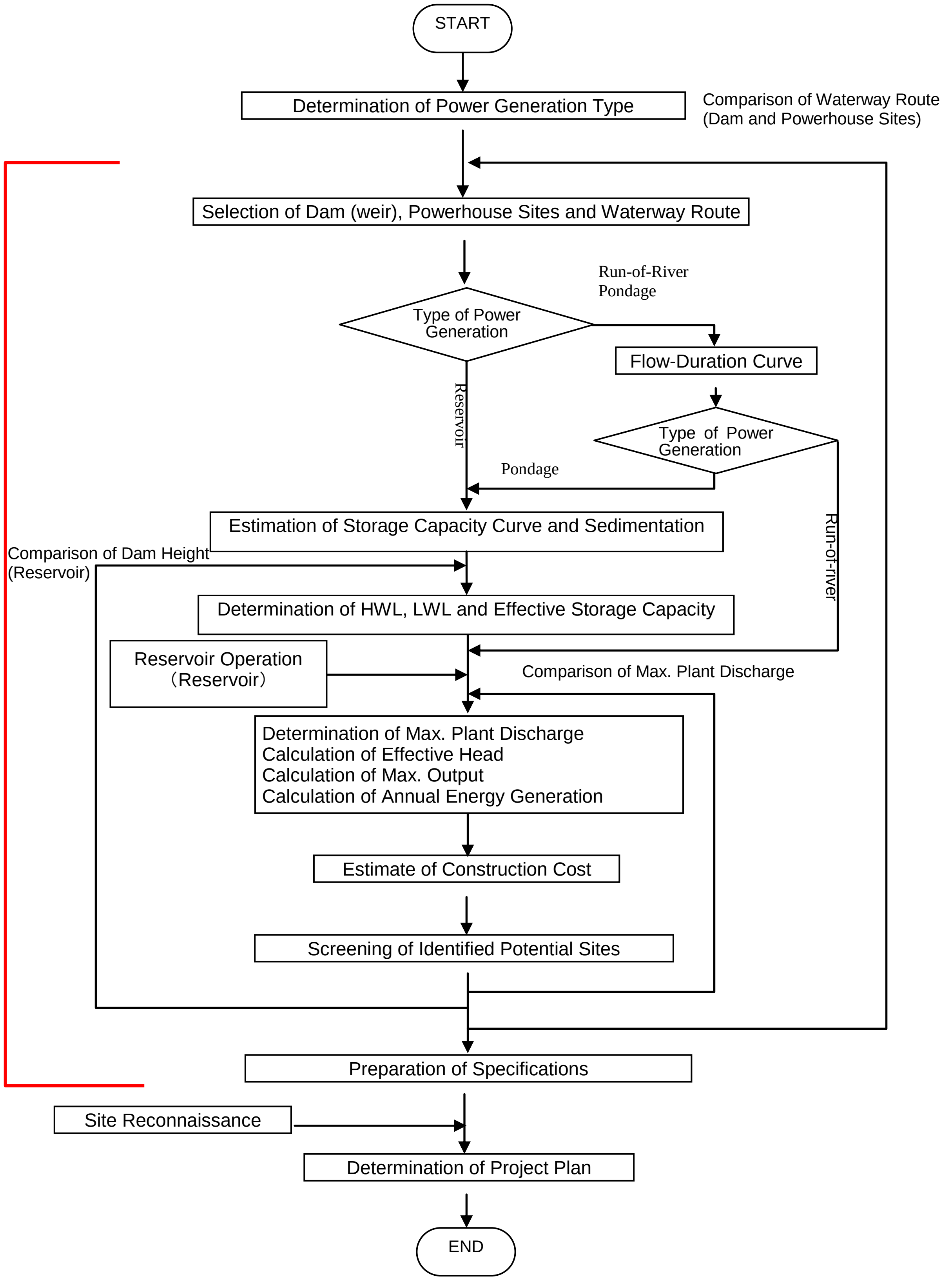


Fig 5.2-1 Planning Flow Chart for Preliminary Study

Reference: Guide Manual for Development Aid Programs and Studies of Hydroelectric Power Projects (New Energy Foundation: 1997)

5.3 Map Study

5.3.1 Method of Map Study

"Map Study" is defined as the process from "START" to "Determination of Optimum Development Scale" in Fig 5.2-1. The method of map study is as follows.

(1) Run-of-river Type

Where topographic features will not permit the development of either a reservoir type or pondage type but have steep river gradient steep where a high head can be obtained by the waterway, a run-of-river type development should be studied. This type has the characteristic of less impact on the environment than the reservoir type and pondage type of development. Even though the project site has topographic features that are suitable for reservoir and pondage types, a run-of-river type should be adopted if environmental problem are foreseen.

The power output and energy will be calculated as the product of river discharge and pressure head. Therefore, a potential site having a short waterway with high pressure head will be considered a prospective site. Therefore, the selection of potential sites will be based on the longitudinal slope (H/L H: height, L length) of the riverbed. In this manual, the potential development site is deemed to be a site having a riverbed slope steeper than 1/200.

The following flow is a summary of the execution for the map study for a run-of-river type project.

① A river segment with a riverbed steeper than 1/200 will be selected from the main river, and the primary and secondary tributaries of the objective river. The river segment will be selected as candidates after further consideration of the tributary junction aspects and the transformation of the longitudinal slope of the riverbed.

② Depending upon the topography along the stream, the objective river segment shall be inclusive of special topography such as waterfalls, winding streamlines or expected shortcuts of water channel. In addition, the location of prospective intakes from other tributaries should be considered.

③ The proper dam/weir site will be selected in each candidate site.

④ The location of the outlet will be selected at a point where the maximum pressure head within 3 to 6 km from the proper dam site can be obtained.

⑤ The shortest waterway route and type (Open channel and Tunnel) will be decided.

⑥ After the measurement of individual catchment areas at the proper dam/weir site, the maximum discharge will be calculated from run-off duration curves.

⑦ The effective head will be measured between the intake and outlet.

⑧ The maximum output and annual energy generation will be calculated.

⑨ The construction cost is estimated and the site is screened.

⑩ Specifications of potential sites will be prepared.

(2) Pondage Type and Reservoir Type

Topographically, where the river is narrow and its immediate upper stream is a wide valley, the reservoir type of development is selected as a reservoir having large storage capacity can be created with a relatively small dam thereat. The pondage type of development is selected where the topography will not permit a large storage reservoir, but a regulating pond to regulate daily or weekly run-off can be constructed. The head of reservoir and pondage types is determined by the dam height, therefore, although river gradient is gentle, potential sites that have the wide catchment area and are topographically suitable for reservoir and pondage types are extracted.

The following is a summary of the execution flow for the map study for reservoir and pondage types.

1. The proper dam site will be selected where the smaller dam volume and much reservoir capacity will be obtained, from a 1/50,000 topographic map.
2. The proper powerhouse site will be selected from the viewpoints of river gradient and the building area for the powerhouse.
3. The shortest waterway route and type (Open channel and Tunnel) will be decided.
4. After the measurement of individual catchment areas at the proper dam site, storage capacity curves will be prepared from the reservoir area at each elevation.
5. Sediment volume in 100 years and sedimentation level will be calculated.
6. Low water level, high water level and effective storage capacity will be decided.
7. The mass curve accumulating daily and monthly inflow to the reservoir will be prepared and the maximum discharge will be calculated.
8. The effective head will be measured between the intake and powerhouse.
9. Maximum output and firm peak output will be calculated.
10. Annual energy generation will be estimated.
11. The construction cost is estimated and the site is screened.
12. Specifications for potential sites will be prepared.

5.3.2 Results of Map Studies

Under the after-mentioned conditions, map studies of the HEP new potential sites have been conducted. As examples of the studies done, the river profile, run-off duration curve and layout on a 1/50,000 topographic map for two potential sites on the Upper Dolores River at Samar Island are shown in Figs. 5.3-1, 5.3-2 and 5.3-3.

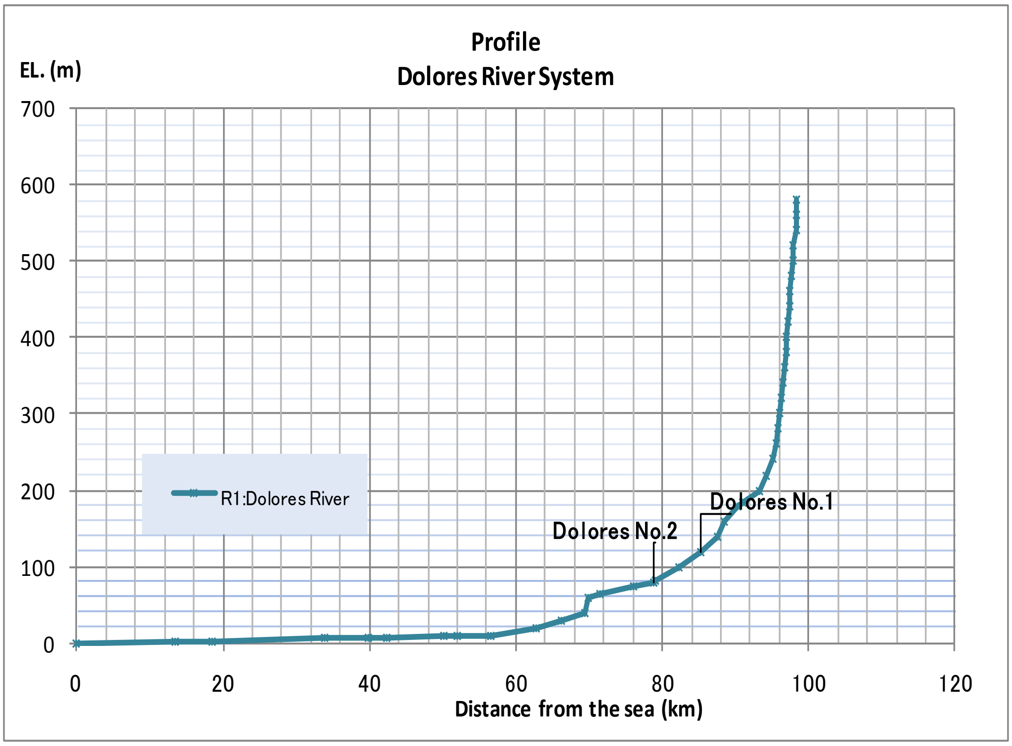


Fig. 5.3-1 Longitudinal Section of River Profile (Dolores River)

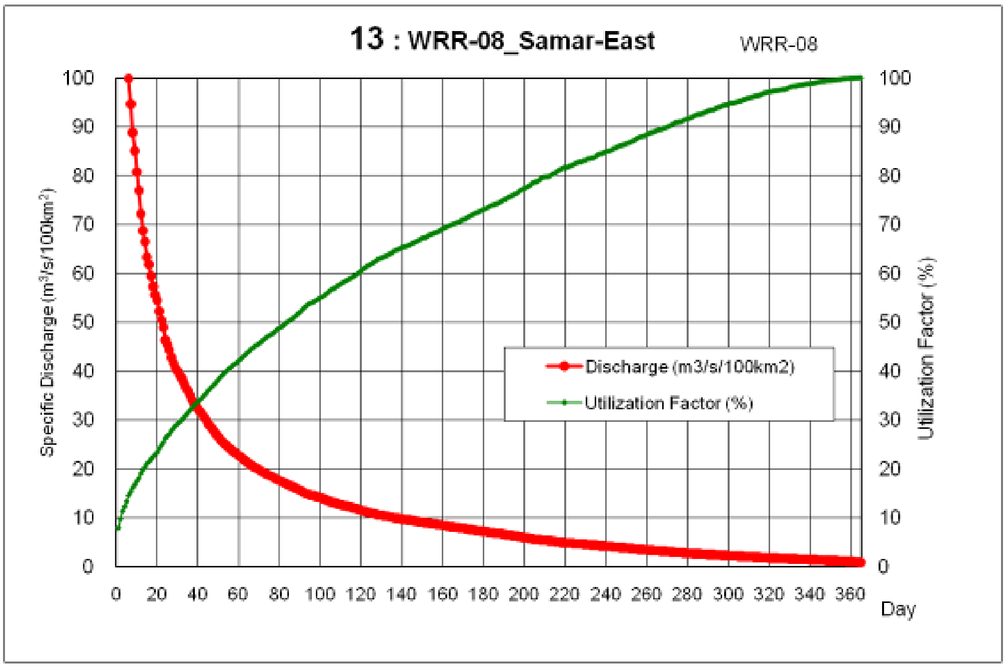


Fig. 5.3-2 Discharge Duration Curve (WRR-08_Samar-East)

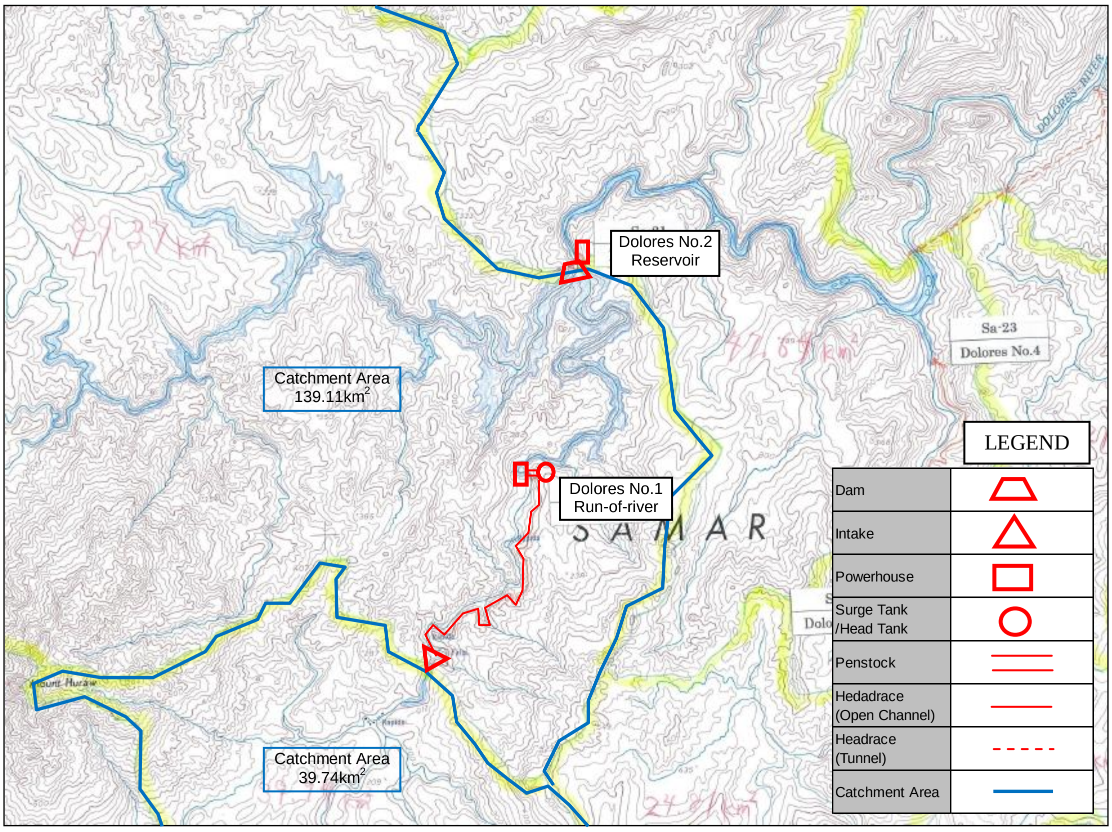


Fig. 5.3-3 Layouts on 1/50,000 Topographic Map

As the result of map studies conducted on this project, a total of 252 HEP potential sites (run-of-river: 222 sites, reservoir and pondage: 30 sites) were identified. A summary of these results is shown in Tables 5.3-1, 5.3-2 and 5.3-3. Seven HEP potential sites had been identified on Palawan Island in the Visayas Grid by the JICA study of 2004. Therefore, although these sites will be described in the new database, additional surveys and preliminary studies shall not be conducted with them.

Table 5.3-1 Regional Distribution and Generation Type of HEP Potential Sites by Map Study

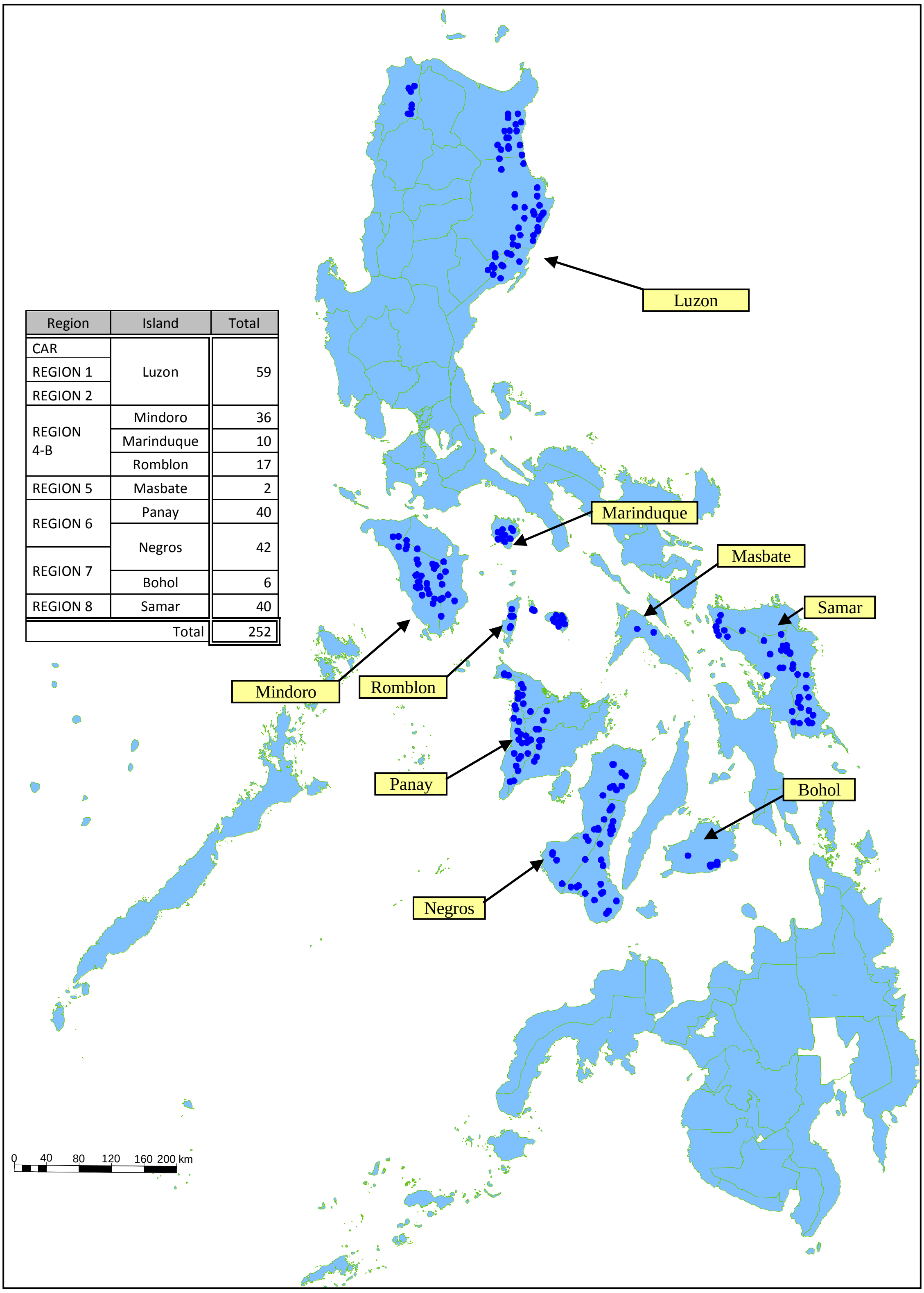
Region		Island	Run-of-river	Reservoir / Pondage	Sub Total
CAR	CORDILLERA ADMINISTRATIVE REGION	Luzon	52	7	59
REGION 1	ILOCOS REGION				
REGION 2	CAGAYAN VALLEY				
REGION 4-B	MIMAROPA	Mindoro	30	6	36
		Marinduque	9	1	10
		Romblon	17	0	17
REGION 5	BICOL REGION	Masbate	2	0	2
REGION 6	WESTERN VISAYAS	Panay	39	1	40
		Negros	35	7	42
REGION 7	CENTRAL VISAYAS				
		Bohol	6	0	6
REGION 8	EASTERN VISAYAS	Samar	32	8	40
		Sub Total	222	30	Total 252

Table 5.3-2 Regional Distribution and Max Output of Run-of-river Type

Island	-100kW	100kW-1MW	1MW-10MW	10MW-	Sub Total
Luzon	0	14	38	0	52
Mindoro	0	2	28	0	30
Marinduque	0	8	1	0	9
Romblon	2	13	2	0	17
Masbate	0	2	0	0	2
Panay	0	17	22	0	39
Negros	0	16	19	0	35
Bohol	0	5	1	0	6
Samar	0	14	18	0	32
Sub Total	2	91	129	0	222

Table 5.3-3 Regional Distribution and Max Output of Reservoir / Pondage Type

Island	-100kW	100kW-1MW	1MW-10MW	10MW-	Sub Total
Luzon	0	0	6	1	7
Mindoro	0	0	4	2	6
Marinduque	0	0	1	0	1
Romblon	0	0	0	0	0
Masbate	0	0	0	0	0
Panay	0	0	1	0	1
Negros	0	0	4	3	7
Bohol	0	0	0	0	0
Samar	0	0	7	1	8
Sub Total	0	0	23	7	30



Region	Island	Total
CAR REGION 1 REGION 2	Luzon	59
REGION 4-B	Mindoro	36
	Marinduque	10
	Romblon	17
REGION 5	Masbate	2
REGION 6	Panay	40
REGION 6 / REGION 7	Negros	42
REGION 7	Bohol	6
REGION 8	Samar	40
	Total	252

Fig. 5.3-4 Regional Distribution of Results of Map Study

5.3.3 Optimum Maximum Power Discharge and Calculation of Generation Energy

(1) Run-of-River Type Hydropower Plant

In the case of run-of-river hydropower plants, under the condition that the power plant is connected to the grid, the maximum power discharge (Qmax) shall be calculated so that unit construction cost (US$/kWh) is the smallest. Then, the optimum scale of the project will be obtained.

The following points are taken into consideration in calculating the generated energy.

- Maintenance flow is 10% of the minimum daily river flow at each potential site.
- The slope of pressure tunnels is 1 : 700. The slope of non-pressure tunnels is 1 : 1,000.
- Total head loss such as head loss of the intake, friction loss of steel penstock and so on, shall be calculated and then the effective head will be obtained. The utilization ratio against total generation energy is 95%.
- The height of the turbine location is 5m above the river bed.

(2) Reservoir-type / Regulating Poundage-type Hydropower Plant

In case of reservoir/poundage type HEP plants, the optimum scale is determined to calculate the maximum power discharge so that B/C or B-C is the maximum.

The following points are taken into consideration in calculating the generated energy.

- Peak hour is basically about 8 hours.
- The effectiveness of reservoir-type/regulating pounded-type hydropower plants is derived by simple rating curve (refer to Fig. 5.3-5).
- For reservoir-type/regulating poundage-type hydropower plants, generation energy is calculated at one-third water level.
- Normal peak output is calculated by means of the normal combined efficiency of turbine and generator obtained by multiplying discharge efficiency by head efficiency.
- Firm output is calculated by means of the normal combined efficiency obtained by multiplying discharge efficiency by head efficiency.

Flow Utilization Factor

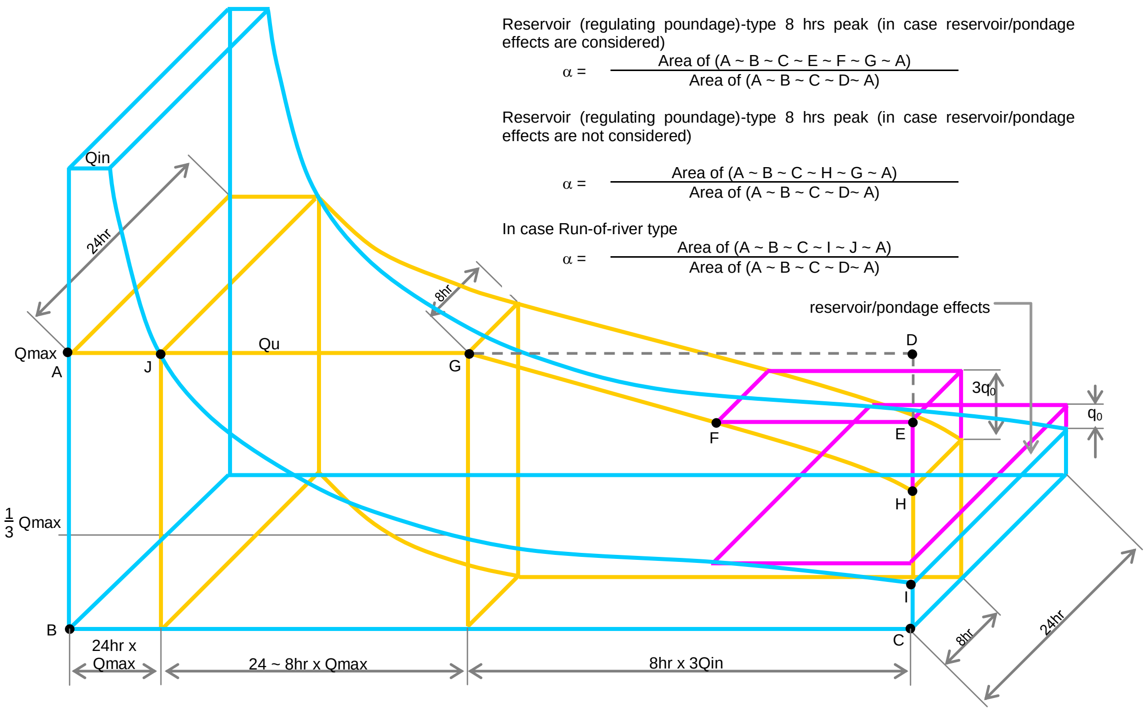


Fig 5.3-5 Operational Effectiveness of Reservoir-type / Regulating Poundage-type Hydropower Plants

5.4 Preliminary Construction Cost Estimates

5.4.1 Construction Work Items of Hydropower Plants

In general, cost items for the preliminary study on HEP planning are as follows and the preliminary total investment cost (total construction cost) is estimated by totalizing the following expenses. Costs for investigations, planning up to the F/S, and operation and maintenance costs are not included in the total cost.

♦ Land
- Land costs, such as land acquisition, land lease, various compensation, etc., are not considered nor are development concession costs.

♦ Preparatory Works
- Access roads and bridges (permanent), improvement of existing roads and bridges, approach roads (temporary), etc.
- Administration offices, lodging houses, auxiliary facilities, etc. (Owner and consultant)

♦ Environmental mitigation
- Natural protection (Natural view, vegetation, wild animals, etc.)
- Water pollution, noise and vibration caused by construction
- Historical relics, cultural assets, valuable and spectacular landscapes

♦ Civil works (Including buildings)
- Structures (Intake weirs, intake structures, settling basins, headrace open channels or tunnels, head tanks, penstocks, spillways, powerhouses, tailraces, outlets, grouting of foundation, switchyards, etc.)
- Temporary facilities (Quarries, borrow pits, spoil areas, stock yards, haul roads, temporary bridges, construction plants and equipment, work shops, surveying equipment, construction offices and accommodations, labor camps, temporary water and power services, telecommunication systems, etc.)
- Building works of powerhouses, transformers, substations and auxiliary facilities, etc.

♦ Hydraulic equipment
- Penstocks
- Gates, screens/trash racks, valves, etc.

♦ Electro-mechanical equipment
- Turbines, generators, control systems, transformers, switchyard equipment
- Auxiliary equipment (Overhead cranes, communication and lighting systems, etc.)

♦ Transmission lines and distribution lines
- Foundations of towers/ poles, substructures, tower structures, wiring, etc.

♦ Management costs
- Expenses of an owner for preparation works before commencement of construction
- Expenses of an owner for administration of construction

♦ Engineering service fee
- Expenses of consultants for detail designs and documentation of construction contracts
- Expenses of consultants for supervision of construction, surveys and tests, etc.

- ♦ Various taxes
  - Import duties, value-added taxes, etc.

- ♦ Contingencies
  - Contingencies against quantity increases
  - Contingencies against price escalation

- ♦ Interest during construction
  - Required interest in each year

Direct costs (preparatory works, environmental mitigation, civil works, hydraulic equipment, electro-mechanical equipment, transmission/distribution lines) and indirect costs (management costs, engineering service fee, various taxes, contingencies, interest during construction) are calculated in the following Table 5.4-1.

Table 5.4-1 Summary of Preliminary Construction Cost (in case of Run-of-River Type)

Items	Estimated Cost	Notes
1. Preparatory Works (1) Access roads (2) Camp and facilities		 (3+4+5) × 0.05
2. Environmental Mitigation Costs		(3) × 0.01
3. Civil Works (1) Intake dams/weirs (2) Intakes (3) Settling basins (4) Headraces (5) Head tanks (6) Penstocks and spillways (7) Powerhouses (8) Tailrace channels (9) Outlets (10) Miscellaneous works		 ((1) ~ (9)) × 0.05
4. Hydraulic Equipment (1) Gates and screens (2) Penstocks and spillways		 Regulating gates, sand flush gates Penstock steel conduits, spillway steel conduits
5. Electro-mechanical equipment		Turbines, generators, main transformers
6. Transmission lines		
Total Direct Cost		1 + 2 + 3 + 4 + 5 + 6
7. Administration cost and engineering fee		(Direct Cost) × 0.15
8. Contingency		(Direct Cost) × 0.1
9. Interest during construction		(1+2+3+4+5+6+7+8) × 0.4 × i × T
Total Project Cost		1+2+3+4+5+6+7+8+9

Wherein, i : Interest, T : Construction period

Source: Guide Manual for Development Aid Programs and Studies of Hydroelectric Power Project, Agency for Natural Resources and Energy & New Energy Foundation, Japan, 1996, Cost Estimate Standards for Construction Costs of Hydropower Projects, Agency for Natural Resources and Energy & New Energy Foundation, Japan, 2005.3

5.4.2 Calculation of Construction Quantities

(1) Method of Quantity Calculation during Detailed Design Stage

During the detailed design stage, each structure is designed in detail and detailed drawings are produced. For each work item, detailed quantities of each work type (rock/soil excavation, rock supports, plain/reinforced concrete, lining concrete, frameworks, reinforcement and so on) are calculated based on detailed drawings.

(2) Method of Quantity Calculation during Preliminary Study Stage

As mentioned above, detailed cost estimates are required for the D/D (detailed design) stage, but in general, a simple method is applied during the preliminary study stage in order to avoid a waste of manpower and time. The quantity formulas that are estimated from past records of HEP projects and based on appropriate parameters of each structure are used.

1/50,000 scale topographic maps are not so accurate for design or quantity calculation of structures, therefore, the quantities of civil works, hydraulic equipment such as penstocks, gates, screens, etc. are estimated by a formula developed from past records of the structures. The said formula is prepared for HEP potential study in Japan, so in the future in the Philippines, the formula is recommended to be revised and modified based on actual data of HEP projects.

5.4.3 Preliminary Construction Quantity Calculation

(1) Preparatory Works

1) Access road works

Road extension is determined by either of the following calculations, and the longer one is applied.

a) The roads to be extended are to be located on the river bank side connecting to the planned powerhouse without crossing the main river, and with an average slope of 10% either up to the dam site or powerhouse site from the nearest main road, whichever elevation difference is larger.

b) The roads to be extended are to be located on the river bank side connecting to the planned powerhouse without crossing the main river, and 1.5 times the shortest length from the nearest main road to the dam site or the powerhouse site, whichever distance is longer.

2) Office and camp facilities

The preliminary cost of the offices and camp facilities is 5% of the costs of civil works, hydraulic equipment and electro-mechanical equipment.

(2) Environmental Mitigation Cost

For a run-of-river type or project, the environmental mitigation cost is 1% of the total cost of the civil works.

(3) Civil Works and Hydraulic Equipment

A preliminary quantity equation is separately prepared for each structure such as dams/weirs, intakes, headrace tunnels/open channels, and so on. The quantities of major types of work such as excavation, concrete, reinforcement, gates, screens and penstock are estimated.

The following symbols and units are used for the quantity calculation.

Ve	:	Excavation volume	(m^3)
Vc	:	Concrete volume	(m^3)
Wr	:	Weight of reinforcement bars	(ton)
Wg	:	Weight of gates	(ton)
Ws	:	Weight of screens	(ton)
Wp	:	Weight of steel conduits/penstocks	(ton)

Quantities other than main work types are not calculated. However, costs estimated as "others" in a lump-sum at a certain ratio against the total cost of main work types are added.

The quantities of headrace tunnels and penstocks are calculated based on their inner diameters. The inner diameter adopted in this study is the economical cross-section based on the prices of commodities in Japan, provided there may be differences due to the price levels in the Philippines.

The quantity of each work item is calculated as follows.

1) Intake dams/weirs

① Weir (Dam) structures

The excavation volume, concrete volume, weight of reinforcement bars and weight of gates are calculated with the following equations.

In case of a dam (According to dam standards, height > 15m)

$$Ve = 8.81 \times (Hd \times L)^{1.04}$$
$$Vc = 9.45 \times (Hd^2 \times L)^{0.722}$$
$$Wr = 0.053 \times Vc^{1.10}$$

In case of a weir (According to weir standards, height ≤ 15m)

$$Ve = 0.289 \times (Hd \times L)^{1.83}$$
$$Vc = 8.64 \times (Hd^2 \times L)^{0.726}$$
$$Wr = 0.053 \times Vc^{1.10}$$

wherein, *Hd* : Dam / Weir height (m)
L : Crest length of dam / weir (m)

② Hydraulic equipment

The sand flush gate of an intake dam / weir is calculated by the following equation.

$$Wg = 0.145 \times Qf^{0.692}$$

wherein, *Qf* : Design flood discharge (m^3/s)

$$Qf = Q = 0.87 \times CA^{(CA^{-0.05}-1)}$$

CA : Catchment area (km^2)

The design flood discharge is obtained by multiplying the coefficient of design flood discharge by drainage area at the dam site (ECFA Guideline, Far East Asia Economic Committee). However, in case such design flood discharge is available around the site, it will be utilized.

③ **Others**

30% of the sum of ① + ② is added. Quantities of the dam / weir at the tributaries are calculated by means of the same method.

2) Intakes

① **Intake structures**

The excavation volume, concrete volume, weight of reinforcement bars and weight of gates are calculated with the following equations.

(a) Non-pressure Intake

$$Ve = 563 \times (R \times Q)^{0.674}$$
$$Vc = 96.2 \times (R \times Q)^{0.759}$$
$$Wr = 0.0522 \times Vc^{0.992}$$

(b) Pressure Intake

$$Ve = 18.4 \times \{[(ha+2R) \times Q]^{1/2} \times n^{1/3}\}^{1.95}$$
$$Vc = 13.0 \times \{[(ha+2R) \times Q]^{1/2} \times n^{1/3}\}^{1.57}$$
$$Wr = 0.0135 \times Vc^{1.20}$$

wherein,

D	:	Inner diameter of waterway	(m)
R	:	Radius of waterway	(= D/2, unit: m)
Q	:	Maximum plant discharge	(m^3/s)
ha	:	Available water depth	(m)
n	:	Number of waterways	

② **Hydraulic equipment**

The weight of gates and screens of intake structures is obtained with the following equations.

(a) Non-pressure Intake

$$Wg = 2.39 \times (R \times Q)^{0.502}$$
$$Ws = 0.898 \times (R \times Q)^{0.589}$$

(b) Pressure Intake

$$Wg = 0.970 \times [(ha + 2R)^{1/8} \times Q]^{0.929}$$
$$Ws = 0.589 \times [(ha + 2R)^{1/8} \times Q]^{0.943}$$

wherein,

R	:	Radius of waterway	(= D/2, unit: m)
Q	:	Maximum plant discharge	(m^3/s)
ha	:	Available water depth	(m)

③ **Others**

25 % of the sum of ① + ② is e added.
The quantities of dams/weirs in the tributaries are calculated by means of the same method.

3) Settling basins

① **Structure of settling basin**

The excavation volume, concrete volume, weight of reinforcement bars and weight of gates are calculated with the following equations.

$Ve = 515 \times Q^{1.07}$
$Vc = 392 \times Q^{0.882}$ (With concrete slab)
$Vc = 188 \times Q^{1.035}$ (Without concrete slab)
$Wr = 0.120 \times Vc^{0.847}$

wherein, Q : Maximum plant discharge (m^3/s)

② **Hydraulic equipment**

The weights of regulating and sand flushing gates and screens are obtained with the following equations.

$Vc = 392 \times Q^{0.882}$
$Wr = 0.120 \times Vc^{0.847}$

wherein, Q : Maximum plant discharge (m^3/s)

③ **Others**

20% of ① + ② are added.

4) Headraces

Headraces can be built as tunnel structures (pressure, non-pressure) and open channel structures. In case a surge tank is required, the tunnel type shall be pressure type.

(a) Non-pressure hood-shape tunnel (Concrete lining invert, shotcrete at side wall and arch part)

① **Tunnel**

The relationship between the power discharge and tunnel inner diameter is obtained with following equations under the condition of 80% of the water depth.
$Q < 3.788\ m^3/s,\ Q = H = 2.1\ m$
$Q > 3.788\ m^3/s,\ Q = H = 1.2743 \times Q^{0.375}\ m$

The excavation volume, concrete volume and weight of reinforcement bars weight are calculated with the following equations.

$Q \leqq 21.127\ m^3/s$
$$Ve = (-2.6185 \times 10^{-5} Q^4 + 1.66586 \times 10^{-3} Q^3 - 4.61724 \times 10^{-2} Q^2 + 1.66586 \times 10^{-3} Q + 1.71336) \times L$$

$$Vc = (-1.61185 \times 10^{-5} Q^4 + 7.74004 \times 10^{-4} Q^3 - 1.35454 \times 10^{-2} Q^2 + 1.54291 \times 10^{-1} Q + 1.68677 \times 10^{-1}) \times L$$

wherein, L : Total length of tunnels (m)
D : Inner diameter of tunnels (m)

$Q > 21.127$ m³/s,

$$Ve = (1.87253 \times 10^{-7} Q^4 - 1.90391 \times 10^{-3} Q^3 - 1.66210 \times 10^{-3} Q^2 + 7.03711 \times 10^{-1} Q + 5.13473) \times L$$

$$Vc = (3.27094 \times 10^{-8} Q^4 - 3.60482 \times 10^{-6} Q^3 - 7.68236 \times 10^{-5} Q^2 + 4.70399 \times 10^{-2} Q + 5.41448 \times 10^{-1}) \times L$$

② **Others**

45% of ① is added.

(b) Non-pressure hood-shape lining tunnel

① **Tunnel**

The relationship between the power discharge and tunnel inner diameter is obtained with following equations under the condition of 80% of the water depth.

$Q < 4.04$ m³/s, $D = H = 1.8$m
$Q > 4.04$ m³/s, $D = H = 1.06643 \times Q^{0.375}$ m

The excavation volume, concrete volume and weight of reinforcement bars are calculated with the following equations.

$Q \leqq 23.791$ m³/s

$$Ve = (9.22643 \times 10^{-5} Q^4 - 4.43409 \times 10^{-3} Q^3 + 6.17799 \times 10^{-2} Q^2 + 3.86416 \times 10^{-1} Q + 3.40431) \times L$$

$$Vc = (1.02187 \times 10^{-4} Q^4 - 5.11983 \times 10^{-3} Q^3 + 8.19956 \times 10^{-2} Q^2 - 2.79037 \times 10^{-1} Q + 2.91308) \times L$$

$$Wr = (-2.09618 \times 10^{-9} Q^4 + 7.31510 \times 10^{-7} Q^3 - 9.74454 \times 10^{-5} Q^2 + 9.73989 \times 10^{-3} Q + 5.95781 \times 10^{-1}) \times L$$

$Q > 23.791$ m³/s,

$$Ve = (-3.86462 \times 10^{-8} Q^4 + 1.69162 \times 10^{-3} Q^3 + 8.19956 \times 10^{-2} Q^2 - 2.79037 \times 10^{-1} Q + 2.91308) \times L$$

$$Vc = (-7.44482 \times 10^{-9} Q^4 + 4.44423 \times 10^{-6} Q^3 - 9.79783 \times 10^{-6} Q^2 + 1.73961 \times 10^{-1} Q + 2.83793) \times L$$

$$Wr = (-2.09618 \times 10^{-9} Q^4 + 7.31510 \times 10^{-7} Q^3 - 9.74454 \times 10^{-5} Q^2 + 9.73989 \times 10^{-3} Q + 5.95781 \times 10^{-1}) \times L$$

② **Others**

35% of ① is added.

(c) Non-pressure standard horse-shoe section tunnel

① Tunnel

The relationship between the power discharge and tunnel inner diameter is obtained with the following equations under the condition of 80% of the water depth.

$Q < 3.806\ m^3/s$, $D = H = 2.1m$
$Q > 3.806\ m^3/s$, $D = H = 1.0905 \times Q^{0.375}$ m

The excavation volume, concrete volume and weight of reinforcement bars are calculated with the following equations.

$Q \leqq 32.006\ m^3/s$

$$Ve = (-1.45111 \times 10^{-5} Q^4 + 1.12846 \times 10^{-3} Q^3 - 3.45836 \times 10^{-2} Q^2 + 1.00296 Q + 1.70592) \times L$$
$$Vc = (-9.88510 \times 10^{-6} Q^4 + 7.15935 \times 10^{-4} Q^3 - 1.92263 \times 10^{-2} Q^2 + 3.84513 \times 10^{-1} Q + 1.16991) \times L$$
$$Wr = (-2.21888 \times 10^{-9} Q^4 + 7.37518 \times 10^{-7} Q^3 - 9.25049 \times 10^{-5} Q^2 + 9.03707 \times 10^{-3} Q + 4.90405 \times 10^{-2}) \times L$$

$Q > 32.006\ m^3/s$,

$$Ve = (-8.26889 \times 10^{-8} Q^4 + 3.06268 \times 10^{-5} Q^3 - 4.56300 \times 10^{-3} Q^2 + 6.44102 \times 10^{-1} Q + 3.28568) \times L$$
$$Vc = (-6.37649 \times 10^{-8} Q^4 + 2.19764 \times 10^{-5} Q^3 - 2.83472 \times 10^{-3} Q^2 + 2.48007 \times 10^{-1} Q + 1.18638) \times L$$
$$Wr = (-2.21888 \times 10^{-9} Q^4 + 7.37518 \times 10^{-7} Q^3 - 9.25049 \times 10^{-5} Q^2 + 9.03707 \times 10^{-3} Q + 4.90405 \times 10^{-2}) \times L$$

② Others

35% of ① is added.

(d) Pressure standard horse-shoe section tunnel

① Tunnel

The relationship between the power discharge and tunnel inner diameter is obtained with the following equations.

$Q < 4.635 m^3/s$, $D = H = 1.8m$
$Q > 4.635\ m^3/s$, $D = H = 1.0128 \times Q^{0.375}$ m

The excavation volume, concrete volume and weight of reinforcement bars are calculated with the following equations.

$Q \leqq 27.297\ m^3/s$

$$Ve = (5.03248 \times 10^{-5} Q^4 - 2.77056 \times 10^{-3} Q^3 + 4.40986 \times 10^{-2} Q^2 + 3.23166 Q + 3.32398) \times L$$
$$Vc = (5.64550 \times 10^{-5} Q^4 - 3.23659 \times 10^{-3} Q^3 + 5.91292 \times 10^{-2} Q^2 - 2.20328 \times 10^{-1} Q + 2.87628) \times L$$

Wr $= (-4.01715 \times 10^{-9} Q^4 + 1.20738 \times 10^{-6} Q^3 - 1.41778 \times 10^{-4} Q^2 + 1.27421 \times 10^{-2} Q + 8.31994 \times 10^{-2}) \times L$

$Q > 27.297$ m^3/s

Ve $= (-5.15736 \times 10^{-8} Q^4 + 1.88926 \times 10^{-5} Q^3 - 3.04391 \times 10^{-3} Q^2 + 5.22516 \times 10^{-1} Q + 4.24043) \times L$

Vc $= (-2.19718 \times 10^{-8} Q^4 + 7.78002 \times 10^{-6} Q^3 - 1.19975 \times 10^{-3} Q^2 - 1.66614 \times 10^{-1} Q + 2.63150) \times L$

Wr $= (-4.01715 \times 10^{-9} Q^4 + 1.20738 \times 10^{-6} Q^3 - 1.41778 \times 10^{-4} Q^2 + 1.27421 \times 10^{-2} Q + 8.31994 \times 10^{-2}) \times L$

② **Others**

50% of ① is added.

(e) Tunnel Audit

In case of long tunnel lengths, work audits are required.

(f) In case of open channel

① **Open Channel**

The width and height of open channels are obtained by the maximum power discharge using the following equation. (B=2H)

$H = (Q / 3.065)^{0.375} \times 1.1 + 0.2$ (m)

$B = (Q / 3.065)^{0.375} \times 2$ (m)

wherein, Q : Maximum plant discharge (m^3/s)
B : Width of open channel (m)
H : Height of open channel (m)

The excavation volume, concrete volume, and weight of reinforcement bars are calculated with the following equations.

$Q \leqq 10$ m^3/s

Ve $= (6.9740 \times Q^{0.3533}) \times L$
Vc $= (1.2526 \times Q^{0.4224}) \times L$
Wr $= (0.0774 \times Q^{0.3930}) \times L$

10 m^3/s $< Q \leqq 100$ m^3/s

Ve $= (6.6143 \times Q^{0.3767}) \times L$
Vc $= (0.8656 \times Q^{0.5757}) \times L$
Wr $= (0.0550 \times Q^{0.5346}) \times L$

$Q > 100$ m^3/s

Ve $= (6.4832 \times Q^{0.3811}) \times L$
Vc $= (0.6813 \times Q^{0.6264}) \times L$
Wr $= (0.0442 \times Q^{0.5811}) \times L$

wherein, Q : Maximum plant discharge (m^3/s)
L : Total length of open channels (m)

② **Others**

30% of ② is added.

5) Head tanks

① **Head tank structure**

The excavation volume, concrete volume and weight of reinforcement bars of concrete are calculated with the following equations.

$$Ve = 808 \times Q^{0.697}$$
$$Vc = 111 \times Q^{0.978}$$
$$Wr = 0.06 \times Vc$$

wherein, Q : Maximum plant discharge (m^3/s)

② **Hydraulic equipment**

The quantities of gates and screens are not considered.

③ **Others**

40% of ① is added.

6) Surge Tanks

① **Surge tank structures**

The excavation volume, concrete volume and weight of reinforcement bars of concrete are calculated with the following equations.

$$Ve = 100 \times Q \times \{(ha+Lt)^{1/4}\}^{0.791}$$
$$Vc = 25.9 \times Q \times \{(ha+Lt)^{1/4}\}^{0.857}$$
$$Wr = 0.0420 \times Vc$$

wherein,
Q : Maximum plant discharge (m^3/s)
ha : Available water depth (m)
Lt : Total length of open channels (m)

② **Others**

40% of ① is added.

7) Penstocks and spillways

① **Penstocks**

An inner diameter of a penstock steel conduit is calculated with the following equation using the maximum power discharge and maximum static head.

$$D_m = \left(1.93333 \times 10^{-9} \times H_g^{\,3} - 6.1000 \times 10^{-7} \times H_g^{\,2} - 1.82333 \times 10^{-4} \times H_g + 0.8984\right)$$
$$\times Q^{(-3.38813\times 10^{-21} \times H_g^{\,3} + 1.37558\times 10^{-18} \times H_g^{\,2} - 6.0\times 10^{-5} \times H_g + 0.373)} \text{ (m)}$$

The maximum and minimum pipe shell thicknesses of penstock steel conduits are calculated with the following equations.

$$t_{max} = D_m \times 100 \times H_{max} / (2 \times 1300 \times 9) + 2 \quad \text{(mm)}$$
$$t_{min} = (D_m \times 1000 + 800) / 400 \quad \text{(mm)}$$

The maximum head H_{max} is the sum of the static head and water hammer. Water hammer H_{wh} is calculated with the following equation.

$$H_{wh} = n \times H / 2 + H_g \times (n^2 + 4 \times n)^2 / 2) \times 1.3 \quad \text{(m)}$$
$$n = (L \times v / (9.8 \times t \times H_g))^2$$

wherein,				
	t	:	Closing time	(sec)
	v	:	Flow velocity	(m/sec)
	L	:	Total length of penstocks	(m)
	H_g	:	Static head (Intake WL – Tailrace WL)	(m)

The weight of penstock steel conduits is calculated with the following equation.

$$W_p = (0.7854 \times (D_m + 2 \times t_{min} / 1000)^2 - D_m{}^2) \times 7.86 \times L(t_{min}) + 0.7854 \times (D_m + 2 \times t_{min} + 1) / 1000)^2 - D_m{}^2) + (D_m + 2 \times t_{max} / 1000)^2 - D_m{}^2) / 2 \times 7.86 \times (L - L(t_{min}))) \times 1.2$$

wherein,				
	W_p	:	Weight of penstock steel conduit	(ton)
	t_{max}	:	Max. thickness of penstock conduit	(mm)
	t_{min}	:	Min. thickness of penstock conduit	(mm)
	D_m	:	Mean inner diameter of penstock conduits	(m)
	H_g	:	Static head (Intake WL – Tailrace WL)	(m)
	H_{max}	:	Max. head (H_g + Water hammer)	(m)
	L	:	Total length of penstocks	(m)
	$L(t_{min})$	:	Penstock length with min. thickness	(m)

An allowable tensile strength of 1,300 kgf/cm^2 is applied for penstock steel conduits.

② Penstock civil works

(a) Open penstocks

The excavation volume, concrete volume, and weight of reinforcement bars for open penstock are calculated with the following equations.

$$Ve_1 = 12.2 \times D_m{}^{1.26} \times L$$
$$Vc_1 = 2.92 \times D_m{}^{1.96} \times L$$
$$Wr_1 = 0.0217 \times Vc_1$$

wherein,				
	D_m	:	Mean inner diameter of penstock conduit	(m)
	L	:	Total length of penstocks	(m)

Provided that the upper horizontal portion is 10 m long and the lower horizontal portion is 10 m long, and the inclined length is calculated. Then, the total length of penstocks is obtained.

(b) Tunnel penstocks

The excavation volume, concrete volume, and weight of reinforcement bars for tunnel penstocks are calculated with the following equations

$D_m < 1.1$m

$Ve_1 = - 1.1369 \times 10^{-13} \times D_m^{\ 2} + 2.16005 \times 10^{-13} \times D_m + 5.022) \times L$

$Vc_1 = (-0.7875 \times D_m^{\ 2} + 4.71938) \times L$

$Wr_1 = 0.0217 \times V c_1$

$D_m \geqq 1.1$m

$Ve_2 = (3.8003 \times 10^{-5} \times D_m^{\ 4} + 2.5389 \times 10^{-3} \times D_m^{\ 3} + 8.9878 \times 10^{-1} \times D_m^{\ 2} + 2.63379 \times D_m + 1.3206) \times L$

$Vc_2 = (2.0857 \times 10^{-5} \times D_m^{\ 4} - 3.5998 \times 10^{-4} \times D_m^{\ 3} + 1.0944 \times 10^{-1} \times D_m^{\ 2} + 2.1375 \times D_m + 1.289) \times L$

$Wr_1 = 0.0217 \times V c_1$

③ Others

In case of open penstocks, 20% of ① + ② is added.
In case of tunnel penstocks, 35% of ② is added.

8) Spillways

① Spillway steel conduit

The inner diameter of the spillway steel conduit is obtained from the following equation.

$$D_s = 0.394 \times (Q / Ss^{0.5})^{0.375}$$

wherein,
- Q : Maximum plant discharge (m^3/s)
- D_s : Inner diameter of steel conduit of spillway (m)
- Ss : Average slope of spillway

The weight of spillway steel conduit is calculated with the following equation.

$$Wp_2 = 0.165 \times Ds^{1.25} \times L$$

wherein,
- Wp_2 : Weight of steel conduit of spillway (ton)
- D_s : Inner diameter of steel conduit of spillway (m)
- L : Total length of spillway conduits (m)

Provided that the upper horizontal portion is 5 m long and the lower horizontal portion is 5 m long, and the inclined length is calculated. Then, the total length of spillway conduits is obtained.

The elevation of the beginning point is obtained by reducing head losses of the intake and headraces from the elevation of the intake.

② Spillway civil works

The excavation volume, concrete volume, and weight of reinforcement bars for spillways are calculated with the following equations.

$$Ve_2 = 9.87 \times D_s^{1.69} \times L$$

$Vc_2 = 3.54 \times D_s^{0.11} \times L$
$Wr_2 = 0.0348 \times Vc_2$

③ **Others**

20% of ① + ② is added.

9) Powerhouses

① **Powerhouse foundation civil works**

The excavation volume, concrete volume, and weight of reinforcement bars for the powerhouse are calculated with the following equations.

(a) In case of open powerhouses

$$Ve = 0.938 \times (Q \times H_e^{\ 2/3} \times n^{\ 1/2})^{\ 1.89}$$
$$Vc = 0.042 \times (Q \times H_e^{\ 2/3} \times n^{\ 1/2})^{\ 2.24}$$
$$Wr = 0.133 \times Vc^{\ 0.849}$$

wherein, Q : Maximum plant discharge (m^3/s)
H_e : Effective head (m)
n : Number of units

(b) In case of semi-underground and underground powerhouses

$$Ve = 30.9 \times (Q \times H_e^{\ 2/3} \times n^{\ 1/2})^{\ 0.968}$$
$$Vc = 39.0 \times (Q \times H_e^{\ 2/3} \times n^{\ 1/2})^{\ 0.756}$$
$$Wr = 0.0233 \times Vc^{\ 1.15}$$

② **Powerhouse building works**

(a) In case of open powerhouses

$$V_{pb} = 7.89 \times P_{max}^{\ 0.653}$$
$$UC_{pb} = 287 \times V_{pb}^{\ -0.306}$$

wherein, V_{pb} : Building volume (m^3)
UC_{pb} : Building unit cost (m^3/USD)
P_{max} : Maximum output (kW)

(b) In case of semi-underground powerhouses

$$V_{pb} = 2.84 \times P_{max}^{\ 0.816}$$
$$UC_{pb} = 362 \times V_{pb}^{\ -0.307}$$

(c) In case of underground powerhouses

$$V_{pb} = 8.71 \times P_{max}^{\ 0.68}$$
$$UC_{pb} = 460 \times V_{pb}^{\ -0.293}$$

③ **Others**

20% of ① is added.

10) Tailraces

① Tailrace structure

The quantity calculation is based on the method of headraces. Basically, the open channel is applied and the length is assumed to be 10 m. However, if required, the tunnel type is applied and the length is obtained by topographic maps.

② Others

Calculation of quantities is the same as with headraces.

11) Outlets

① Outlet structures

There are pressure type and non-pressure types of outlets. Basically, no screens are provided.

The excavation volume, concrete volume, and weight of reinforcement bars for outlet are calculated with the following equations.

(a) In case of non-pressure type outlets with gates

$$Ve = 413 \times (R \times Q)^{0.583}$$
$$Vc = 84.5 \times (R \times Q)^{0.579}$$
$$Wr = 0.0336 \times Vc^{1.10}$$

Wherein, *Q*	:	Maximum plant discharge	(m^3/s)
R	:	Radius of outlet	(m)

(b) In case of non-pressure type outlets without gates

$$Ve = 395 \times (R \times Q)^{0.470}$$
$$Vc = 40.5 \times (R \times Q)^{0.687}$$
$$Wr = 0.278 \times Vc^{0.610}$$

(c) In case of pressure type outlets with gates

$$Ve = 18.4 \times \{[(ha + 2R) \times Q]^{1/2} \times n^{1/3}\}^{1.95}$$
$$Vc = 13.0 \times \{[(ha + 2R) \times Q]^{1/2} \times n^{1/3}\}^{1.57}$$
$$Wr = 0.0135 \times Vc^{1.20}$$

wherein, *D*	:	Inner diameter of tailrace	(m)
R	:	Radius of tailrace (= D/2)	(m)
ha	:	Available water depth	(m)
n	:	Number of outlets	

② Hydraulic equipment

The weight of outlet gates is calculated with the following equations.

(a) In case of non-pressure type outlets

$$Wg = 2.39 \times (R \times Q)^{0.502}$$

(b) In case of pressure type outlets

$$Wg = 0.970 \times [(ha + 2R)^{1/8} \times Q]^{0.929}$$

wherein, R : Radius of outlet (= D/2) (m)
Q : Maximum power discharge (m^3/s)
ha : Available water depth (m)

③ Others

25% of ① + ② is added.

12) Miscellaneous works

5% of total of (2) ~ (9) is added.

(5) Works related to Electro-mechanical Equipment

Preliminary costs of works related to electro-mechanical equipment are estimated separately for turbines, generator sand other electrical equipment. Calculations of those costs are shown in Section 4.10.3 "(1) Price of Water Turbines and Generators."

1) Selection of turbine type

Turbine type is selected according to the following diagram using power discharge and effective head. In the study, reaction type water turbines such as Francis, propeller and Kaplan and impulse type water turbines such as Pelton, crossflow and Turgo impulse are selected.

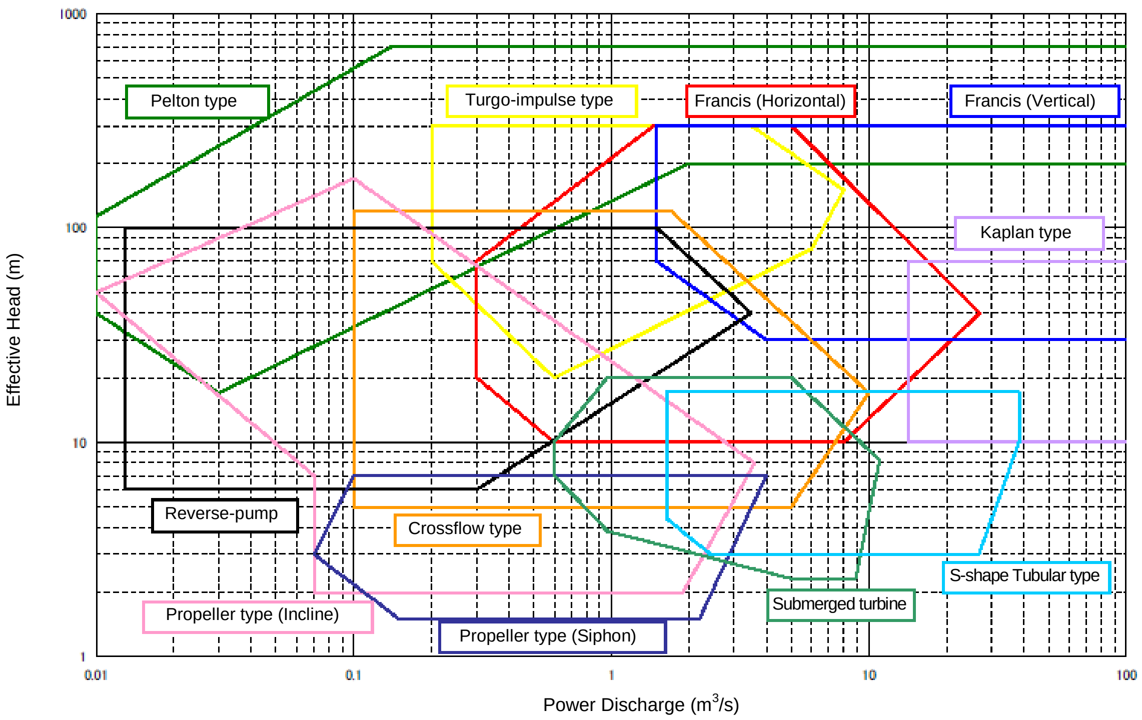


Fig. 5.4-1 Selection Diagram for Water Turbines

Source : Guide Book for Hydro Valley Scheme, Agency for Natural Resources and Energy & New Energy Foundation, Japan, 2005

2) Combined efficiency of turbine and generator

The combined efficiency of turbine and generator by type of turbine is calculated as follows.

(a) Pelton-type ($Q / Q_{max} > 0.10$)

$Q \geqq 0.44\, Q_{max}$ (2 nozzles)

$$\eta_{tg} = 0.96275 \times (Q / Q_{max})^5 - 34.551 \times (Q / Q_{max})^4 + 48.761 \times (Q / Q_{max})^3 - 34.195 \times (Q / Q_{max})^2 + 12.132 \times (Q / Q_{max}) - 0.7895$$

$0.10\, Q_{max} < Q < 0.44\, Q_{max}$ (1 nozzle)

$$\eta_{tg} = -118.09 \times (Q / Q_{max})^5 + 157.06 \times (Q / Q_{max})^4 - 77.669 \times (Q / Q_{max})^3 + 16.189 \times (Q / Q_{max})^2 - 0.6024 \times (Q / Q_{max}) + 0.7524$$

wherein, Q : Power discharge (m^3/s)
Q_{max} : Maximum power discharge (m^3/s)

(b) Propeller-type turbine ($Q / Q_{max} > 0.20$)

$$\eta_{tg} = -0.5643 \times (Q / Q_{max})^4 + 2.1371 \times (Q / Q_{max})^3 - 3.1732 \times (Q / Q_{max})^2 + 2.1484 \times (Q / Q_{max}) + 0.449$$

(c) Francis-type turbine($Q / Q_{max} > 0.30$)

$$\eta_{tg} = -1.0399 \times (Q / Q_{max})^2 + 1.7913 \times (Q / Q_{max}) + 0.2245$$

(d) Turgo-impulse-type turbine($Q / Q_{max} > 0.10$)

$Q \geqq 0.50\, Q_{max}$ (2 nozzle)

$$\eta_{tg} = 0.0926 \times (Q / Q_{max})^3 - 0.7083 \times (Q / Q_{max})^2 + 1.0187 \times (Q / Q_{max}) + 0.5906$$

$0.10\, Q_{max} < Q < 0.50\, Q_{max}$ (1 nozzle)

$$\eta_{tg} = -0.3333 \times (Q / Q_{max})^3 - 2.0286 \times (Q / Q_{max})^2 + 2.0705 \times (Q / Q_{max}) + 0.4758$$

(e) Crossflow type turbine ($Q / Q_{max} > 0.20$)

$$\eta_{tg} = 1.2087 \times (Q / Q_{max})^4 - 3.6272 \times (Q / Q_{max})^3 + 2.9822 \times (Q / Q_{max})^2 + 0.1479 \times (Q / Q_{max}) + 0.5349$$

Plant utilization ratio is set about 5 to 10% lower than the flow utilization ratio by multipling the correction coefficient.

(6) Transmission Lines

The distance of transmission lines is calculated as 1.2 times the straight distance from the powerhouse site to the nearest transmission line. In case the distance is less than 30 km, 1 circuit with 22 kV is applied. The transmission capacity is determined based on the transmission distance and output of the powerhouse as shown in Fig. 5.4-2.

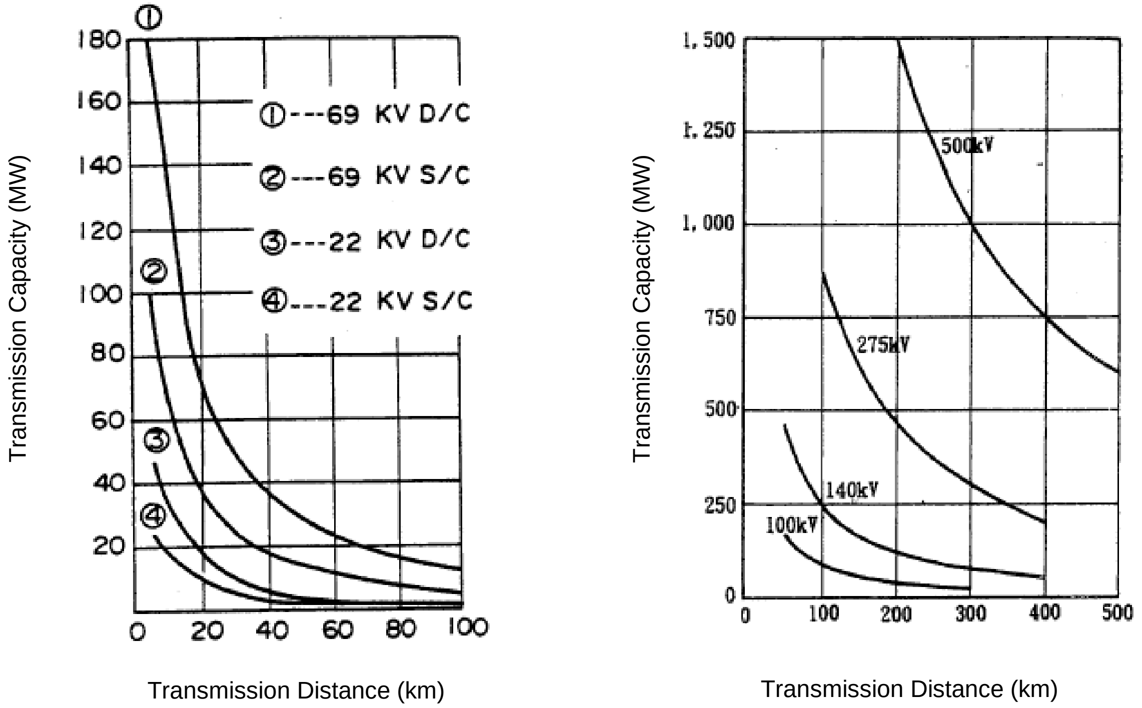


Fig 5.4-2 Transmission Capacity

Source: Guide Manual for Development Aid Programs and Studies of Hydro Electric Power Project, Agency for Natural Resources and Energy & New Energy Foundation, Japan, 1996

(7) Indirect Costs

1) Administration cost and engineering fee

15% of the direct construction cost (total cost for preparatory works, environmental mitigation, civil works, hydraulic equipment, electro-mechanical works and transmission/distribution line works) is applied to the preliminary cost.

2) Contingencies

10 % of the direct construction cost is applied to the preliminary cost.

3) Interests during construction

Interests are calculated by multiplying the total project cost including administration cost, engineering fee and contingencies by 40% of the cash-flow coefficient and interest rate during the construction period.

5.5 Screening of Identified Potential Sites

5.5.1 Criteria of Screening

The screening of identified potential sites is conducted from the viewpoints of economic criteria, accessibility and social environmental assessment. Through this screening, 50 potential sites are extracted as site reconnaissance candidates. This screening aims to extract 50 sites for site reconnaissance, while the economic and financial evaluation will be considered in draft final report.

(1) Economic Evaluation

Normally, the unit cost per kWh, Net Present Value (NPV), B/C, Internal Rate of Return (IRR), etc. are used for the economic evaluation of an HEP project.

Construction unit cost per kWh (USD), which is calculated by annual energy generation and construction cost mentioned in Sections 5.3 and 5.4, is adopted as economic criteria for the screening.

$$Constructi\ on\ Cost\ \ per\ \ kWh = \frac{Constructi\ on\ Cost\ (\$)}{Annual\ \ Energy\ \ Generation\ \ (kWh)}$$

(2) Accessibility Evaluation

The HEP plants are generally built in mountainous areas. As the construction cost of road extension occupies a high percentage of the total construction cost, it has a significant impact on the economic evaluation and construction period of the project. Priority is set according to the distance of road extension in this study.

(3) Environmental Impact Assessment

Generally, an environmental impact assessment is implemented from the F/S stage on HEP projects. Additionally, the memorandum between the DOE and DENR (Department of Environment and Natural Resources) as shown in Table 3.5-6 indicates that HEP projects of less than 1MW are not subject to environmental impact assessments and projects of 1MW – 10MW output or less than 20,000,000 m^3 reservoir volume are only required to submit an IEE (Initial Environmental Examination) checklists. Most of new identified potential sites are subject to the above assessment in terms of output and reservoir volume, though the development of mini-HEP projects is considered to have a small impact in terms of the environmental impact assessment system of the Philippines.

However, if there are no problems with regards to the environmental impact assessment system, there are many cases that social environmental issues become obstacles in project implementation as in the case of resettlement of local residents. The preparation of IEE checklists for each project shall be conducted in the F/S stage. In this study, new identified potential sites are evaluated by 1) nature conservation areas, 2) volcanic activities and 3) resettlement of local residents from the viewpoint of project feasibility.

1) Nature conservation areas

Nature conservation areas, which were designated before/after NIPAS (National Integrated Protected Area System) in 1992, are shown in Fig. 4.9-2. The construction of a hydropower plant in these areas is not prohibited by law, but it requires parliamentary approval and needs time for the required procedure. In Panay of the NIPAS area, Villasiga HEP (8 MW) is being constructed by a private developer, and Timbabban HEP (18 MW) is being prepared for construction also by a private developer. On Palawan, Longogan Power Corporation has obtained development concessions from the Palawanco Council for Sustainable Development to develop Longogan HEP (6.8 MW) located in an environmental critical area.

HEP sites located in nature conservation areas receive lower valuations from an environmental point of view.

2) Volcanic activities

The hazard range of eruption is different among volcanoes. The active Mt. Pinatubo at present has the largest hazard range at 30 km in radius, while Mt. Canlaon has a range of 18 km in radius.

In this study, hydropower sites located within a 30 km radius from the crater of each volcano are given a lower evaluation from an environmental point of view, just to be on the safe side.

3) Local residents

A HEP plant of the run-of-river type has a small impact on local residents upstream of dams because of the low dam height and narrow reservoir area. However, villages will be submerged in the case of reservoir and pondage types. Therefore, the resettlement cost should be estimated for reservoir and pondage types. In addition to this cost, the resettlement of local resident requires various studies such as selection of a new residential address and living conditions.

If there are local residents in the reservoir area on 1/50,000 topographic maps, the sites receive a lower valuation from an environmental point of view.

5.5.2 Method of Screening

The new identified sites are rated on 10 levels according to the economic evaluation, accessibility and environmental impact assessment.

The score of economic evaluation and accessibility are given as follows. In addition, if there are environmental or social obstacles at the site, the negative score shown below is given. The sites are eventually rated by the total score.

Table 5.5-1 Evaluation of Screening

kWh Unit Cost (USD)	Point	Road Extension (km)	Point
- 0.9	10	- 5 km	0
0.9 - 1.2	9	5 – 10 km	−1
1.2 - 1.5	8	10 – 15 km	−2
1.5 - 1.8	7	15 – 20 km	−3
over 1.8	6	over 20km	−4

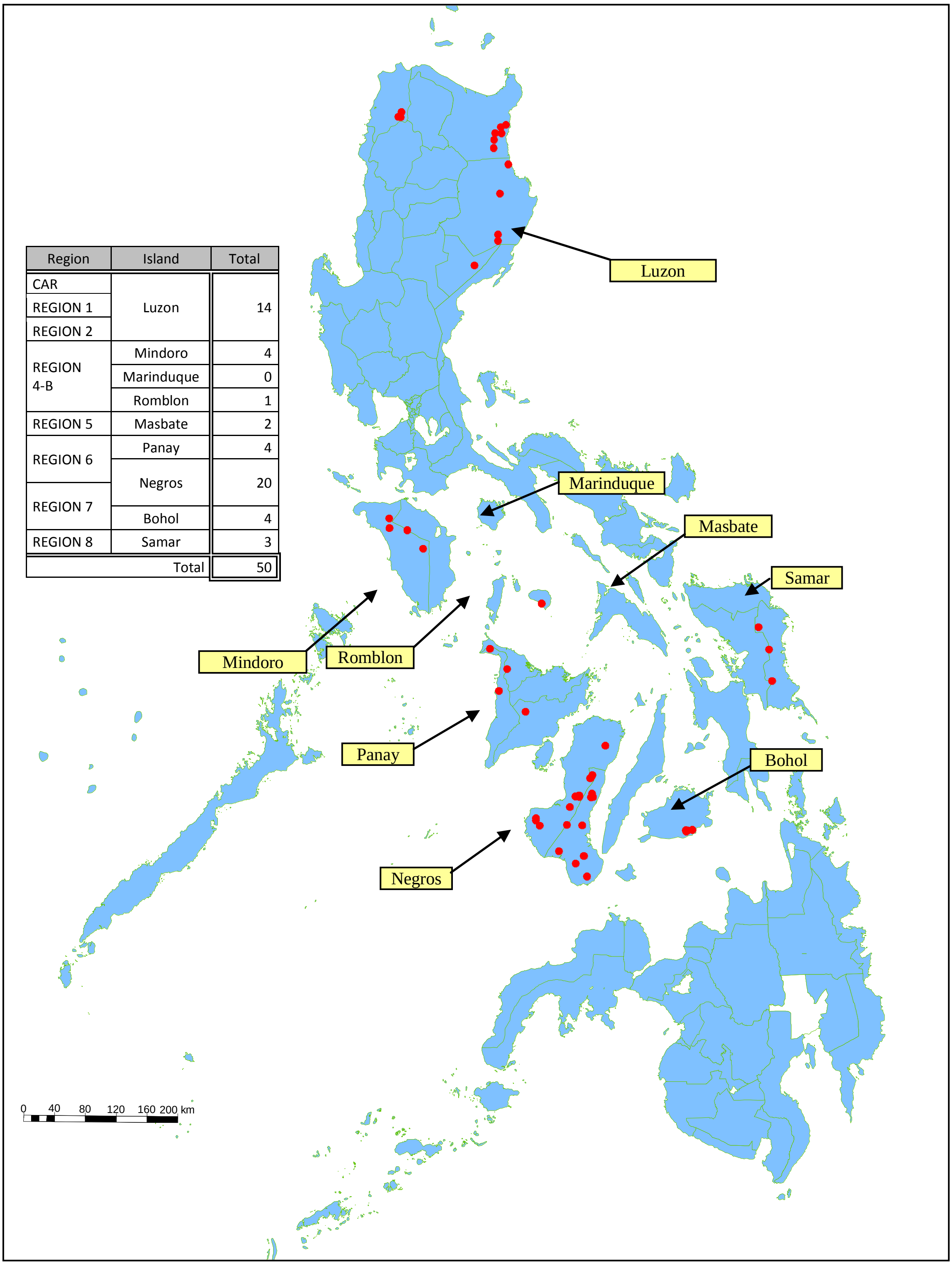
Environmental Impact Assessment Factors	Point
Nature conservation areas existence	Run-of-river: −1 Reservoir and Pondage: −4
Volcanic activities in 30 km radius	−1
Local residents existence	Run-of-river: 0 Reservoir and Pondage: −4

5.5.3 Results of Screening

As a result of screening, 45 sites of the run-of-river type and 5 sites of the reservoir type were selected. The results of screening are shown in Table 5.5-2 and general information on the selected 50 potential sites is shown in the Appendix.

Table 5.5-2 Regional Distribution and Generation Type of Top 50 Sites

Region		Island	Run-of-River	Reservoir / Pondage	Subtotal
CAR	CORDILLERA ADMINISTRATIVE REGION	Luzon	11	3	14
REGION 1	ILOCOS REGION				
REGION 2	CAGAYAN VALLEY				
REGION 4-B	MIMAROPA	Mindoro	4	0	4
		Marinduque	0	0	0
		Romblon	1	0	1
REGION 5	BICOL REGION	Masbate	0	0	2
REGION 6	WESTERN VISAYAS	Panay	4	0	4
		Negros	18	2	20
REGION 7	CENTRAL VISAYAS				
		Bohol	4	0	4
REGION 8	EASTERN VISAYAS	Samar	3	0	3
		Subtotal	45	5	Total 50



Region	Island	Total
CAR	Luzon	14
REGION 1		
REGION 2		
REGION 4-B	Mindoro	4
	Marinduque	0
	Romblon	1
REGION 5	Masbate	2
REGION 6	Panay	4
REGION 6 / REGION 7	Negros	20
REGION 7	Bohol	4
REGION 8	Samar	3
	Total	50

Fig. 5.5-1 Top 50 Sites Resulted from Screening

5.6 Method and Results of Site Reconnaissance

5.6.1 Objectives of Site Reconnaissance

The objective of site reconnaissance is to confirm site conditions of major structures of HEP potential sites and to improve the accuracy of the results from the map study. Especially, it is most important to obtain a reliable head and river flow at the site, which are basic factors for HEP generation planning.

Also, it is important to confirm the required distance of access roads and the length of transmission / distribution lines because the accuracy of this data is not sufficient in the course of map studies. In addition, water utilization such as existing irrigation facilities, water supply facilities and general uses, existence of precious fauna and flora, resources for tourism, inhabitancy by indigenous people and so on shall be confirmed as to whether or not those conditions constitute serious problems for the implementation of HEP projects.

At promising potential sites for reservoir / regulating poundage type HEP plants, the possibility of resettlement of inhabitants, land expropriation of agriculture land, etc. and possible impacts therefrom shall be investigated.

5.6.2 Methods of Site Reconnaissance

As preparation for site reconnaissance, a survey plan is to be prepared according to nearby-site access conditions, security situation and so on, which are collected from local governments and concerned agencies.
Characteristics of topography and geology at HEP potential sites shall be figured out by 1/50,000 topographic map and geological maps before site reconnaissance.

Outlines of the head, and the scale and layout of main structures are to be checked at the site and it is confirmed whether or not there are big discrepancies between the actual topography and geology characteristics, and those of maps. Especially, in the case of a place that has a negative factor for construction such as lineament, large landslides, distribution of thick alluvium, karsts topography, volcanic topography, lode, etc., it shall be checked at the site.
Head between the intake and outlet is measured by GPS. Discharge measurement is conducted by the flow-meter method or floating method, and hearing from inhabitants, visual observation of flood traces, collection of hydrological data from nearby gauging stations and so on are carried out.

Survey items and survey methods for site reconnaissance are summarized in the following table.

Table 5.6-1 Survey Items and Survey Methods for Site Reconnaissance

	Location	Study Item	Study Method
1	Access route to investigation site	1) Current situation of road width, pavement conditions, traffic density, bridge specifications, river transportation, approximate time required, etc. 2) Probable transmission/distribution line route	1) Measurement of distance and time required, visual check and use of topographic map, photographs, GPS survey 2) Use of topographic map
2	Dam	1) River discharge 2) River flow during flood 3) River flow in the dry season 4) River bed slope 5) Sediment on riverbed 6) Location / Elevation 7) Topography at dam site and surrounding area 8) Geological condition at dam area and surrounding area (Faults, fractured zones, outcrops, rock type, sand deposits on riverbed, spring water, slope stability, etc.) 9) Vegetation in upstream dam, socio-economic activities	1) Visual checks (Current measurement by float, estimation of cross-section) 2) Observation of river channel, traces of flood, interviews with residents 3) Interviews with residents 4) Visual checks 5) Observation of river channel, observation of particle distribution, and photograph 6) Measurement using topographic map, GPS survey, and pressure altimeter 7) Simple surveys using laser distance meter 8) Surface surveys 9) Visual checks, interviews with residents
3	Waterway	1) Topography and vegetation at intake area, tunnel route, head tank area, and penstock route (Current direction, location of tributary stream and valley, mountain scale, elevation, land slides, etc.) 2) Nature of soil (Faults, weak layers, outcrops, rock type, sand filters on riverbed, spring water, slope stability, etc.)	1) Visual checks, and use of topographic map 2) Surface surveys
4	Power station	1) Location and elevation 2) River flow during flood (Flood level, current direction) 3) River bed slope 4) Topography at power station and surrounding area (Land area, elevation, slope of penstock approach route, etc) 5) Geological condition of power station area and surrounding area (Faults, weak layers, outcrops, rock type, sand deposits on riverbed, spring water, slope stability, etc.)	1) Use of topographic map, GPS survey, and pressure altimeter 2) Observation of river channel, traces of flood, interview with residents 3) Visual checks 4) Use of topographic map and sketch, simple survey using hand level and laser distance meter 5) Surface surveys
5	Reservoir and project area	1) Topography and geology of reservoir (Distribution of limestone, presence of mineral resources, existence of large scale land slides, slope stability, etc.) 2) Natural and social environment (Vegetation, valuable species, land use, agriculture, forestry and fishery, mining industry, scenic resources, cultural heritage, etc.) 3) Socioeconomic activities in lower area (River water usage, irrigation facilities, river transportation, fishery, etc.)	1) Visual checks, and use and sketch on topographic map, and interviews with residents 2) Interviews with residents, and on-site research to regional authorities 3) Observation of river channel and surrounding area, interview with residents, use and sketch on topographic map, visit to regional authorities

5.6.3 Results of Site Reconnaissance

(1) Implementation of Site Reconnaissance

Site reconnaissance were conducted by three teams, namely, Team A (Bohol, Samar, Panay and Mindoro), Team B (Negros) and Team C (Luzon). The schedule of site reconnaissance is shown below.

According to the discussions with LGUs on site and parties concerned, site reconnaissance of 9 of the 50 selected sites in Section 5.5 were canceled due to inaccessibility and safety of the surrounding area. Instead of these sites, alternatives sites had been selected from 20 spared sites, evaluated among others, considering the progress of the whole schedule and accessibility, and site reconnaissance were conducted accordingly. Hereby, the results of site reconnaissance at 47 sites were obtained. The results are shown in Table 5.6-2 and Fig. 5.6-1.

Table 5.6-2 Schedule of Site Reconnaissance (1/4)

Team			Team A (Negros)	Team B (Bohol, Mindoro, Samar & Panay)	Team C (Luzon & Romblon)
			Activities	Activities	Activities
1	07-Mar-11	Mon	Travel Manila-Bacolod, Coordination with Canlaon City LGU/Military/ Police	Travel Manila-Tagbilaran-Garcia-Hernandez, Coordination with Garcia-Hernandez LGU & data collection	Travel Manila-Isabela
2	08-Mar-11	Tue	Site reconnaissance for 52_Binalbagan1	Site reconnaissance for 2_Upper Manaba	Coordination with Penablanca LGU & PNP
3	09-Mar-11	Wed	Site reconnaissance for 52_Binalbagan1	Site reconnaissance for 2_Upper Manaba	Coordination with Barangay Minanga, coordination with CAGELCO I & data collection
4	10-Mar-11	Thu	Site reconnaissance for 52_Binalbagan1	Site reconnaissance for 2_Upper Manaba	Site reconnaissance for 223_Tuguegarao2
5	11-Mar-11	Fri	Coordination with Moises Padilla LGU, site reconnaissance for 53_Binalbagan2	Coordination with Jagna LGU and data collection, coordination with BOHECO II & data collection	Site reconnaissance for 223_Tuguegarao2
6	12-Mar-11	Sat	Site reconnaissance for 53_Binalbagan2	Site reconnaissance for 5_Odiong	Site reconnaissance for 223_Tuguegarao2
7	13-Mar-11	Sun	Rest Day	Rest Day	Rest Day
8	14-Mar-11	Mon	Site reconnaissance for 53_Binalbagan2	Site reconnaissance for 5_Odiong	Coordination with Penablanca LGU & Barangay Lapi, visit NGCP Penablanca substation
9	15-Mar-11	Tue	Site reconnaissance for 54_Binalbagan3	Site reconnaissance for 3_Balili	Coordination with Baggao LGU & PNP, Barangays Immurung, San Miguel & Sta. Margarita
10	16-Mar-11	Wed	Site reconnaissance for 54_Binalbagan3	Site reconnaissance for 3_Balili	Site reconnaissance for 229_Immurung
11	17-Mar-11	Thu	Coordination with Kabankalan LGU, site reconnaissance for 61_Hilabangan3	Site reconnaissance activities suspended due to heavy rainfall at site	Site reconnaissance for 229_Immurung
12	18-Mar-11	Fri	Site reconnaissance for 61_Hilabangan3	Site reconnaissance for 3_Balili	Site reconnaissance for 229_Immurung
13	19-Mar-11	Sat	Travel Kabankalan-Dumaguete-Manila	Site reconnaissance for 4_Lower Manaba	Site reconnaissance for 229_Immurung
14	20-Mar-11	Sun	Rest Day	Rest Day	Coordination with Barangay Sta. Margarita
15	21-Mar-11	Mon	Team Coordination Meeting (Manila)	Site reconnaissance for 4_Lower Manaba	Site reconnaissance for 229_Immurung
16	22-Mar-11	Tue	Team Coordination Meeting (Manila)	Site reconnaissance for 4_Lower Manaba	Site reconnaissance for 223_Taboan R
17	23-Mar-11	Wed	Travel Manila-Dumaguete-Kabankalan	Travel Tagbilaran-Manila	Site reconnaissance for 235_Taboan 2
18	24-Mar-11	Thu	Coordination with Binalbagan LGU, site reconnaissance for 58_Pangiplan	Office Work, at Manila	Site reconnaissance for 223_Taboan R
19	25-Mar-11	Fri	Site reconnaissance for 58_Pangiplan	Office Work, at Manila	Return to Barangay Sta. Margarita
20	26-Mar-11	Sat	Site reconnaissance for 57_Lag-il2	Rest Day	Travel to Tuguegarao, coordinate with CAGELCO
21	27-Mar-11	Sun	Rest Day	Rest Day	Site reconnaissance for 226_Pared 1
22	28-Mar-11	Mon	Site reconnaissance for 56_Lag-il1	Office Work, at Manila	Site reconnaissance for 226_Pared 1
23	29-Mar-11	Tue	Site reconnaissance for 56_Lag-il1 and 57_Lag-il2	Office Work, at Manila	Site reconnaissance report preparation
24	30-Mar-11	Wed	Site reconnaissance for 56_Lag-il1 and 57_Lag-il2	Office Work, at Manila	Coordination with CAGELCO I at Solsona
25	31-Mar-11	Thu	Site reconnaissance for 57_Lag-il2	Office Work, at Manila	Travel Tuguegarao-Manila

Table 5.6-2 Schedule of Site Reconnaissance (2/4)

Team			Team A (Negros)	Team B (Bohol, Mindoro, Samar & Panay)	Team C (Luzon & Romblon)
			Activities	Activities	Activities
26	01-Apr-11	Fri	Coordination with Sipalay LGU	Office Work, at Manila	Office Work, at Manila
27	02-Apr-11	Sat	Site reconnaissance for 65_Binulog	Rest Day	Rest Day
28	03-Apr-11	Sun	Rest Day	Rest Day	Rest Day
29	04-Apr-11	Mon	Site reconnaissance for 65_Binulog	Coordination meeting	Coordination meeting
30	05-Apr-11	Tue	Site reconnaissance for 63_Calatong1	Travel Manila-Iloilo-Lambunao, coordination with Lambunao LGU & data collection	Travel Manila-Cauyan, Isabela
31	06-Apr-11	Wed	Site reconnaissance for 63_Calatong1	Site reconnaissance for 165_Ulian2	Coordination with Ilagan LGU, MPDO, MENRO, Barangay Batong, RHU & ISELCO II
32	07-Apr-11	Thu	Site reconnaissance for 64_Calatong2	Site reconnaissance for 165_Ulian2 & data collection at ILECO II	Site reconnaissance for 219_Maplas
33	08-Apr-11	Fri	Site reconnaissance for 64_Calatong2	Coordination with Libertad LGU & data collection, site reconnaissance for 132_Bulanao1	Site reconnaissance for 219_Maplas
34	09-Apr-11	Sat	Site reconnaissance for 64_Calatong2	Site reconnaissance for 132_Bulanao1	Travel Ilagan, Isabela-Manila
35	10-Apr-11	Sun	Rest Day	Rest Day	Travel Manila-Dumaguete
36	11-Apr-11	Mon	Coordination with Mabinay LGU, site reconnaissance for 62_Ilog	Coordination with Malinao LGU	Joint site recon for reservoir type dam, 62_Ilog, Negros (with NEWJEC team)
37	12-Apr-11	Tue	Coordination with Bayawan LGU	Site reconnaissance for 129_Ibajay1	Travel Dumaguete-Manila
38	13-Apr-11	Wed	Site reconnaissance for 69_Mana-ol	Coordination withTibiao LGU & data collection	Rest Day
39	14-Apr-11	Thu	Site reconnaissance for 69_Mana-ol	Site reconnaissance for 139_Tibiao2	Travel Manila-Tuguegarao
40	15-Apr-11	Fri	Travel Bayawan-Dumaguete-Manila	Site reconnaissance for 139_Tibiao2	Coordination with Penablanca LGU & CAGELCO I, site reconnaissance for 225_Natulod2
41	16-Apr-11	Sat	Rest Day	Coordination with Ibajay LGU for 131_Dugayan site	Site reconnaissance for 225_Natulod2
42	17-Apr-11	Sun	Rest Day	Rest Day	Site reconnaissance for 219_Maplas
43	18-Apr-11	Mon	Coordination Meeting	Site reconnaissance for 131_Dugayan	Travel Ilagan, Isabela-Manila
44	19-Apr-11	Tue	Coordination Meeting	Data collection at ANTECO, San Jose, Antique	Coordination Meeting
45	20-Apr-11	Wed	Office Work, at Manila	Travel Kalibo-Manila	Office Work, at Manila
46	21-Apr-11	Thu	Holidays (Holy Week)	Holidays (Holy Week)	Holidays (Holy Week)
47	22-Apr-11	Fri			
48	23-Apr-11	Sat			
49	24-Apr-11	Sun			
50	25-Apr-11	Mon	Team Coordination Meeting	Team Coordination Meeting	Team Coordination Meeting
51	26-Apr-11	Tue	Travel Manila-Dumaguete-Siaton	Office Work, at Manila	Travel Manila-Ilocos Norte

Table 5.6-2 Schedule of Site Reconnaissance (3/4)

Team			Team A (Negros)	Team B (Bohol, Mindoro, Samar & Panay)	Team C (Luzon & Romblon)
			Activities	Activities	Activities
52	27-Apr-11	Wed	Coordination with Sta. Catalina LGU	Office Work, at Manila	Coordination with Nueva Era LGU
53	28-Apr-11	Thu	Site reconnaissance for 71_Sta. Catalina	Travel Manila-Tacloban-Borongan Eastern Samar	Site reconnaissance for 199_Madongan1 and 200_Madongan2
54	29-Apr-11	Fri	Site reconnaissance for 71_Sta. Catalina	Coordination with Maydolong LGU, Army & PNP	Site reconnaissance for 200_Madongan2
55	30-Apr-11	Sat	Site reconnaissance for 71_Sta. Catalina	Site reconnaissance for 118_Bihid	Site reconnaissance report preparation
56	01-May-11	Sun	Rest Day	Site reconnaissance for 118_Bihid	Rest Day
57	02-May-11	Mon	Coordination with Siaton LGU	Rest Day	Coordination with Nueva Era & Solsona LGU's and INEC
58	03-May-11	Tue	Site reconnaissance for 72_Canauay	Coordination with Taft LGU, Army & PNP	Coordination with Solsona LGU & CENRO Laoag
59	04-May-11	Wed	Site reconnaissance for 72_Canauay	Site reconnaissance for 114_Tubig	Site reconnaissance for 198_Solsona
60	05-May-11	Thu	Site reconnaissance for 72_Canauay	Site reconnaissance for 114_Tubig	Site reconnaissance for 198_Solsona
61	06-May-11	Fri	Coordination with Bindoy LGU	Site reconnaissance for 114_Tubig, travel to Tacloban City	Coordination with CAGELCO 1 & Penablanca LGU
62	07-May-11	Sat	Site reconnaissance for 81_Talaptap	Rest Day/Typhoon "Bebeng"	Site reconnaissance for 224_Natulod 1, travel Tuguegarao-Manila
63	08-May-11	Sun	Rest Day	Rest Day/Typhoon "Bebeng"	Rest Day
64	09-May-11	Mon	Site reconnaissance for 81_Talaptap	Travel Tacloban-Dolores, Eastern Samar, coordination with the Army Battalion HQ	Office Work, at Manila
65	10-May-11	Tue	Site reconnaissance for 81_Talaptap	Travel Dolores-Maslog, coordination with Maslog LGU	Travel Manila-Isabela
66	11-May-11	Wed	Coordination with Libertad LGU	Site reconnaissance for 105_Dolores3	Coordination with Echague & Madela LGU's
67	12-May-11	Thu	Site reconnaissance for 77_Guinoba-an1	Site reconnaissance for 105_Dolores3	Site reconnaissance for 202_Ngilinan2
68	13-May-11	Fri	Site reconnaissance for 77_Guinoba-an1	Travel Maslog-Dolores-Tacloban-Manila	Coordination with Echague LGU & QUIRELCO
69	14-May-11	Sat	Site reconnaissance for 78_Pacu-an	Rest Day	Site reconnaissance for 202_Ngilinan2
70	15-May-11	Sun	Rest Day	Rest Day	Travel Santiago-Tuguegarao
71	16-May-11	Mon	Site reconnaissance for 78_Pacu-an	Office Work, at Manila	Coordination with San Pablo & San Vicente LGU's
72	17-May-11	Tue	Site reconnaissance for 79_Guinoba-an2	Office Work, at Manila	Travel Tuguegarao-Sta. Ana port Cagayan
73	18-May-11	Wed	Site reconnaissance for 79_Guinoba-an2	Office Work, at Manila	Site reconnaissance report preparation, coordination with San Pablo LGU
74	19-May-11	Thu	Site reconnaissance for 80_San Jose	Office Work, at Manila	Travel Tuguegarao-Isabela, site reconnaissance report preparation
75	20-May-11	Fri	Site reconnaissance for 80_San Jose	Office Work, at Manila	Coordination with Maddela LGU, site reconnaissance for 204_Dabubu2
76	21-May-11	Sat	Travel Dumaguete-Manila (Demobilization)	Rest Day	Site reconnaissance for 204_Dabubu2
77	22-May-11	Sun		Rest Day	Rest Day

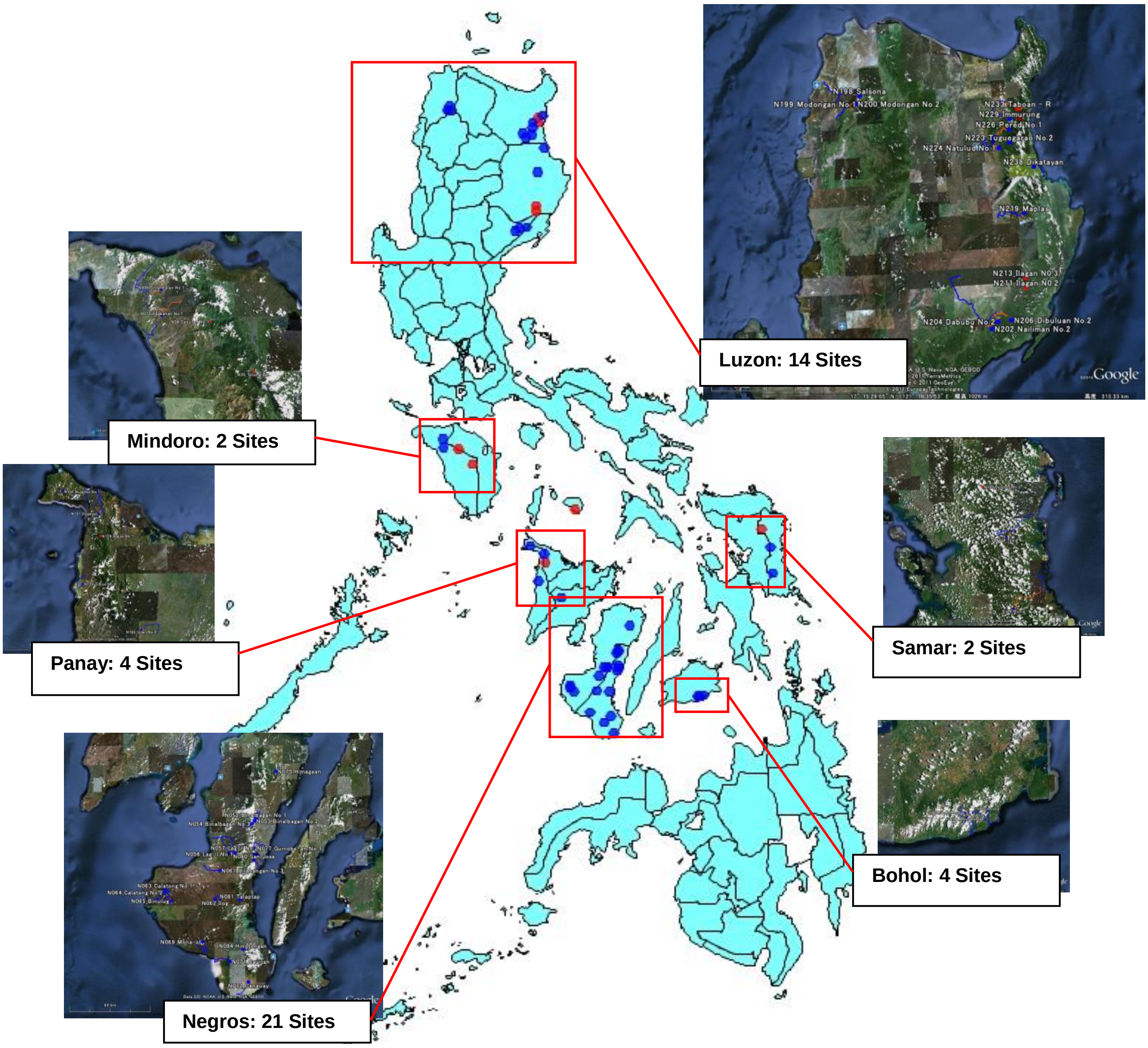
Table 5.6-2 Schedule of Site Reconnaissance (4/4)

Team			Team A (Negros)	Team B (Bohol, Mindoro, Samar & Panay)	Team C (Luzon & Romblon)
			Activities	Activities	Activities
78	23-May-11	Mon		Office Work, at Manila	Coordination with Maddela, Nagtipunan & Cabarroguis LGU's
79	24-May-11	Tue		Office Work, at Manila	Coordination with Nagtipunan LGU,Military and Brgy Disimungal.
80	25-May-11	Wed		Travel schedule to Mindoro postpone due to inclement weather condition, office work	Coordination with San Mariano LGU.
81	26-May-11	Thu		Travel schedule to Mindoro postpone due to inclement weather condition, office work	Site reconnaissance for 206_Dibuluan2
82	27-May-11	Fri		Travel schedule to Mindoro postpone due to inclement weather condition, office work	Coordination with Maddela LGU, Barangay San Dionisio & Army
83	28-May-11	Sat		Rest Day	Site reconnaissance for 206_Dibuluan2
84	29-May-11	Sun		Rest Day	Site reconnaissance for 206_Dibuluan2
85	30-May-11	Mon		Travel Manila-Batangas-Abra de Ilog, coordination with Abra de Ilog LGU, PNP RMG & Army's Alpha Company	Travel Quirino-Sta. Ana, Cagayan
86	31-May-11	Tue		Site reconnaissance for 9_Sinambalan1	Travel Sta. Ana, Cagayan-Maconacon
87	01-Jun-11	Wed		Site reconnaissance for 9_Sinambalan1	Coordination with Maconacon LGU & data gathering
88	02-Jun-11	Thu		Coordination with Santa Cruz LGU & CAFGU detachment at Barangay Alacaak	Site reconnaissance for 238_Dikatayan
89	03-Jun-11	Fri		Site reconnaissance for 13_Pagbahan2	Travel Maconacon-Sta. Ana, Cagayan-Tuguegarao
90	04-Jun-11	Sat		Coordination with Brgy Capt. Melbe of Alacaak for the site recon for 12_Pagbahan1	Travel Tuguegarao-Manila (Demobilization)
91	05-Jun-11	Sun		Rest Day	
92	06-Jun-11	Mon		Site reconnaissance for 12_Pagbahan1	
93	07-Jun-11	Tue		Site reconnaissance for 12_Pagbahan1	
94	08-Jun-11	Wed		Site reconnaissance for 12_Pagbahan1	
95	09-Jun-11	Thu		Coordinated with NCIP provincial office in Mamburao regarding site recon activities in the area under the ancestral domain, was advised to get the necessary permit from NCIP before the team can proceed the conduct of site recon at 34_Catuiran1 & 35_Tinangi-on	
96	10-Jun-11	Fri		Travel Mamburao-Abra de Ilog-Batangas-Manila (Demobilization)	

Table 5.6-3 Results of Site Reconnaissance

ID	Island	Province	Site	Type	Measured Discharge (m^3/s)	Remarks
2	Bohol	Bohol	Upper Manaba	Run-of-River	0.19	Done
3	Bohol	Bohol	Balili	Run-of-River	0.53	Done
4	Bohol	Bohol	Lower Manaba	Run-of-River	0.91	Done
5	Bohol	Bohol	Odiong	Run-of-River	0.07	Done
9	Mindoro	Occidental Mindoro	Sinambalan1	Run-of-River	0.30	Done
12	Mindoro	Occidental Mindoro	Pagbahan1	Run-of-River	Strong Flow	Done
34	Mindoro	Oriental Mindoro	Catuiran1	Run-of-River	-	Canceled *1
35	Mindoro	Occidental Mindoro	Tinangi-on	Run-of-River	-	Canceled *1
52	Negros	Negros Occidental	Binalbagan1	Reservoir	2.89	Done
53	Negros	Negros Occidental	Binalbagan2	Run-of-River	2.82	Done
54	Negros	Negros Oriental	Binalbagan3	Run-of-River	2.82	Done
56	Negros	Negros Occidental	Lag-il 1	Run-of-River	1.21	Done
57	Negros	Negros Occidental	Lag-il 2	Run-of-River	1.33	Done
58	Negros	Negros Occidental	Pangiplan	Run-of-River	1.29	Done
61	Negros	Negros Occidental	Hilabangan3	Run-of-River	10.82	Done
62	Negros	Negros Oriental	Ilog	Reservoir	9.00	Done
63	Negros	Negros Occidental	Calatong 1	Run-of-River	0.93	Done
64	Negros	Negros Occidental	Calatong 2	Run-of-River	1.17	Done
65	Negros	Negros Occidental	Binulog	Run-of-River	0.05	Done
69	Negros	Negros Oriental	Mana-ol	Run-of-River	0.07	Done
71	Negros	Negros Oriental	Cauitan	Run-of-River	1.83	Done
72	Negros	Negros Oriental	Canauay	Run-of-River	0.61	Done
75	Negros	Negros Occidental	Himogaan	Run-of-River	Strong Flow	Done
77	Negros	Negros Oriental	Guinoba-an1	Run-of-River	4.15	Done
78	Negros	Negros Oriental	Pacu-an	Run-of-River	1.25	Done
79	Negros	Negros Oriental	Guinoba-an2	Run-of-River	1.40	Done
80	Negros	Negros Oriental	San Jose	Run-of-River	0.26	Done
81	Negros	Negros Oriental	Talaptap	Run-of-River	2.09	Done
84	Negros	Negros Oriental	Hinotongan	Run-of-River	Strong Flow	Done
105	Samar	Eastern Samar	Dolores3	Run-of-River	-	Canceled *2
114	Samar	Eastern Samar	Tubig	Run-of-River	Strong Flow	Done
118	Samar	Eastern Samar	Bihid	Run-of-River	Strong Flow	Done
129	Panay	Aklan	Ibajay1	Run-of-River	-	Canceled *3
131	Panay	Antique	Dugayan	Run-of-River	0.94	Done
132	Panay	Antique	Bulanao1	Run-of-River	Strong Flow	Done
139	Panay	Antique	Tibiao2	Run-of-River	6.47	Done
165	Panay	Iloilo	Ulian2	Run-of-River	4.45	Done
190	Romblon	Romblon	Catingas3	Run-of-River	-	Canceled *2
198	Luzon	Ilocos Norte	Solsona	Run-of-River	1.21	Done
199	Luzon	Ilocos Norte	Madongan1	Run-of-River	1.60	Done
200	Luzon	Ilocos Norte	Madongan2	Run-of-River	1.59	Done
202	Luzon	Quirino	Ngilinan2	Run-of-River	5.50	Done
204	Luzon	Cagayan	Dabubu2	Run-of-River	1.53	Done
206	Luzon	Cagayan	Dibuluan2	Run-of-River	1.50	Done
211	Luzon	Isabela	Ilagan2	Run-of-River	-	Canceled *2
213	Luzon	Isabela	Ilagan3	Reservoir	-	Canceled *2
219	Luzon	Isabela	Maplas	Run-of-River	0.36	Done
223	Luzon	Cagayan	Tuguegarao2	Run-of-River	Strong Flow	Done
224	Luzon	Cagayan	Natulud1	Run-of-River	0.69	Done
225	Luzon	Cagayan	Natulud2	Run-of-River	13.68	Done
226	Luzon	Cagayan	Pered1	Run-of-River	Strong Flow	Done
229	Luzon	Cagayan	Immurung	Run-of-River	Strong Flow	Done
233	Luzon	Cagayan	Taboan	Run-of-River	-	Canceled *2
234	Luzon	Cagayan	Twin Peaks	Run-of-River	-	Canceled *2
235	Luzon	Cagayan	Taboan2	Reservoir	Strong Flow	Done
238	Luzon	Isabela	Dikatayan	Reservoir	20.33	Done

*1 Due to ancestral domain issue
*2 Due to accessibility issue
*3 Due to accessibility and security issues
*4 Discharge was measured by current meter.



Region	Island	Run-of-River	Reservoir Pondage	Cancelled	Subtotal
CAR	Luzon	11	3	4	14
REGION 1					
REGION 2					
REGION 4-B	Mindoro	2	0	2	2
	Romblon	0	0	1	0
REGION 6	Panay	4	0	1	4
	Negros	20	1	0	21
REGION 7	Bohol	4	0	0	4
REGION 8	Samar	2	0	1	2
	Subtotal	43	4	9	Total 47

Fig. 5.6-1 Location of Site Reconnaissance

(2) Example of Site Reconnaissance

As an example of implementation of site reconnaissance, the results from the Hinotongan site in Negros Occidental conducted on February 16 of 2011 are shown below.

1) Outline of Site Reconnaissance

An outline of the Hinotongan site and a list of survey team members are shown below.

Table 5.6-4 Outline of Hinotongan Site

Name	No. 84 Hinotongan
Region	Region 7 (CENTRAL VISAYAS)
Province	Negros-Oriental
Municipality	Sibulan
Basin	Hinotongan
River	Hinotongan
Type	Run-of-River
Catchment Area	36.0 km^2

Table 5.6-5 List of Survey Team Members

Organization	Name	Position
NEWJEC (Japanese Consultants)	Yuichi Sano	Team Leader / Electric Power Development
	Yoshikazu Ishii	Hydropower Generating Technology
	Hideo Takase	Hydropower Civil Engineering
	Takao Saruhashi	Renewable Energy (Small scale hydropower) / Hydrology & Geology
	Sho Shibata	Coordinator
DOE-REMB	Rey V. Salvania	Electric Equipment Engineer
	Winifredo S. Malabanan	Geologist
DOE Cebu Branch	Eduardo Amante	Civil Engineer
PKII (Local Consultant)	Gil V. Berdin	Civil Engineer
	Jerry O. Rita	Civil Engineer
	Arnel M. Mendoza	Civil Engineer

2) Results of Site Reconnaissance at Hinotongan

Pictures on site taken during site reconnaissance at Hinotongan are shown in Fig. 5.6-2, the results of the survey in Table 5.6-6 and the hearing investigations with the LGU and EC in Table 5.6-7.

Proposed weir site

Proposed powerhouse site

Access road to weir site

WL gauging station on Tanjay River

Fig. 5.6-2 Pictures of Hinotongan Site

Table 5.6-6 Records of Site Reconnaissance at Hinotongan Site

Site No.	84 Hinotongan			River	Hinotongan		
Preliminary Layout Study (based on 1:50,000 topographic map)				***Site Survey (based on preliminary site reconnaissance results)***			
	Latitude	Longitude	EL (m)		Latitude	Longitude	EL (m)
Dam/Weir	N 9°23’22”	E 123°5’0”	220	Dam/Weir	N 9°23’22”	E 123°5’0”	220
P/H	N 9°24’18”	E 123°5’21”	150	P/H	N 9°24’18”	E 123°5’21”	158
Total Head		70 m		Total Head		62 m	
Dam/Weir height		15 m		Dam/Weir height		5 m	
Dam/Weir crest length		50 m		Dam/Weir crest length		35 m	
Penstock length		180 m		Penstock length		180 m	
Weir	Access road and submerged bridge to the weir site were constructed.						
Submerged bridge	(H=3m, B=5m, L=50m, N 9°23’22”, E 123°5’0”)						
Water depth	h = 0.22m at the bridge Q: 4 – 5 m^3/sec						
Sediment deposits	Sand, gravel, boulders						
Powerhouse	Space for powerhouse is sufficient and flat. Slope of penstock route is average of 30°.						

Table 5.6-7 Results of Hearing Investigation at Hinotongan Site

1. Environmental and Social Investigation (Sibulan Municipality)

Item	Results
(1) Protected area / National park	Area around Twin Lake is a national park, but the data of border lines was not obtained from the Sibulan Municipal Office.
(2) Water use	River water is used for irrigation. As the outlet is located upstream from the irrigation facility, river water can be used for irrigation after use for generating.
(3) Irrigation facility	The irrigation facility is located downstream from the outlet.
(4) Indigenous people	None
(5) Tourist resources such as waterfalls, lakes, recreation facilities, relics, etc.	Twin Lake
(6) Endangered species (Fauna and flora)	Wild pigs, Spotted Dear, monkeys and bats

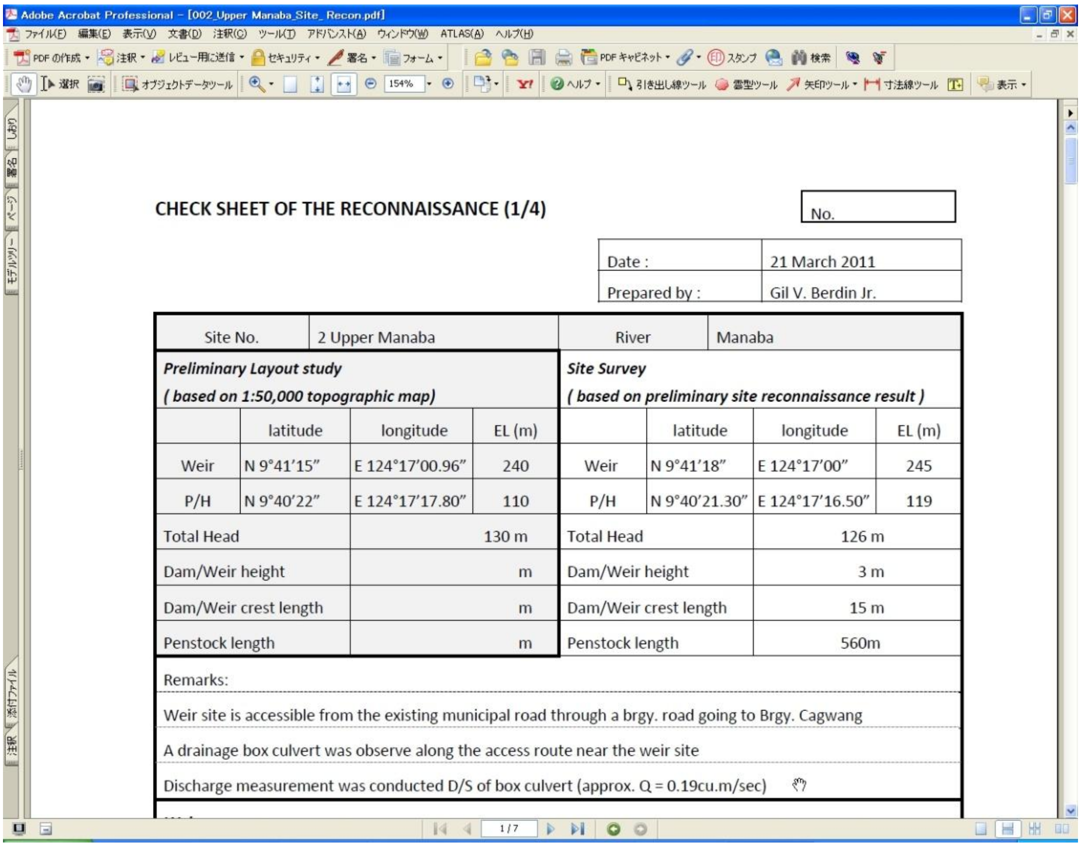
2. Distribution Lines, Substation (V-M-C RURAL ELECTRIC SERVICES COOPERATIVE, INC.)

Item	Results
(1) Single line diagram	None
(2) Load flow chart	None
(3) Route map of distribution line and location map of substation to be connected	None
(4) Outline of distribution line and substation to be connected: Voltage, No. of circuit and size etc.	The electricity generated by the powerhouse is expected to be supplied directly to the 13.2 kV distribution lines of Minapasoc Town. The nearest 13.2 kV distribution line will be upgraded from a single phase to three phases within some years.
(5) Construction cost per km	Construction cost of distribution lines is as follows. (Approximated) 13.2 kV Three Phase Line: 500,000 PHP/km 220 V Single Phase Line: 200,000 PHP/km
(6) Others	Obtained information is shown below. - Substation List - Summary of Demand and Energy Requirement - Name of Power Supplier and Contracted Capacity

5.6.4 Reflections on Results of Site Reconnaissance

The results of site reconnaissance are concluded in the site reconnaissance report, and a route map of GIS (Geographic Information System) files is prepared from records of accessibility to sites and waypoints of surrounding facilities. In addition, based on discharge data of sites or same river systems, duration curves are corrected or newly prepared.

The obtained information is reflected in the map study, and preliminary studies of 47 sites are re-conducted. Since the accuracy of study is different between the sites where site reconnaissance was conducted and others, these sites are classified into two categories in the HRD (Hydropower Resource Database).



CHECK SHEET OF THE RECONNAISSANCE (1/4)

No.

Date :	21 March 2011
Prepared by :	Gil V. Berdin Jr.

Site No.	2 Upper Manaba			River	Manaba		
Preliminary Layout study (based on 1:50,000 topographic map)				***Site Survey (based on preliminary site reconnaissance result)***			
	latitude	longitude	EL (m)		latitude	longitude	EL (m)
Weir	N 9°41'15"	E 124°17'00.96"	240	Weir	N 9°41'18"	E 124°17'00"	245
P/H	N 9°40'22"	E 124°17'17.80"	110	P/H	N 9°40'21.30"	E 124°17'16.50"	119
Total Head		130 m		Total Head		126 m	
Dam/Weir height		m		Dam/Weir height		3 m	
Dam/Weir crest length		m		Dam/Weir crest length		15 m	
Penstock length		m		Penstock length		560m	

Remarks:

Weir site is accessible from the existing municipal road through a brgy. road going to Brgy. Cagwang

A drainage box culvert was observe along the access route near the weir site

Discharge measurement was conducted D/S of box culvert (approx. Q = 0.19cu.m/sec)

Fig. 5.6-3 Site Reconnaissance Report

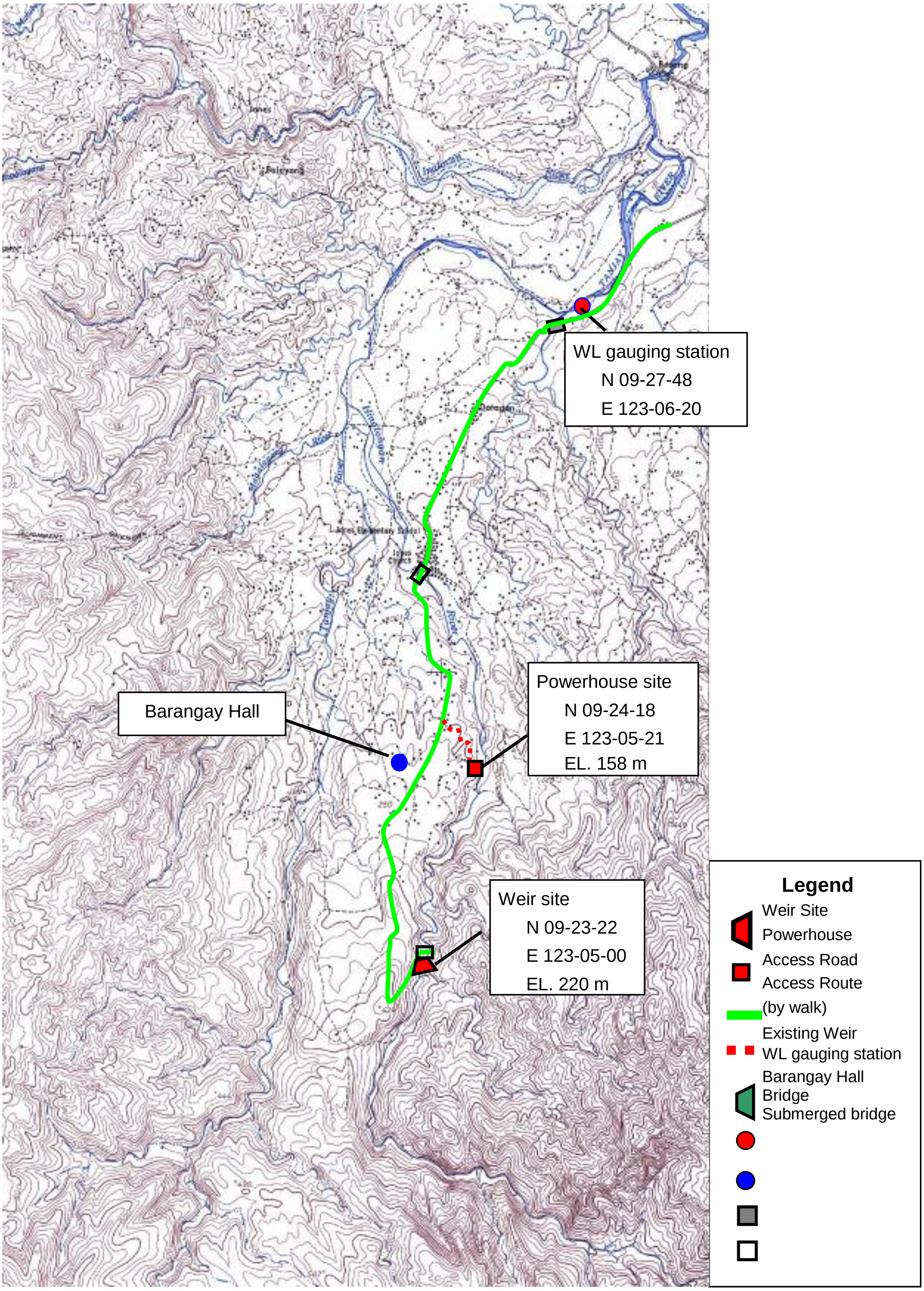
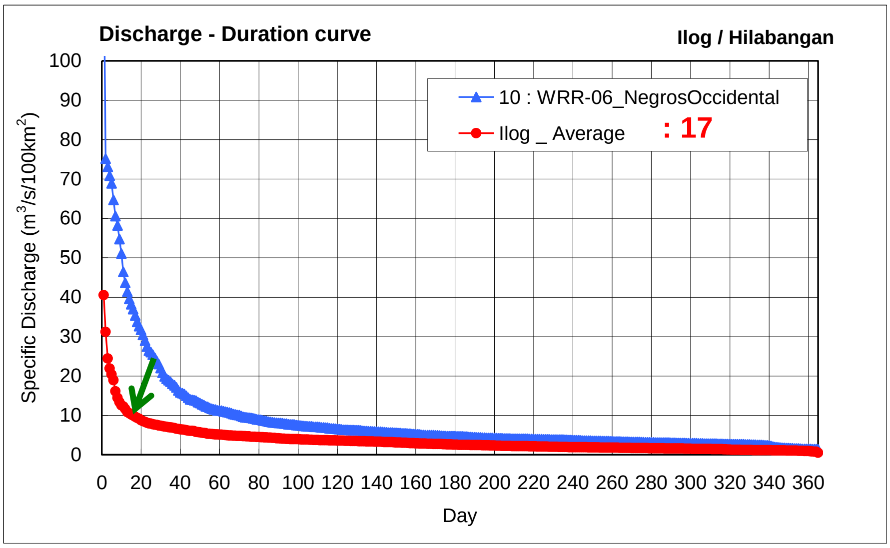


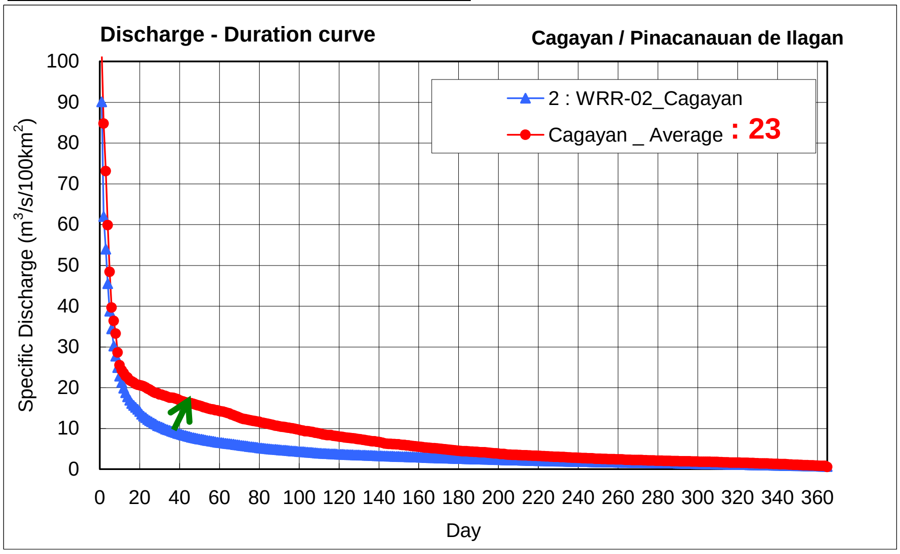
Fig 5.6-4 Route Map (Hinotongan Site)

Additional hydrological data was collected for the target sites of site reconnaissance. The results of a review of discharge-duration curves based on this additional hydrological data are shown in the table below. Discharge-Duration curves are shown in Fig. 5.6-5.

ID	Site	RiverName	RiverSystem
A061	Hilabangan N	Hilabangan	Ilog
A062	Ilog	Ilog	Ilog



ID	Site	RiverName	RiverSystem
A219	Maplas	Pinacanauan	Cagayan



"Original" data was prepared from 15 zones described in Chap. 4.7 (Table 4.7-5 and Fig. 4.7-8).
"New" data was prepared for the relevant river or the river system where the project site is located.

Fig. 5.6-5 Comparison between "Original" Data and "New" Data

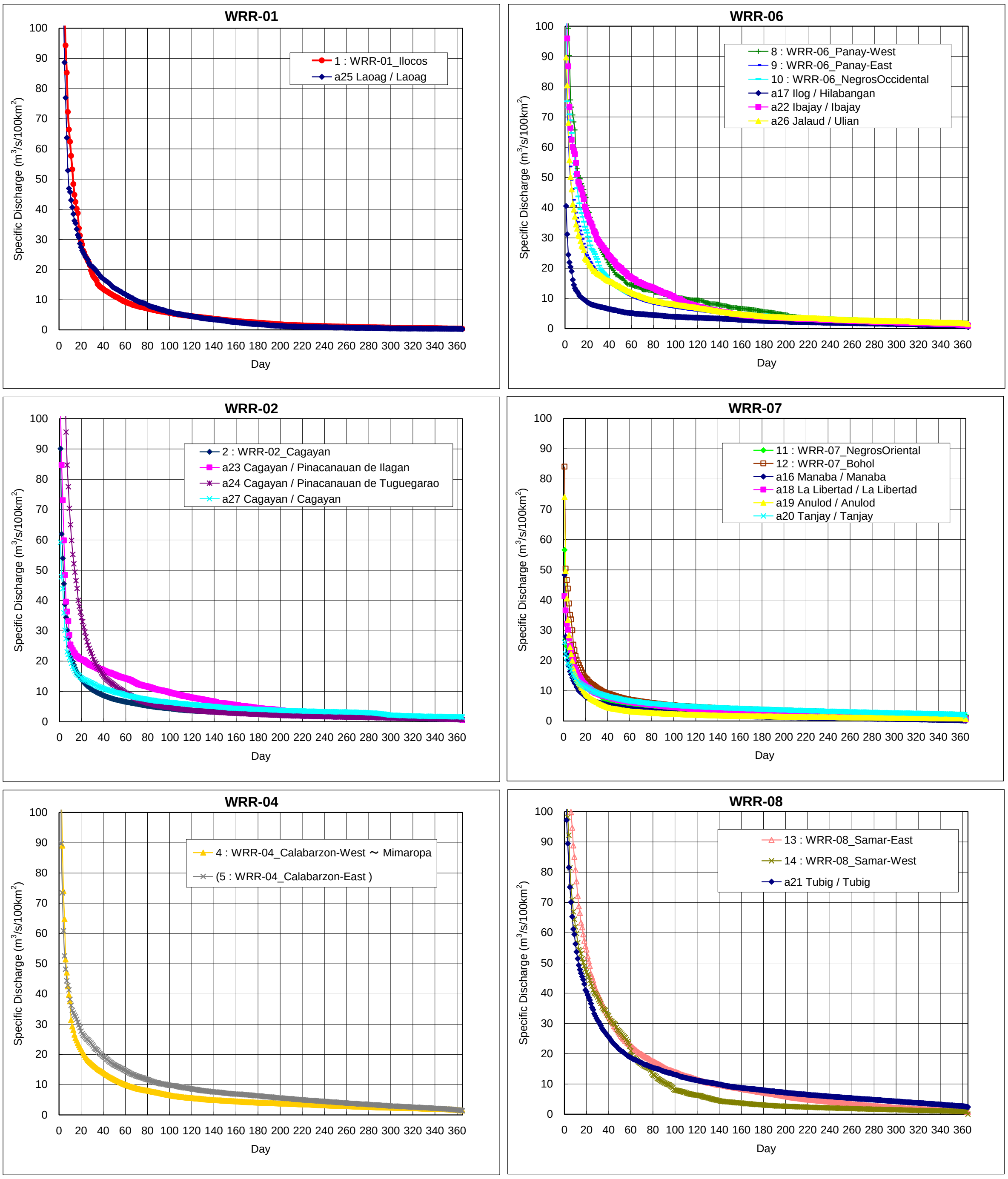


Fig. 5.6-6 Revised Discharge-Duration Curve for Each Zone and Each WRR

(a: Additional discharge-duration curves)

5.7 Initial Environmental Evaluation of Each Power Facility

5.7.1 Current IEE Checklists for Power Facilities

Based on the EMB (Environmental Management Bureau) Memorandum Circular No.01 Series of 2000, IEE checklists are prepared for the following power facilities: mini hydropower plant of a capacity greater than 1 to 10 MW or with less than 20 million m^3 water impoundment, power barges with a capacity of greater than 1 to 10 MW, and power transmission systems and substations greater than 220 kV. It is possible to obtain these IEE checklists from the EMB website. And, there is another example of the IEE checklist for land-based power plant (for thermal, hydropower, and renewable energy) made by the EMB. Basically, the contents of the IEE checklists are as follows.

- General information regarding the proponent; project location, project area description, plan/design components and activities during the development and operation phases
- Information regarding the description of the existing environmental condition where the road or bridge will be located; the physical biological, socio-cultural and economic environment
- Listing of possible potential impacts that may occur in the various stages of the project establishment and operation; corresponding mitigation and enhancement measures to prevent the occurrence of adverse impacts and to strengthen the positive effects of the project
- Required attachments

As for the environmental checklist for this master plan, the description of the existing environmental conditions and the impact assessment, and the mitigation measures will be discussed among the above-mentioned contents of the current IEE checklists.

(1) Description of the existing environmental conditions

The items included in the description of the existing environmental conditions, which are described in the existing IEE checklists, are listed in Table 5.7-1. They are roughly classified into the following three categories.

- Natural and physical environment such as topography, geology, water, air, disaster (erosion, flood, typhoon, earthquake, others)
- Biological environment such as significant wildlife, forest, vegetation, and others
- Socio-cultural and economic environment such as settlements, infrastructures, economic conditions, and others

Table 5.7-1 Components / Parameters for the Description of the Existing Environment on the Current IEE Checklist

Land-Based Power Plant	Mini Hydropower Plant	Transmission Line, Substation
1. Slope and topography 2. Areas where soil erosion is possible 3. Indicators of erosion, liquefaction, landslide, ground subsidence 4. Flooding during the wet season or typhoon 5. Bodies of water within 1.5 km such as creeks or streams 6. Present usage of the body of water; bathing, washing, fishing, drinking, recreation 7. Critical ecological system: mangroves, forestlands, aquifer, sanctuary, coral 8. Reclaimed area 9. Existing structures 10. Public or private easements 11. Existing environmental problems within 500 m; water pollution, air pollution, noise, erosion, flooding 12. Existing trees and vegetation 13. Birds and wildlife of significant value 14. Fishery resources 15. Existing settlement that will be affected; households, legitimate landowners, tenants, squatters 16. Local organizations 17. Opposition	**<Natural and Physical Environment >** 1. River characteristics 2. Flood characteristics (Statistical flood discharge) 3. Soil erosion, causes 4. Landslides 5. Present uses of bodies of water (Washing, recreation, source of drinking, Sanitation, irrigation, fishing, others) 6. Present land use of the area (Prime agricultural land, grassland, built-up, orchard, mangroves, fishpond, others) 7. Present water quality (pH, SS, coliform, oil and grease, chlorides, copper, lead, iron, manganese, total hardness, alkalinity, pesticides) **<Biological Environment>** 8. Flora and/or fauna of ecological or commercial significance in the bodies of water 9. Methods and data source for assessing the flora and fauna in the bodies of water 10. Flora and/or fauna of ecological or commercial significance outside the bodies of water 11. Methods and data source for assessing the flora and fauna outside the bodies of water 12. Lying within a watershed or forest reservation area **<Socio-Cultural, Economic and Political Environment>** 13. Existing settlements in the watershed area (Location/number of households, families and population) 14. Methods and data source for obtaining information on the existing settlement 15. Social infrastructures (Location and capacity of schools, health centers, clinics, hospitals and others) 16. Political situation (Peace and order) 17. Major employment & income sources 18. Existing local NGOs 19. Social acceptability of the project (Community, government, NGO)	**< Physical Environment >** 1. Elevation range 2. Slope and topography 3. General geology 4. Indications of landslides 5. Occurrences of flooding 6. Soil type 7. Indication of erosion occurring 8. Affected river or bodies of water 9. Other natural drainage ways/creeks that drain towards communities downstream 10. Records of typhoons 11. Records of tornadoes/twisters 12. Nearest earthquake, fault zone or volcano, others 13. Lightning strikes 14. Present water utilization Water bath, wash, fishery, drinking water, leisure, etc. **<Biological Environment>** 15. Existing trees and other types of vegetation, list of the species 16. Birds and other forms of wildlife, list of the species 17. Fishery resources in the bodies of water, list of the species 18. Watershed or forest reservation area 19. Existing forest resources (Timber, fuel wood, non-timber products, food plants, medicinal plants, wild animals, minerals, others) **<Socio-Cultural, Economic and Political Environment>** 20. Existing settlements (Number of households and families, legitimate landowners, tenants, caretakers, squatters) 21. Number of households to be resettled 22. Total population of the barangays 23. Average family size 24. Number of the houses (Made of concrete, wood, brick, adobe) 25. Ancestral lands or indigenous people communities 26. Leading causes of morbidity and mortality 27. Existing local organizations 28. Social infrastructures (Schools, health center/clinics, roads, communication, police station, community center, hospital, transportation, churches/chapels, others)

As for the natural and physical environments, the current IEE checklists cover the items that are considered to have major impacts or to be strongly related to the target power facilities, such as the river characteristics and water quality for mini hydropower plants, typhoons, tornadoes and lightning for transmission lines. As for biological environments, almost the same items are prepared for each power facility. As for socio-cultural and economic environments, although detailed items are not entered in the case of a land-based power plant, detailed items such as health conditions, education level, employment and income are included in the case of a mini hydro and transmission lines.

To describe the existing environmental conditions, the proponent will answer "Yes" or "No" to simple questions related to each component/parameter, select the most probable answer among the proposed items, or describe the situation briefly. For example, Table 5.7-2 shows the questions for each component/parameter and the description of remarks for the items.

Table 5.7-2 Examples for the Description of the Existing Environment in the Case of a Land-Based Power Plant

Components/Parameters	Yes	No	Remarks
1. Slope and topography of the area covered by the project -Terrain is flat (0 – 3%) -Gently sloping or undulating (3- 8%) -Undulating to rolling (8 – 18 %) -Rolling to moderately steep (18 – 30%) -Steeply rolling (30 – 50%) -Very steep to mountainous (>50%)			
2. Are there areas in the site where there is possible occurrence of soil erosion?			Cause of erosion [ ] Heavy rains [ ] Unstable slope [ ] Others, Specify
3. Are there indicators in the area of the following?			[ ] Erosion [ ] Liquefaction [ ] Landslides [ ] Ground subsidence [ ] None
4. Has the area experienced any flooding during the wet season?			Period of flooding: ________________ Cause of flooding: [ ] Low area [ ] Poor drainage [ ] Water-logged areas
5. Are there existing bodies of water within 1.5 km of the proposed building such as creeks or streams?			If Yes, indicate the name and distance to the body of water

Source : EMB RQE/9/18/2001/Guide for IEE Checklist on Land-Based Power Plants (final)

(2) Predicted impacts and mitigation measures

An outline of the description about predicted impacts, evaluation and mitigation measures in the existing IEE checklists for each power facility is as follows/

As for a land-based power plant, various predicted impacts are listed and the proponents have to evaluate the significance of the impacts for the pre-construction, construction, and operation phases of the project, respectively. Some mitigation/enhancement measures are also described corresponding to each predicted impact. Evaluations of the significance of the impact is composed of the following four alternatives: positive or negative, direct or indirect, long-term or short-term, and reversible or irreversible. Table 5.7-3 shows the predicted impacts and mitigation/enhancement measures for a land-based power plant.

Table 5.7-3 Environmental Impact Assessment and Mitigation for a Land-Based Power Plant

Predicted Impacts	Significance of Impacts				Mitigation/Enhancement Measures
	+/-	D/In	L/S	R/I	
Pre-Construction and Construction Phase of the Project					
1. Increase in dust generation due to cleaning, civil works and earthmoving activities					▪ Regular watering of unpaved roads or exposed soil/ground ▪ Removal of soil/mud from tires of trucks and equipment before leaving the area ▪ Hauling trucks should be covered with canvass or any equivalent materials. ▪ Installation of a temporary fence around the construction area
2. Top soil removal and loss due to earthmoving activities, transport, access road construction					▪ Stockpiling the top soil in a safe place and use as final grading material or final layer ▪ As soon as possible, rip-rap or re-vegetate the area.
3. Erosion from exposed cuts and landslides due to earthmoving and excavation activities					▪ Conduct construction activities during the dry season. ▪ Avoid long exposure of opened cuts. ▪ Installation of barrier nets
4. Sedimentation/Siltation of drainage or waterways from unconfined stockpiles or soil and other materials					▪ Installation of temporary silt traps/ponds to prevent siltation ▪ Proper stockpiling of spoils (On flat areas and away from drainage routes) ▪ Disposal of spoils generated from civil works as filling materials
5. Pollution of nearby body of water due to improper disposal of construction wastes					▪ Deployment of temporary disposal mechanism within the construction area and proper disposal of the generated solid wastes ▪ Installation of proper and adequate toilet facilities ▪ Strictly require the contractor and its workers to observe proper waste disposal and proper sanitation.
6. Loss of vegetation due to land clearing					▪ Limit land clearing as much as possible. ▪ Provide temporary fencing for vegetation that will be retained. ▪ Use markers and fences to direct heavy equipment traffic in the construction site and avoid damage to plants. ▪ Re-plant/plant indigenous tree species and ornamental plants.
7. Disturbance or loss of wildlife within the influence area due to noise and other construction activities					▪ Re-establish or simulate the habitat of affected wildlife in another suitable area. ▪ Schedule noisy construction activities during the day time. ▪ Undertake proper maintenance of equipment and use sound dampers.
8. Noise generation that can affect the nearby residents					▪ Schedule noisy construction activities during the day time. ▪ Undertake proper maintenance of equipment and use sound dampers.
Pre-Construction and Construction Phase of the Project					
9. Generation of employment					▪ Hiring priority shall be given to qualified local residents.
10. Conflict with residents regarding site use for transmission line					▪ Prior informed consent before decision on the design details
11. Increasing traffic and occurrence of congestion					▪ Compliance to traffic rules ▪ Proponents' cooperation to control congestion during peak hours
12. Increasing crimes and accidents					▪ Require the constructors and workers to comply with safety rules in the regions or project site.
Operation phase of the project					
13. Occurrence of wastewater at the plant					▪ Installation of efficient tanks ▪ Establish a wastewater disposal facility.
14. Occurrence of solid wastes					▪ Isolation of renewable materials ▪ Proper collection and disposal ▪ Proper management and minimization of wastes
15. Increasing traffic and occurrence of congestion as well as increasing traffic accidents					▪ Compliance with traffic rules ▪ Installation of traffic signs and alerts in proper places

Legend +/- : Positive impact/Negative impact D/In : Direct impact/Indirect impact
L/S : Long-term/Short-term R/I : Reversible/Irreversible

Source: EMB RQE/9/18/2001/Guide for IEE Checklist on Land-Based Power Plants (final)

As for a mini HEP plant, a total of 18 items are listed as the predicted impacts regarding the project location and design, construction phase, operation and maintenance, and abandonment and rehabilitation phase. The proponents have to evaluate those predicted impacts and answer simple questions about mitigation measures. Regarding the evaluation, it will be described in the project specifications or relevant parameters considered as being the cause of environmental impacts. The magnitude of the impact will be selected from four degrees: none, low, moderate, and high. Regarding the mitigation measures, the proponents will select the most likely measure from prescribed measures or specify other measures. Table 5.7-4 shows some examples of impact assessment/mitigation measures for a mini hydropower plant. These are extracted from the current IEE checklist for a mini HEP plant.

Regarding transmission lines and substations, the same format as a land-based power plant is prepared, but it does not describe the predicted impact and mitigation. Therefore, the proponents need to prepare another list.

Table 5.7-4 Examples of Environmental Impact and Assessment / Mitigation Measures for a Mini Hydropower Plant

Impact	Evaluation		Mitigation Measures
	Relevant Subject and Parameters	Magnitude of Impact	
Project Location and Design			
Loss of species due to obstructions to movement of aquatic life	Height of the weir (m): __________	☐ none ☐ low ☐ moderate ☐ high	☐ No mitigation measure ☐ Fishway or by-pass planned. Please describe the design and arrangement of the proposed mitigation facility and attach plans: ☐ Further measures, please specify.
Dying out of the riverbed between the intake and the outlet	Minimum residual flow with proposed project: - In m^3/s or l/s: _________ In % of mean annual flow without proposed project: __________	☐ none ☐ low ☐ moderate ☐ high	How is the residual flow provided? ☐ With a residual flow section in the weir ☐ By-pass pipeline ☐ Other, please specify:
Construction Phase			
Contamination of soil and water due to spilling of dangerous substances (fuel, oil, lubricants, chemicals)	Storage, handling and disposal of dangerous substances	☐ none ☐ low ☐ moderate ☐ high	☐ following of the regulation of RA6969 ☐ Other measures, please specify:
Operation and Maintenance			
Accumulation of floating debris at the intake	Design of intake	☐ none ☐ low ☐ moderate ☐ high	☐ No mitigation measure ☐ Measures to reduce or avoid accumulations of floating debris at the intake, please describe: If there will be accumulations of floating debris at the intake, how will it be disposed? Please describe:
Abandonment and Rehabilitation Phase			
Flooding due to blocking of abandoned dam or weir	Abandonment of plant facilities including all equipment (machinery, electro-mechanical equipment)	☐ none ☐ low ☐ moderate ☐ high	☐ No mitigation measure ☐ Abandonment plan including cost estimate, please describe and attach plan: ☐ Other measures, please specify;

5.7.2 Basic Concepts of Preparing an Environmental Checklist by Oneself [1]

The concepts of preparing environmental checklist for mini or micro HEP plants by oneself are summarized herein. As mentioned in the foregoing paragraph, the IEE checklists have already been created by the DENR for mini HEP plants, transmission lines and substations. They are opened to the public on the EMB website (http://www.emb.gov.ph/eia/checklist.htm) and can be downloaded.

In the case that power plants or related facilities are considered in the master plan, it is necessary to study the development of those facilities. At the same time, the procedures that satisfy the existing Philippines EIS (Environmental Impact Statement) system will be necessary.

Therefore, the environmental checklist proposed by this master plan follows the style and the contents that have already been employed as the existing IEE checklists for mini or micro hydropower plants, transmission lines and substations. Furthermore, items considered to be required will be added to the existing IEE checklist in consideration of the natural and social environments. Especially regarding transmission lines and substations, because there are no descriptions in the existing IEE checklists about the predicted impacts and mitigating/ enhancement measures, they should be included as much as possible.

While the existing IEE checklists consist of many items, including general information on the project and required attachments, the environmental checklist for the small hydropower development master plan narrows down the targets to the description of the existing environment and the impact assessment and mitigation. By correlating the content with the form of the existing IEE checklists for the EIS system, it will be useful as basic information on the necessary data for requiring EIS documents at the time of development.

5.7.3 Environmental Checklist for Mini and Micro Hydropower Plants

The following contents will be added to the existing IEE checklist for a mini hydropower plant.

(a) Description of existing environment

<Natural environment>

- What area of the environmental critical area, like ECAN zoning in Palawan, is the project site located in?

<Socio-cultural, economic environment>

- Are there any cultural heritage sites around the project area?
- Are there any ancestral lands or communities of indigenous people?
- Is the project site located in a protected area of NIPAS?

<Impact assessment and mitigation measures>

The items shown in Table 5.7-5 will be added to the existing IEE checklist. Moreover, the items indicated as the predicted impacts and mitigating/enhancement measures of a land-based power plant shown in Table 5.7-3 will be also examined, if necessary.

1 S.1.2 Environmental Checklist for the Master Plan, Master Plan Study of Power Development In Palawan Province Republic of the Philippines Final Report (Technical Background Report), Japan International Cooperation Agency, September 2004

Table 5.7-5 Additional Impact Assessment / Mitigation Measure Items for a Hydropower Plant

Impact	Evaluation		Mitigation Measures
	Relevant Subject and Parameters	Magnitude of Impact	
Project Location and Design			
Depletion of existing water sources around conduits	Location relationship between planned route of conduits and existing water sources	□ None □ Low □ Moderate □ High	□ No mitigation measure □ Secure an alternative water source □ Others (if any)

5.7.4 Environmental Checklist for Transmission Lines and Substations

The following contents will be added to the existing IEE checklist for transmission lines and substations, and the impact assessment and the mitigation measures will be described.

(1) Description of existing environment

<Natural environment>

- What area of the environmental critical area, like ECAN zoning in Palawan, is the project site located in?

<Socio-cultural, economic environment>

- Are there any cultural heritage sites around the project area?
- Is the project site located in a protected area of NIPAS?

(2) Impact assessment and mitigation measures

Table 5.7-6 shows the impact assessment and the mitigation measures for transmission lines and substations.

Table 5.7-6 Impact Assessment and Mitigation Measures for Transmission Lines and Substations

Predicted Impacts	Mitigation Measures
Pre-Construction and Construction Phase of the Project	
1. Loss of vegetation due to land clearing along the proposed route	▪ Limit land clearing as much as possible ▪ Provide temporary fencing for vegetation that will be retained ▪ Re-plant/plant indigenous tree species and ornamental plants
2. Top soil removal and loss due to earthmoving activities, transport, access road construction	▪ Stockpile the top soil in a safe place and use as final grading material or final layer ▪ As soon as possible, rip-rap or re-vegetate the area
3. Erosion from exposed cuts and landslides due to earthmoving and excavation activities	▪ Conduct construction activities during the dry season ▪ Avoid long exposure of opened cuts ▪ Installation of barrier nets
4. Sedimentation/siltation of drainage or waterways from unconfined stockpiles or soil and other materials	▪ Set-up temporary silt traps/ponds to prevent siltation ▪ Proper stockpiling of spoils (on flat areas and away from drainage routes) ▪ Dispose of spoils generated from civil works as filling materials
5. Pollution of nearby body of water due to improper disposal of construction wastes	▪ Set-up temporary disposal mechanism within the construction area and properly dispose of the generated solid wastes ▪ Set-up proper and adequate toilet facilities ▪ Strictly require the contractor and its workers to observe proper waste disposal and proper sanitation
6 Disturbance or loss of wildlife within the influence area due to noise and other construction activities	▪ Re-establish or simulate the habitat of affected wildlife in another suitable area ▪ Schedule noisy construction activities during the day time ▪ Undertake proper maintenance of equipment and use sound dampers
7 Noise generation that can affect the nearby residents	▪ Schedule noisy construction activities during the day time ▪ Undertake proper maintenance of equipment and use sound dampers
8 Generation of employment	▪ Hiring priority shall be given to qualified local residents
9 Conflicts in right of way	▪ Conduct consultations and settle agreements before finalizing the detailed design
10. Significant decrease in the aesthetic value of the area due to the tower or transmission line	▪ Consider the shape and color of the tower to minimize the impact to the aesthetic value of the area
11. Increased traffic and possible congestion	▪ Strict enforcement of traffic rules and regulations ▪ Proponents should provide traffic aid during peak hours
12. Increase in the incidence of crime and accidents	▪ Strictly require the contractor and its workers to follow safety rules and regulations in the construction and in the locality (in coordination with local authorities)
Operation Phase of the Project	
13. Obstacle to the movement of wildlife	▪ Installation of trails for wildlife
14. Economic growth as the result of stable supply of electricity	▪ Stable supply of electricity
15. Increased traffic and possible congestion as well as increased risk of vehicular related accidents	▪ Strict enforcement of traffic rules and regulations ▪ Placement of signs and warnings in appropriate places

5.7.5 Results of Site Reconnaissance (Environment)

The results of site reconnaissance are shown in the table below from an environmental point of view. The checklist for determining the need to study or not the IEE based on the Table 3.5-6 in Chapter 3 is shown in this table. If the project is required by the IEE, an examination must be conducted according to the procedures mentioned above.

Table 5.7-7 Checklist for Determining the Necessity of Initial Environmental Examination

No.	Site No.	ProjectName	RivSysName	RiverName	Proposed Capacity [MW]	Type	Reservoir Volume ($M.m^3$)	Reviewed Duration ID	Check list of Environmental Study: Effect of Active Volcano (<30km)	Check list of Environmental Study: NIPAS	Necessity of Study: IEE	Necessity of Study: EIS	Necessity of Study: FPIC from ICCs/IPs	Information about Socio-environment
1	2	Upper Manaba	Manaba	Manaba	1.0	Run-of-River		16			O			Irrigation / Roxas park
2	3	Balite	Manaba	(Balite)	1.1	Run-of-River		16			O			Irrigation / Roxas park
3	4	Lower Manaba	Manaba	Manaba+ Balite	0.7	Run-of-River		16						Irrigation / Roxas park
4	5	Odiong	Alihanan	(Odiong)	0.4	Run-of-River		16						Irrigation / Water use at the event in dry season
5	9	Sinambalan No.1	Mamburao	Sinambalan	3.0	Run-of-River		4			O		O	Irrigation / Luyang Baga cave
6	12	Pagbahan No.1	Pagbahan	Pagbahan	5.7	Run-of-River		4			O		O	Water use for Irrigation Indigenous people (Mangyans)
7	52	Binalbagan No.1	Binalbagan	Binalbagan	12.6	Reservoir	229	17	O			O		Irrigation / Kipot Falls
8	53	Binalbagan No.2	Binalbagan	Binalbagan	4.5	Run-of-River		17	O		O			-
9	54	Binalbagan No.3	Binalbagan	Binalbagan	3.6	Run-of-River		17	O		O			-
10	56	Lag-il No.1	Binalbagan	Guintobahan	1.4	Run-of-River		17			O			Irrigation
11	57	Lag-il No.2	Binalbagan	Guintobahan	2.0	Run-of-River		17			O			-
12	58	Pangiplan	Binalbagan	Guintobahan	1.3	Run-of-River		17			O			-
13	61	Hilabangan No.3	Ilog	Hilabangan	3.8	Run-of-River		17		O	O			Protected area (Ilog-Hilabangan Watershed Forest Reserve)
14	62	Ilog	Ilog	Ilog	25.4	Reservoir	699	17				O		Irrigation / Key Biodiversity Area
15	63	Calatong No.1	Sipalay	Calatong	1.4	Run-of-River		17			O			Protection Forest Zone
16	64	Calatong No.2	Sipalay	Calatong	1.8	Run-of-River		17			O			Irrigation / Protection Forest Zone
17	65	Binulug	Sipalay	Sipalay	3.4	Run-of-River		17			O			-
18	69	Mona-ol	Bayawan	Bayawan	0.9	Run-of-River		20					O	Water use for Irrigation Indigenous people (Bukidnon tribe)
19	71	Cauitan	Cauitan	Cauitan	1.4	Run-of-River		20			O		O	Irrigation / Indigenous people (Bukidnon tribe) / Talustos Fall
20	72	Canauay	Canauay	Canauay	0.6	Run-of-River		20						Irrigation
21	75	Himagaan	Himogaan	Himogaan	2.0	Run-of-River		17		O	O		O	Protected area / Irrigation / Indigenous people (Bukidnon tribe)
22	77	Guinobe-an No.1	Libertad	Guinobe-an	4.5	Run-of-River		18			O			Irrigation
23	78	Pacu-an	Libertad	Pacu-an	4.0	Run-of-River		18			O			Irrigation
24	79	Guinoba-an No.2	Libertad	Guinoba-an	3.4	Run-of-River		18			O			Irrigation
25	80	San Jose	San Jose	San Jose	0.6	Run-of-River		18						Irrigation
26	81	Talaptap	Payabon	Talaptap	1.2	Run-of-River		19			O			Irrigation
27	84	Hinotongan	Tanjay	Hinotongan	0.6	Run-of-River		20		O				Twin Lake National Park near the site / Irrigation
28	114	Tubig	Taft	Tubig	7.6	Run-of-River		21			O			Eagle sanctuary
29	118	Buhid	Suribao	Buhid	6.5	Run-of-River		21			O			Water fall
30	131	Dugayan	Ibajay	(Dugayan)	1.4	Run-of-River		22			O			Protected area
31	132	Bulanao No.1	Bulanao	Bulanao	1.3	Run-of-River		22			O			Protected area / Irrigation
32	139	Tibiao No.2	Tibiao	Tibiao	1.9	Run-of-River		22			O			Irrigation
33	165	Ulian No.2	Jalaud	Tagbacan	1.4	Run-of-River		26		O	O			Near the protected area / Irrigation
34	198	Salsona	Laoag	Salsona	2.6	Run-of-River		25			O			Protection forest of DENR project / Irrigation
35	199	Modongan No.1	Laoag	Salsona	3.6	Run-of-River		25			O		O	Protection forest of DENR project / Irrigation / Indigenous people (Isneg and Tinguian)
36	200	Modongan No.2	Laoag	Salsona	4.7	Run-of-River		25			O		O	Protection forest of DENR project / Irrigation / Indigenous people (Isneg and Tinguian)
37	202	Nailiman No.2	Cagayan	Nailiman	2.6	Run-of-River		27			O		O	Protection forest of DENR project / Irrigation / Indigenous people (Agta or Dumagat)
38	204	Dabubu No.2	Cagayan	Dabubu	3.7	Run-of-River		27			O		O	Protection forest of DENR project / Irrigation / Indigenous people (Agta or Dumagat)
39	206	Dibuluan No.2	Cagayan	Dibuluan	4.8	Run-of-River		27			O		O	Protection forest of DENR project / Irrigation / Indigenous people (Agta or Dumagat)
40	219	Maplas	Cagayan	Pinacanauan	4.1	Run-of-River		23			O		O	Community Based Forest Management Zone / Irrigation / Indigeneous people (Igorot)
41	223	Tuguegarao No.2	Cagayan	P. de Tuguegara	3.4	Run-of-River		24		O	O		O	Protected Landscape and Seascape of Penablanca area / Irrigation / Indigeneous people (Aeta)
42	224	Natulud No.1	Cagayan	P. de Tuguegara	2.4	Run-of-River		24		O	O		O	Protected Landscape and Seascape of Penablanca area / Irrigation / Indigeneous people (Aeta)
43	225	Natulud No.2	Cagayan	P. de Tuguegara	3.2	Run-of-River		24		O	O		O	Protected Landscape and Seascape of Penablanca area / Irrigation / Indigeneous people (Aeta)
44	226	Pered No.1	Cagayan	Pered	3.2	Run-of-River		24		O	O		O	Protected Landscape and Seascape of Penablanca area / Irrigation / Indigeneous people (Aeta)
45	229	Immurung	Cagayan	Pered	1.0	Run-of-River		24		O	O		O	National Park / Irrigation / Indigeneous people (Aeta) / Hot springs
46	235	Taboan No.2	Taboan	Taboan	1.4	Reservoir	41	24				O	O	CADT (Certificate of Ancestral Domain Title) / Indigeneous people (AETAS)
47	238	Dikatayan	Dikatayan	Dikatayan	5.1	Reservoir	125	24				O	O	Protection forest of DENR project / Irrigation / Indigenous people (Agta or Dumagat)

NIPAS : Natural Integrated Protected Areas System (Act of 1992)
IEE : Initial Environmental Examination
EIS : Environmental Impact Statement
FPIC : Free Prior and Informed Consent
ICCs : Indigeneous Cultural Communities
IPs : Indegeneous People
Effect of Active Volcano (<30km):
In this study, hydropower sites located within 30 km radium from the active volcano are given lower evaluation on the safe side from the environmental point of view.

5.8 Economic and Financial Evaluation of Each Promising Power Project

Economic and financial analyses are conducted of promising hydropower potential sites. Calculations are conducted for run-of-river type hydropower projects under the following preconditions. The study is done in the preliminary stage and the results of economic and financial analyses are used for reference only. The economic and financial analyses by comprehensive field investigation shall be carried out during the F/S stage.

5.8.1 Economic Analysis for Promising Potential Projects

As parameters of economic analysis, EIRR (Economic Internal Rate of Return) and BCR (Benefit-Cost Ratio) are calculated under the following preconditions.

(1) Preconditions

Preconditions for economic analysis are as below.

- Thermal efficiency of 40%
- 1 kWh = 3,600 KJ
- Heating value of Bunker C of 41,700 KJ/kg
- Thermal plant construction unit cost of 750 USD/kW
- Fixed Operational and Maintenance (O&M) cost of 30 USD/kW
- Variable O&M cost of 1 USD/kW

(2) Calculation Results

Calculation results are given in Table 5.8-1.

5.8.2 Financial Analysis for Promising Potential Projects

As parameters of financial analysis, FIRR (Financial Internal Rate of Return) is calculated under the following preconditions.

(1) Preconditions

Preferential tax treatment under the Renewable Energy Law, financial conditions under DBP (Development Bank of the Philippines) EDP (Environmental Development Project) and provisional FIT (Feed-in-Tariff) shall be taken into consideration in financial analyses. Preconditions for economic analyses are as below.

- ITH (Income Tax Holiday) is valid for 7 years. After the 7th year, 10% is to be applied.
- Period of depreciation of 30 years
- Import duty for electro-mechanical equipment of 0%
- Period of loan of 10 years and period of amortization of 5 years
- Loan interest rate of 10%
- Electricity tariff is 6.15 PhP/kWh for 12 years, and, after 12 years, the same tariff is applied.

(2) Other Conditions

- Debt ratio of 20%

- Annual O&M cost is 3.4% of project cost excluding tax.
- Administration cost is 10% of sales revenues.
- Project life time of 30 years
- Annual inflation rate of 4.5%
- Privilege tax is 0% of sales revenue.
- Real estate tax is 1.5% of electro-mechanical equipment.
- Exchange rate of 46 PhP/USD
- Physical contingency of civil work portion is 10% and that of electro-mechanical works is 10%.
- Price contingency of foreign currency portion is 0% and that of local currency portion is 5%.
- Construction period of 2 years

(3) Calculation Results

Calculation results are given in Table 5.8-1.

Table 5.8-1 Summary of Economic and Financial Analysis Results at 47 Promising Hydropower Potential Sites

ID	Island	Point	Max Output (MW)	Annual Energy Generation (MWh)	Type	Catchment Area (Km^2)	Max Power Discharge (m^2/s)	Effective Head (m)	Water Level (m)		Dam			Reservoir			Headrace (m)		Penstock (m)	Tailrace (m)	Capacity		Construction Cost (MUSD)	Road Extension (m)	Socio Environmental Assessment			EIRR (30 Year)	FIRR (30 Year)	Unit Cost /kWh ($)	Site Recon-naissance
									Intake	Tailrace	Type	Height (m)	Crest Length (m)	High Water Level (m)	Total Reservoir Volume ($M.m^3$)	Effective Volume ($M.m^3$)	Open Channel	Tunnel			River Water (%)	Facility (%)			Protected Area	Volcano	Residence				
2	Bohol	Upper Manaba	0.95	4522.8	Run of River	22.8	1.03	117.2	245.0	119.0		3.0	15.0				1300	0	730	10	42%	52%	6.23	1335				3.8%	0.7%	1.27	Done
3	Bohol	Balite	1.30	5979.7	Run of River	26.8	1.25	130.1	247.0	109.0		4.0	15.0				1500	0	400	10	41%	50%	6.04	1300				8.5%	4.4%	0.93	Done
4	Bohol	Lower Manaba	0.51	2712.2	Run of River	67.0	2.48	26.7	111.0	79.0		4.0	22.0				2100	0	90	30	48%	58%	6.03	1400				-3.8%	-6.0%	2.20	Done
5	Bohol	Odiong	0.42	2053.2	Run of River	11.1	0.50	109.1	180.0	64.0		3.0	15.0				0	0	580	15	42%	53%	3.30	270				2.1%	-0.6%	1.43	Done
9	Mindoro	Sinambalan No.1	3.10	22370.5	Run of River	58.4	4.00	96.7	165.0	60.0		7.0	35.0				0	2150	180	10	64%	78%	19.86	4700				17.9%	12.3%	0.55	Done
12	Mindoro	Pagbahan No.1	12.00	53189.4	Run of River	44.4	6.45	224.9	468.0	229.0		5.0	30.0				5800	0	620	10	39%	48%	28.45	15000				24.6%	16.2%	0.50	Done
52	Negros	Binalbagan No.1	13.00	52914.0	Pondage	216.9	20.32	76.9	295.0	210.0	Rock Fill	75.0	526.0	295.0	229	31	0	1948	180	10	35%	44%	136.79	1740		Kanloan		-4.6%	-7.1%	2.33	Done
53	Negros	Binalbagan No.2	3.60	27346.2	Run of River	229.5	8.21	54.2	196.0	133.0		5.0	30.0				0	2788	130	10	71%	82%	28.23	3370		Kanloan	1.0	13.3%	9.0%	0.66	Done
54	Negros	Binalbagan No.3	1.40	10346.6	Run of River	238.7	8.54	20.2	165.0	136.0		5.0	85.0				0	2960	110	10	71%	80%	25.02	1980		Kanloan		0.0%	-2.1%	1.61	Done
56	Negros	Lag-il No.1	1.30	8802.7	Run of River	35.7	1.67	99.8	361.0	253.0		5.0	55.0				1979	0	190	10	60%	73%	8.58	3340				11.3%	7.3%	0.75	Done
57	Negros	Lag-il No.2	2.30	15513.1	Run of River	64.8	3.03	95.6	276.0	174.0		5.0	35.0				6000	0	240	10	60%	73%	13.77	4330				13.3%	8.8%	0.68	Done
58	Negros	Pangiplan	1.40	8969.2	Run of River	40.5	1.92	89.2	273.0	174.0		5.0	35.0				3448	0	250	10	60%	69%	9.86	2182				8.8%	5.3%	0.87	Done
61	Negros	Hilabangan No.3	3.60	28628.3	Run of River	390.9	12.87	35.1	138.0	97.0		5.0	67.0				1280	2200	110	10	74%	86%	30.54	3370	Ilog Hilabangan Water Forest Reserve		1.0	12.2%	8.3%	0.69	Done
62	Negros	Ilog	21.60	144358.9	Reserovir	887.3	41.53	62.0	162.0	94.0	Rock Fill	70.0	240.0	115.0	699	189	0	0	130	50	60%	72%	115.60	1330				13.3%	9.0%	0.66	Done
63	Negros	Calatong No.1	1.30	8862.0	Run of River	31.4	1.47	114.0	318.0	196.0		4.0	30.0				1600	0	240	10	60%	74%	7.68	3300				14.1%	9.3%	0.66	Done
64	Negros	Calatong No.2	1.70	11474.1	Run of River	46.7	2.21	98.5	180.0	71.0		4.0	35.0				4050	0	270	10	60%	73%	11.59	3150				10.5%	6.7%	0.78	Done
65	Negros	Binulug	4.50	24092.3	Run of River	51.7	3.50	159.8	263.0	93.0		3.0	35.0				4050	0	320	10	46%	58%	14.08	4360				19.9%	13.2%	0.54	Done
69	Negros	Mona-ol	1.90	14064.8	Run of River	31.3	2.26	103.8	175.0	63.0		3.0	42.0				1600	0	320	10	59%	80%	11.49	3680				19.5%	13.6%	0.51	Done
71	Negros	Cauitan	3.30	25109.4	Run of River	48.7	3.52	117.8	226.0	96.0		5.0	17.0				5774	0	260	30	59%	83%	21.53	6800				17.4%	12.1%	0.55	Done
72	Negros	Canauay	1.40	10327.8	Run of River	33.1	2.39	72.5	268.0	187.0		3.0	45.0				2600	0	130	10	59%	80%	10.75	1297				13.9%	9.5%	0.65	Done
75	Negros	Himagaan	0.19	1161.2	Run of River	64.5	4.10	6.3	290.0	275.0		3.0	60.0				1250	0	840	10	48%	66%	10.54	600	Northern Negros Natural Park			-	-	9.02	Done
77	Negros	Guinobe-an No.1	6.70	37580.2	Run of River	71.3	4.27	192.3	321.0	117.0		3.5	10.0				0	4800	330	10	52%	61%	24.40	4260				20.0%	12.7%	0.53	Done
78	Negros	Pacu-an	8.30	41574.5	Run of River	103.2	7.62	131.8	266.0	125.0		4.0	45.0				0	2600	270	10	45%	54%	22.39	4711				23.0%	15.7%	0.49	Done
79	Negros	Guinoba-an No.2	2.90	21969.4	Run of River	183.1	6.71	54.2	117.0	54.0		4.0	35.0				0	2923	100	10	68%	82%	26.54	3571				11.8%	7.9%	0.71	Done
80	Negros	San Jose	1.20	6113.3	Run of River	28.5	2.08	73.4	204.0	123.0		2.5	22.0				1500	0	170	10	45%	55%	6.68	4413				7.0%	3.9%	1.03	Done
81	Negros	Talaptap	1.20	9362.7	Run of River	82.0	2.40	65.9	199.0	124.0		4.0	35.0				3000	0	170	10	61%	85%	11.66	3670				9.7%	6.2%	0.81	Done
84	Negros	Hinotongan	1.70	9475.0	Run of River	36.0	3.85	54.5	220.0	158.0		5.0	35.0				1890	0	180	50	47%	60%	8.18	0				8.7%	4.9%	0.89	Done
114	Samar	Tubig	20.20	101920.9	Run of River	126.9	27.39	87.9	120.0	19.0		10.0	93.0				6600	0	260	10	46%	55%	44.87	0	Samar Island Natural Park			21.3%	13.0%	0.51	Done
118	Samar	Buhid	20.20	120333.2	Run of River	160.8	26.17	92.2	139.0	37.0		7.0	10.0				0	0	310	3100	56%	65%	50.21	12000	Samar Island Natural Park			32.0%	19.9%	0.38	Done
131	Panay	Dugayan	0.98	4745.9	Run of River	17.4	2.31	54.0	141.0	78.0		5.0	5.0				2930	0	330	30	46%	53%	9.85	11000				-2.0%	-4.3%	2.00	Done
132	Panay	Bulanao No.1	3.30	10223.4	Run of River	11.3	2.87	139.8	269.0	122.0		7.0	28.0				600	0	420	30	31%	34%	8.39	3350	Northwest Panay Peninsula Natural Park			11.2%	5.9%	0.88	Done
139	Panay	Tibiao No.2	1.50	7449.2	Run of River	49.3	5.86	32.3	85.0	44.0		10.0	65.0				2650	0	160	50	49%	54%	11.98	450				1.6%	-1.1%	1.47	Done
165	Panay	Ulian No.2	1.00	7664.7	Run of River	59.2	3.78	33.8	193.0	151.0		7.0	10.0				1500	0	240	400	69%	83%	12.51	700				6.2%	3.4%	1.00	Done
198	Luzon	Salsona	5.90	17990.8	Run of River	61.3	7.75	93.3	270.0	167.0		10.0	27.0				4300	0	190	10	33%	33%	19.88	685				8.4%	3.3%	1.01	Done
199	Luzon	Modongan No.1	11.00	28647.3	Run of River	71.9	12.41	107.7	385.0	267.0		5.0	20.0				3980	0	200	30	27%	28%	23.57	7995				12.6%	6.1%	0.87	Done
200	Luzon	Modongan No.2	10.40	33405.6	Run of River	120.8	13.60	92.6	255.0	156.0		10.0	53.0				0	6620	190	230	35%	35%	35.36	2870				6.8%	2.4%	1.09	Done
202	Luzon	Nailiman No.2	2.80	22334.9	Run of River	147.0	7.72	44.8	220.0	166.0		5.0	102.0				0	3200	160	10	75%	87%	28.59	2000	Quirino Protected Landscape			8.9%	5.7%	0.84	Done
204	Luzon	Dabubu No.2	6.70	39282.3	Run of River	74.1	7.06	115.7	305.0	175.0		5.0	40.0				0	6590	580	10	51%	64%	35.24	600	Quirino Protected Landscape			10.2%	6.6%	0.80	Done
206	Luzon	Dibuluan No.2	2.20	17748.0	Run of River	100.5	5.36	51.8	360.0	300.0		5.0	30.0				0	5230	310	10	74%	87%	26.29	9700	Quirino Protected Landscape			3.4%	0.9%	1.24	Done
219	Luzon	Maplas	9.50	56438.4	Run of River	137.9	11.27	102.6	210.0	98.0		5.0	12.0				3200	7000	190	10	60%	64%	61.30	11600				11.0%	6.8%	0.77	Done
223	Luzon	Tuguegarao No.2	4.70	23997.3	Run of River	172.0	11.77	49.7	178.0	122.0		5.0	30.0				0	3320	230	10	48%	55%	25.79	7250	Penablanca Protected Landscape and Seascape			7.2%	3.7%	0.99	Done
224	Luzon	Natulud No.1	4.10	18948.9	Run of River	56.4	4.45	114.4	210.0	85.0		5.0	30.0				0	4300	220	10	44%	50%	18.93	953	Penablanca Protected Landscape and Seascape			8.6%	4.6%	0.92	Done
225	Luzon	Natulud No.2	3.20	23997.7	Run of River	323.5	10.55	38.1	110.0	63.0		5.0	74.0				6370	0	130	10	71%	81%	29.00	4200	Penablanca Protected Landscape and Seascape		1.0	11.8%	7.9%	0.72	Done
226	Luzon	Pered No.1	2.10	10714.1	Run of River	57.5	3.94	67.6	215.0	138.0		10.0	30.0				3050	0	260	10	48%	55%	13.63	11000	Penablanca Protected Landscape and Seascape			4.6%	1.5%	1.21	Done
229	Luzon	Immurung	4.10	12000.8	Run of River	23.3	3.65	136.5	245.0	100.0		5.0	25.0				2050	0	370	30	29%	32%	8.65	0				10.5%	5.8%	0.92	Done
235	Luzon	Taboan No.2	2.30	12088.9	Reserovir	313.0	20.28	14.3	25.0	5.0	Concrete	15.0	150.0	25.0	41	21	0	0	40	30	49%	57%	19.01	9000				1.2%	-1.4%	1.53	Done
238	Luzon	Dikatayan	9.20	41308.7	Reserovir	220.0	18.08	62.0	121.0	53.0	Rock Fill	70.0	180.0	75.0	125	25	0	0	120	50	43%	49%	62.85	2700				2.5%	-0.4%	1.38	Done

CHAPTER 6

MEASURES TO PROMOTE MINI-HYDROPOWER PROJECTS AND ISSUES TO BE CONSIDERED

CHAPTER 6 MEASURES TO PROMOTE MINI-HYDROPOWER PROJECTS AND ISSUES TO BE CONSIDERED

In this Chapter, we analyze the issues to be considered in the post-F/S (Feasibility Study) phase of mini-hydro power projects.

6.1 CURRENT SITUATION OF MINI-HYDROPOWER PROJECTS IN THE PHILIPPINES

The capacity of HEP is the largest among RE (Renewable Energy) (Table 6.1-1), and it is expected to increase in the future. However, there are only 6 projects that reached MHPDOC (Mini-Hydro Electric Power Development Operating Contract); Table 6.1-2).

Of these projects, Villasiga MHP (Mini-HEP) is the only project contracted under the Renewable Energy Act (RA) No.9513, while all other projects are contracted under RA No.7156 of 1991.

Table 6.1-1 Installed Capacity of Renewable Energy (RE)

(MW)

RE Resource	Installed Capacity
Hydropower	3,367.07
Geothermal	2,027.06
Wind	33.50
Biomass	20.93
Solar	5.16
TOTAL	5,453.72

Source: DOE

Table 6.1-2 Status of Mini-Hydro Electric Projects

Project	Proponent	Capacity (MW)	Location	Operating Contracts under
Solong River MHP	Sunwest Water & Electric Co., Inc.	2.3	Brgy, Solong, San Miguel, Catanduanes	RA No.7156
Hitoma 1 MHP		1.5	Brgy, Obi, Caramoran, Catanduanes	
Hitoma 2 MHP		1.57		
Villasiga MHP		8.0	Bugasong, Antique	RA No.9513
Sipangpang Falls MHP	LGU of Cantilan	1.0	Cantilan, Surigao del Sur	RA NO.7156
Panoon Falls MHP	GerPhil Renewable Energy, Inc.	0.11	Impasugong, Bukidnon	

Note: RA No.7156: An Act Granting Incentives to Mini-HEP Developers and for Other Purposes (1991)
RA No.7156 Amongst those where “incentive policy for mini-HEP“ was applied, the following 4 projects were changed to RA No.9513: Solong River MHP, Hitoma 1, Hitoma 2 and Villasiga MHPs,
RA No.9513: An Act Promoting the Development, Utilization and Commercialization of Renewable Energy Resources and for Other Purposes (2008)

Source: Revised from materials from the DOE

6.2 IMPACT OF RENEWABLE ENERGY LAWS ON THE PROFITABILITY OF MINI-HYDRO PROJECTS

The two main impacts on profitability of mini-HEP are FIT (Feed-in-Tariff) and fiscal incentives.

(1) Feed-In-Tariff (FIT) System

- The FIT system provides the mini-HEP priority connection to the grid for electricity generated and pays a fixed tariff for electricity produced from each type of RE over a fixed period.
- The NREB (National Renewable Energy Board[1]) seeks to adopt 5.5 PhP/kWh (as of September 2011) for 20 years in the case of a run-of-river HEP plant. The Philippines government targets 250 MW within 3 (three) years from the introduction of FIT.
- Purchase price and purchase period under the FIT system in the Philippines will be set to internationally accepted averages (Fig. 6.2-1).

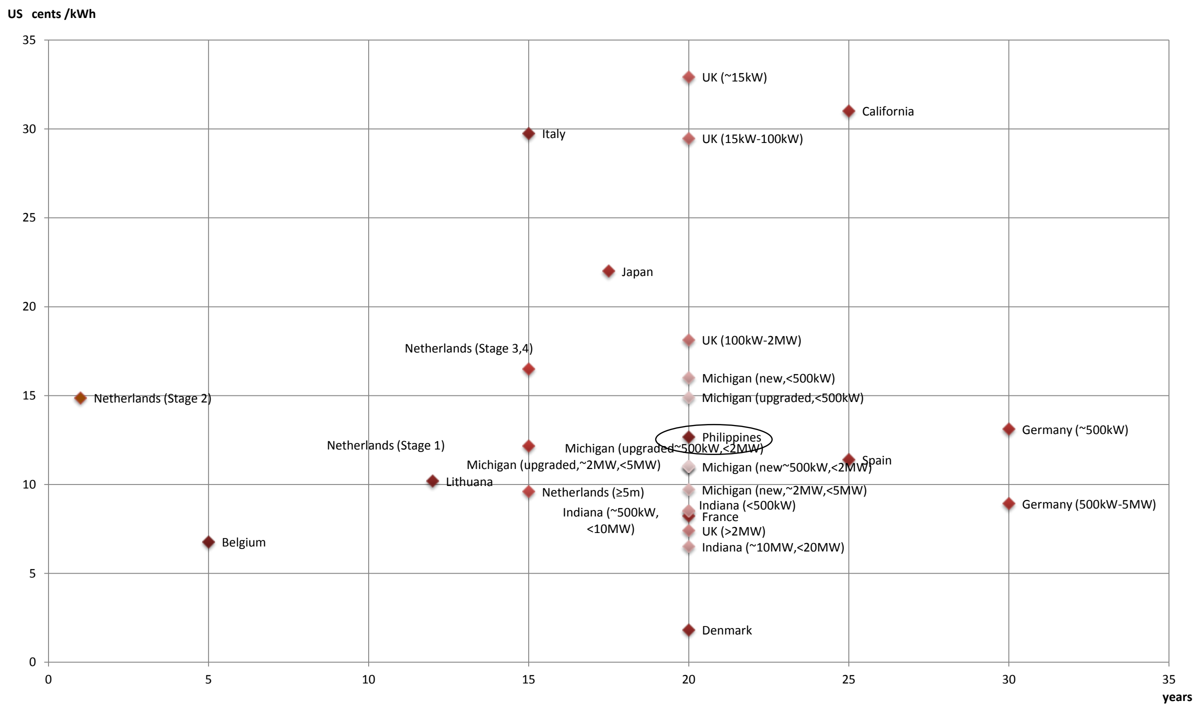


Fig. 6.2-1 Incentive of RA No. 9513

Note: In Japan, detailed conditions awarded under FIT are not yet finalized.

Source: "Integration of electricity from renewables to the electricity grid and to the electricity market - RES Integration," Institute for Applied Ecology (2011)

1 NREB was created under RA No.9513.

In the Philippines, the RPS (Renewable Energy Portfolio) is concurrently introduced together with FIT. According to RPS rules version 2 (draft as of March 8, 2011), the DOE shall increase the RPS rate by at least 1% of its annual energy demand within a period of ten (10) years from the introduction of these rules, provided that the annual increase corresponds to the installation target. Furthermore, all electric power industry participants mandated to comply with the RPS shall also increase the share of RE in their energy portfolios annually by at least 1% or by the annual rate to be determined by the DOE.

(2) Fiscal Incentive

Fiscal investment incentives of RA No.9513 are shown in Table 6.2-1.

Table 6.2-1 Tax Incentives regarding "Renewable Energy Act of 2008" (RA No.9513)

Fiscal incentives	Explanations
1) Income Tax Holiday (ITH)	7 years from the start of operation
2) Net Operating Loss Carry Over (NOLCO)	The first 3 years from the start of commercial operation shall be carried over as a deduction from gross income for the next 7 consecutive taxable years immediately following the year of such loss.
3) Tax Credit on Domestic Capital Equipment and Services	
4) Corporate Tax Rate	After 7 years of ITH, all RE Developers shall pay a corporate tax of 10% on its net taxable income as defined in the NIRC of 1999.
5) Special Realty Tax Rates on Equipment and Machinery	Less than 1.5 % of the original cost less accumulated normal depreciation (= Net worth)

Source: BOI (Board of Investments)

The two main types of investment incentives are those determined by the BOI (Board of Investments) independently and those required to be coordinated with other government offices. (Table 6.2-2)

Table 6.2-2 Fiscal Incentives and Approval Agency

	Fiscal Incentives	Approval Agency
RA No.9513 (Renewable Energy Law 2008)	1) Income Tax Holiday for 7 years. 2) Duty-free Importation of RE Machinery, Equipment and Materials including control and communication equipment 3) Tax Exemption of Carbon Credits	Only BOI
	1) Special Realty Tax Rates on Equipment and Machinery 2) NOLCO 3) Accelerated Depreciation 4) Zero-percent Value-added Tax rate 5) Cash Incentives of Renewable Energy Developers for Missionary Electrification 6) Tax Credit on Domestic Capital Equipment and Services	Must be coordinated between the BOI and other government offices. e.g. Special Realty Tax on Equipment and Machinery is coordinated with the LGU. Net Operating Loss Carryover (NOLCO) is coordinated with the Bureau of Internal Revenue.

Note 1 : The BOI can provide incentives only to registered companies.
Note 2 : The BOI provides exemptions from carbon credit tax as an incentive, but there are no applications as of the moment.

Source: BOI

Table 6.2-3 shows the incentives provided under RA No.9513 and Executive Order (EO) 226.

Regarding ITH, when a company has Filipino capital of 60% or more, it is qualified under the RA No.9513, and can enjoy and ITH for seven years from the start of operation.

Table 6.2-3 Comparison of Incentives Provided by RA No.9513 and EO226

	RA No.9513	EO226(IPP)
Owner Status	Filipino capital 60 % or more	Other than that on the left. It could be 100 % foreign capital.
Merit	- 7 years from the start of operation - Duty-free importation of RE machinery, equipment and materials including control and communication equipment - Tax exemption of carbon credits	- Pioneer status companies can enjoy ITH for 6 years. Furthermore, when its CSR (Corporate Social Responsibility) activity is approved, ITH can be extended to 8 years 2 additional years total. - Duty-free importation of RE machinery, equipment and materials including control and communication equipment - Tax exemption of carbon credits

Note: RA: Republic Act
EO: Executive Order
IPP: Investment Priorities Plan

Source: BOI

Since RA No.9513 went into effect, a Special privilege Tax (2%) on gross revenue, which is given under RA No.7156 (An Act Granting Incentives to Mini-HEP Developers and for Other Purposes) was repealed (RA No.9513, Sec 39).

Fig. 6.2-2 is an illustrative comparison of incentives provided under RA No.9513 and under EO226. Under RA No.9513, the project is awarded 7 (seven) years of ITH (Income Tax Holidays) from the start of operation and the first 3 (three) years from the start of commercial operation are carried over as a deduction from gross income for the next 7 (seven) consecutive taxable years immediately following the year of such loss.

On the other hand under the EO226, the project is awarded 6 (six) years of tax holidays and awarded another 2 (two) years of tax holidays if it is recognized as a CSR (Corporate Social Responsibility) project. But, after that period, the project has to be charged at the normal (30%) tax rate.

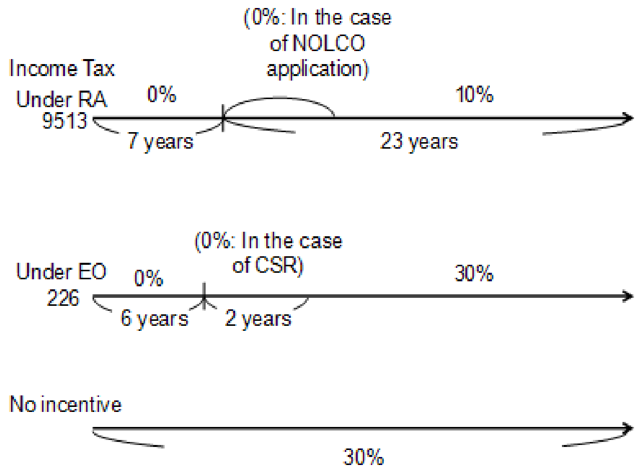


Fig. 6.2-2 Illustrative Comparison of Incentives under RA No.9513 and EO226

6.3 MAJOR FINANCIAL MECHANISMS PROVIDED BY FINANCIAL INSTITUTIONS

In the Philippines, the lending for mini-HEP projects is carried out by private banks and DBP (Development Bank of the Philippines). LGU-GC (Local Government Unit Guarantee Corporation) offers loan guarantee. For F/S and CDM (Clean Development Mechanism), Land Bank and DBP provide supporting schemes. Renewable Energy Trust Fund has become available for research activities.

(1) LGU-GC

1) Overview of LGU-GC's activities with mini-hydro projects

The LGUGC (Local Government Unit Guarantee Corporation) was established in 1998 with the support of the USAID (United States Agency for International Development). Its main function is to provide guarantees for loans and bonds.

Borrowers are Local Government Units (LGUs), Electric Cooperatives (ECs), and Private Developers of Medium to Large Enterprises (MLEs).

For ECs, there are three requirement: 1) must be registered with the NEA (National Electrification Administration), 2) must have passed both NEA and LGU-GC credit evaluation standards, 3) must have hydropower CAPEX (Capital Expenditure) projects approved by the ERC (Energy Regulatory Commission) and DOE.

Collateral is as follows.

- Project Cash Flows / Revenues / Receivables
- Project Assets (Real Estate, Chattel)
- Project Reserve Funds

The Guarantee Coverage for Regular Guarantee Program is up to 85% of the debt service (principal and interest).

The Guarantee Fee for Regular Guarantee Program is as follows.

- LGUs: 1.00% to 1.25% p.a.
- ECs: 1.25% to 1.75% p.a.
- MLEs: 1.50% to 2.00% p.a.

The Processing Fee for Regular Guarantee Program is 1/8 of 1% of the guaranteed amount, and is negotiable.

With the Renewable Energy Loan Guarantee Fund (RE-LGF), CBRED (Capacity Building to Remove Barriers for Renewable Energy Development project) is being implemented by the DOE, and the LGU-GC operates as the program fund manager of LGFs.

The current amount that the LGU-GC is able to guarantee is 80 million PhP (1.606 million US$), and this is applied for mini-HEP, biomass and solar power projects.

One mini-MHP project has already been guaranteed for 9.2 million PhP (approved in 2008).

In addition to the guaranteed rate of 0.25%, a 1000 PhP processing fee is collected.

Although final approval by the ERC is required for PPA (Power Purchase Agreement), the LGU-GC can make determinations on its own if it takes a long time.

2) Criteria for Evaluation and Examination

- While the DOE works on the technical parts, the LGU-GC examines financial indices such as FIRR and ROE (Return on Equity). It uses a program connected to B/S (Balance Sheet) and P/L (Profit and Loss Statement), on its own cash flow table. CDM is not calculated as it requires a lot of effort (mini-HEP projects supported by the LGU-GU are small scale).

- Rating for a borrower is considered.

- The financial situation of an EC is not considered. The scale of projects supported by the LGU-GC is so small at this stage that there is no crucial impact on EC financial viability.

3) Recent projects implemented by LGU-GC

A mini-HEP project is being implemented by German Phil Renewable Energy Incorporated, which is a local company of a German parent company. It is a 226 KW mini-HEP project in point “B”. The off-taker is BUSECO (Bukidnon Second Electric Cooperative) (with a good rating as EC). The total project cost is 13.2 million PhP, and 10.8 million of this is from a private Allied bank loan. The LGU-GC guarantees 9.2 million PhP, which is 80% of the debt (85% of principal or 20 million PhP is the maximum on RE-LGFs). After that, a large change was made to the “B” project.

Because Gerphil Renewable Energy, who was the main actor of the project, was unable to pay the first principal payment (2 years grace period at first) in October 2010 (the loan had been disbursed in 2008), the lender Allied bank called on guarantee, and the LGU-GC purchased their credit. Because of this, the LGU-GC became the only creditor. Therefore, the period of the loan was extended from 10 years to 15 years. This was partly because of the scarcity of rain caused by El Niño, mechanical troubles (breaker accident) and so forth.

Upon this change, the LGU-GC changed the major assumptions of the “B” project.

a) Original plan

- Cashflow model of the LGU-GC
  It is calculated based on a 10-year loan period and a 2-year grace period. (Private banks in the Philippines can only provide loans up to 10 years including grace period.)

- Interest rate of 10.5%

- ITH of 7 years

- Electricity tariff of 3.41 PhP/kWh, which was set to be increased by 5% every year from 2010 (based on PPA contract).

- Population is predicted by each barangay in the benefited area in its own way. Following this, sales are then predicted.

- Guaranteed amount of PhP 80 million. Aside from the mini-hydro project, there are some pipeline projects such as a biomass project, thus the amount will be used up soon. After that, it may request the GEF (Global Environment Facility) / BAP (Bank Association of the Philippines) / DBP to increase the amount of capital contribution.

- The loan covers only civil work and indirect costs. Other costs, such as electro-mechanical and contingencies, are covered by the development entity. Since land is provided by the development entity, the loan is not used for this purpose.

- Breakdown of project costs

- Price contingency accounts for 5%, civil work accounts for 4% and mechanical equipment accounts for 24% of the total cost (refer to Table 6.3-1).

Table 6.3-1 Cost Structure (Example) in a LGU-GC Project

Particulars	Total Amount	Loan	Equity
Civil Works	7,048,005	7,048,005	-
Electro-Mechanical Equipment & Transmission Line	3,198,168	-	3,198,168
Contingency	662,774	-	662,774
Sub-total	*10,908,946*	*7,048,005*	*3,860,942*
Indirect Cost	2,254,800	2,151,995	102,805
Total Project Cost	**13,163,747**	**9,200,000**	**3,963,747**

Source : LGU-GC

- The loan is initially provided on a one-time basis.
- 85% of the loan is guaranteed. The guarantee charge is 0.25% of the total amount, then a 12% VAT (Value Added Tax) is imposed on the guarantee charge (therefore, the amount is small).
- Plant factor is set as 50%.
- For the first 2 years, there is no escalation, then there is a 5% escalation from the third year to the 20th year. The electricity tariffs in the 20th year will be 6.3 PhP/kWh with escalation, which is rather cheap compared to the current electricity tariff of 8 PhP.

- kW cost is $\frac{13{,}163{,}747}{113kW}$ =116,493 PhP/kW

- $\frac{13{,}163{,}747}{313kW}$ = 42,057 PhP/kW
- The reason why project life is not 30 years but 20 years is that they are looking at calculation results from the conservative side.
- Administration cost is set as 35% of revenue plus O&M (Operation and Maintenance) cost of 1.6% of the total project cost.
- Indirect cost includes tax and preparation costs for F/S
- Contingency and indirect cost will be capitalized and then amortized in 10 years.
- It is forecasted to operate with 113 kW for the first 2 years, and 313 kW after the third year.
- Depreciation is 15 years straight line (conservative side).
- Interest during construction is not capitalized and paid out because it is expected that there will be solvency during the 2-year construction period.
- Project costs will be 1.4 PhP/kWh when levelized.
- The guarantee fee is subjected to 0.25%/year of 85% of debt (guaranteed amount).
- O&M cost is 1.6%/year of the total project cost, and it will be 22% of the total project cost in the 10th year.
- The tax holiday is applied for the first 5 years, and 30% is applied after that.
- As a result, IRR (Internal Rate of Return) is 25% for the first 10 years.

b) Revision of the Plan

The following modifications were made to the preconditions of the project.

Table 6.3-2 Modifications to the Preconditions of C Project Guaranteed by LGU-GC

Item		Original Plan	Revised Plan
Price		3.41 PHP/kWh 5% escalation every year	2.81 PHP/kWh until 2011 3.41 PHP/kWh until 2012 3.41 PHP/kWh until 2013 3.92 PHP/kWh(15% escalation) until 2014 3.92 PHP/kWh until 2015 3.92 PHP/kWh until 2016 4.50 PHP/kWh (15% escalation) until 2017
Scale of the project		226	220 (110 kW × 2)
Depreciation		15 years	20 years
Loan			
	Term	10 years	15 years
	Grace period	2 years	1 year
	Interest rate	10%	6%
O&M cost		1.6% of project cost	18% of revenue
Administration cost		36% of revenue	52% of revenue

Source: LGU-GC

- As for the price, they started with 2.83 PhP/kWh because the ERC has not admitted 3.41 PhP/kWh as of 2011
- In addition, one of the two waterpower turbines has not been registered with the DOE yet, so they use 2.83 PhP/kWh (time of use tariff of NPC (National Power Corporation)).

(2) Land Bank

1) Overview of Land Bank

Land Bank is a 100% government-owned bank mandated to spur countryside development. It has the most extensive branch network, with 325 branches and extension offices in 80 out of 81 provinces and a manpower compliment of 7,187 (as of Dec. 31, 2010).

The bank is financing 4 HEP projects (9.928 MW) with an aggregate loan amount of 1.04 billion PhP.

2) Major programs of Land Bank

a) CBRED (Capacity Building to Remove Barriers for Renewable Energy Development project)

CBRED provides a Project Preparation Fund. This is one of the capacity-building goals of removing barriers of RE by the DOE, and provides assistance for F/S of RE projects. Two (2) out of more than ten (10) projects are now under F/S. Funding for F/S is paid directly to consultants. The DOE examines the qualifications of the consultant. Funding is for detailed F/Ss, detailed engineering design, micro-siting analysis, and securing permits & licenses and is available to RE project developers, ECs, LGUs, private corporations and MFIs (Micro-Finance Institutions). It offers a 0% interest rate.

- The loanable amount is 50% of total project cost but not to exceed 5.0 million PhP.
- Payable quarterly in 3 years including 6 month grace period

CBRED in currently funding 3 mini-HEP projects (16.3MW) with an aggregate loan amount of 10.47 million PhP. Funding for F/S is paid directly to the consultant. The DOE evaluates qualifications.

b) Carbon Finance Support Facility (CFSF)

- In November 2006, Land Bank's Management Committee approved the establishment of the CFSF (Carbon Finance Support Facility). The CFSF primarily aims to promote climate change-mitigating activities to clients and assist them in every step of the CDM project cycle.

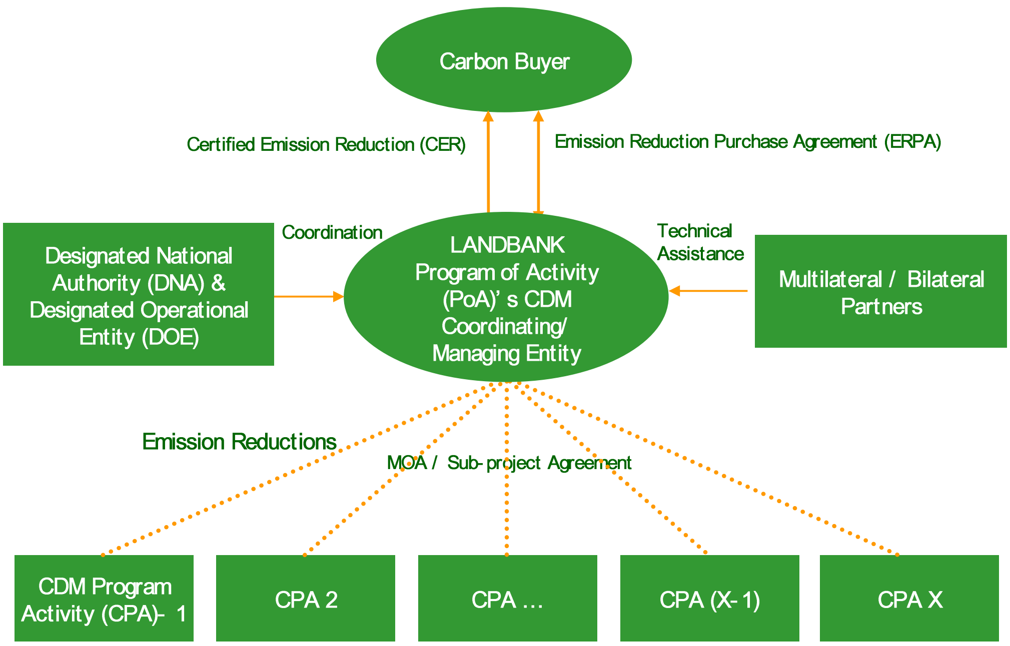
- Under the CFSF, Land Bank developed 3 CDM PoAs (Program of Activities).

- \- Animal Waste-to-Energy PoA
  \- Landfill Gas-to-Energy PoA
  \- Mini-Hydro PoA

Land Bank signed an ERPA (Emission Reduction Purchase Agreement) with KfW of Germany (carbon buyer) for the mini-HEP PoA.

The Mini-HEP PoA is under validation by the DOE.
Land Bank is a Coordinating/Managing Entity of CDM PoA.
The World Bank will purchase 250,000 CERs from 2010 to 2013.

The financial structure is shown in Fig 6.3-1.



Source: Land Bank

Fig 6.3-1 Financial Structure of the CFSF

Eligibility Criteria for mini-HEP plants includes 1) a capacity of electricity generation of 15 MW or below, 2) grid connection, 3) run-of-river design, 4) compliance with strict environmental regulations, and 5) the intent to participate in the mini-HEP PoA by signing a CFSF Reply Form and MOA (Memorandum of Agreement) with Land Bank.

c) Others

Although Land Bank does not provide a loan directly to mini-HEP projects (as of September, 2010), it conducts the following three (3) activities related to climate change.

1) Technical due diligence in compliance with environment regulations
2) Planning and technical service for environmental protection and development of CSR
3) Environmental program and management

At Land Bank, the Environmental Department coordinates with external agencies, and partly examines loans. The Lending Department conducts most of due diligence and loan examination related to environmental issues. This department also provides funding for F/S.

Multilateral funding of 10.5 million PhP for phasing out ozone depleting substance is granted through the WB (World Bank).

(3) DBP (Development Bank of the Philippines)

1) Overview of the DBP

The DBP (Development Bank of the Philippines) is a state-owned bank and attaches priorities to development of 1) infrastructure and logistics, 2) environment, 3) social development, and 4) promotion of small and medium-size enterprises (SMEs).

The bank's development of RE is in Luzon (164.94 MW [On-grid: 159.66 MW, off-grid: 5.28 MW), Visayas 0.50 MW (On-grid: 10.50 MW), and Mindanao 0.5 MW (Off-grid: 0.50 MW).

The DBP formed Official Development Assistance Funds through financing from the WB (World Bank), JICA (Japan International Cooperation Agency), and JBIC (Japan Bank for International Cooperation). The advantages of DBP financing are concessional term, technical assistance provision, and project preparation financing for eligible projects, which includes preparation of project F/Ss and preparation of detailed engineering designs.

The DBP is the first Philippine bank to secure endorsement from the DNA (Designated National Authority), DENR (Department of Environment and Natural Resources), for CDM registrable projects.

2) Loan projects carried out by the DBP

The DBP is currently providing 6 loans to HEP projects. The capacity of one project is 175 MW, and those of other 5 projects are less than 1 MW. There are other rehabilitation projects.

Though FIRR and hurdle rate (which is set at 9-10%) serve as indicators, loans to ECs are not commercial. This is because the funding source is a low-interest yen-loan and fundamentally it does not pursue profit when a borrower is an EC.

For the examination standard for mini-HEP projects, the DBP examines not only from the aspect of profit but also from a supply aspect that includes social and environment aspects (from the point of view of EIRR (Economic Internal Rate of Return)). Although the size is not specified, this holistic approach is applied. There is no special format of the business plan requested by the DBP to get a loan, but detailed designs should be complete.

There are checklists (see Table 6.3-3).

Table 6.3-3 Checklist of Requirements for Hydropower Project

1.	Feasibility Study a. Brief background with location map b. Overall design methodology and specific design approach including design criteria adopted c. Feasibility study grade with hydraulic and structural design calculations d. Full hydrological study describing the methodology used and data sources e. Geological and geotechnical investigation methodology and results of investigation f. Quantity and cost estimates outlining unit prices g. Power demand and supply situationer in the area h. Estimate of energy output and basis of calculation i. Watershed management plan j. Carbon abatement benefits k. Economic evaluation l. Alternative schemes of development m. Conclusions and recommendations n. Feasibility grade drawings - Overall scheme/project layout showing all components - Civil work structures including access roads - Electromechanical works and equipment
2.	Environmental Compliance Certificate including the following: **- Environmental Impact Statement** – For water impounding capacity ≥ 20 million m^3 **- Environmental Examination Report/Checklist** – For water impounding capacity < 20 million m^3 Certificate of Non-Coverage including Project Description Report
3.	A dam height of 15 meters and above is considered a **large dam**; the following documents should be prepared and submitted to ensure safety of dam. **Plan for construction supervision and quality assurance** – Covers the organization, staffing levels, procedures, equipment, and qualifications for supervision of the construction of a new dam. The plan should take into account the usual long construction period, covering the supervision requirements as the dam grows in height. **Instrumentation plan** – Detailed plan for the installation of instruments to monitor and record dam behavior and the related hydrometeorological, structural and seismic factors. **Operation and maintenance (O&M) plan** – Covers organizational structure, staffing, technical expertise, and training required; equipment and facilities needed to operate and maintain the dam; O& M procedures; and arrangements for funding O&M, including long-term maintenance and safety inspections. The O&M plan for a dam other than a water storage dam, in particular, reflects changes in the dam's structure or in the nature of the impounded material that may be expected over a period of years. **Emergency preparedness plan** – Specifies the roles of responsible parties when a dam failure is considered imminent, or when expected operational flow release threatens downstream life, property, or economic operations that depend on river flow levels. It includes the following items: clear statements on the responsibility for dam operations decision-making and for the related emergency communications; maps outlining inundation levels for various emergency conditions; flood warning system characteristics; and procedures for evacuating threatened areas and mobilizing emergency forces and equipment.
4.	Water Permit issued by the National Water Resources Board
5.	Renewable Energy Development Service/Operating Contract issued by the Department of Energy
6.	Certification Precondition/Certificate of Non-overlap including Free Prior Informed Consent issued by the National Commission on Indigenous People
7.	Grid Impact Study from TRANSCO/NGCP (If grid connected)
8.	Electricity Sales Agreement between the buyer and seller approved by the Energy Regulatory Commission

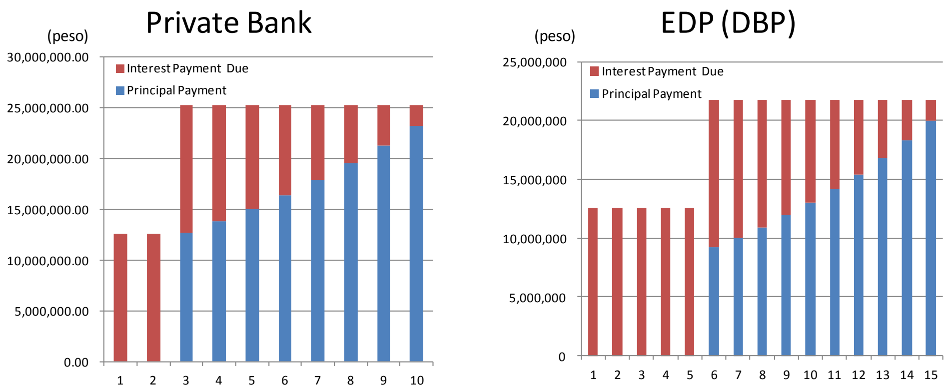
Source: DBP

3) Interest rate of the DBP

The interest rate of the DBP is the same as the market interest rate, and the loan period is 15 years including the grace period (maximum of 5 years; 10 years including grace period in the market). Fig.6.3-2 compares a typical payment schedule by private bank and by the EDP(Environmental Development Project) of DBP.

Fig.6.3-2 is a comparison of payment schedules between a private bank and an EDP. A private bank offers a 10-year loan period and 2-year grace period. On the other hand, the DBP offers loan period of 15 years, which includes a 5-year grace period.

Interest should be paid during the grace period. The loan rate is 9~11%. That is also a hurdle rate, which is a little lower than 12.5% of a commercial bank.



(Case 1) (Case 2, 3, 4, 5)

Note1: 9%
2 years grace
10 years repayment period

Note2: 9%
5 years grace
15 years repayment period

Fig.6.3-2 Comparison of Payment Schedule

The DBP is trying to increase CDM projects, and there are teams for application and registration at the bank. Currently, 3 projects are going through the validation process at the DNA.

CDMs help to improve cash flow and enable earlier loan payoff. An EC has to consult with the NEA when it applies for a loan with the DBP. When used in combination with the environmental development fund from the DBP, the FIRR looks better. The WACC (Weighed Average Cost of Capital), which is required for private companies, is not required of an EC.

4) Loan standard of EDP

- Land is not paid for in an EDP.
- The transaction cost for validation of the CDM is included in the EDP.
- The Lake Mainit HEP Project (25kW) is now undergoing validation within the EDP framework.
- The target IRR is 15% and can be increased by about +1% if this project is registered as a CDM project.

- There is no target for an allocation to (mini)hydropower project within the EDP framework.
- The F/S and D/D (Detailed Design) should be completed for examination as an EDP. However, these cannot be financed with a EDP loan.

5) Conditions for EDP

- A syndicated loan can be used for an EDP.
- The debt-to-equity ratio is 7:3.
- Interest during construction is capitalized.
- The physical contingency of mechanical and electric equipment cost is 10%.
- The physical contingency of civil and building works is higher than 15%.

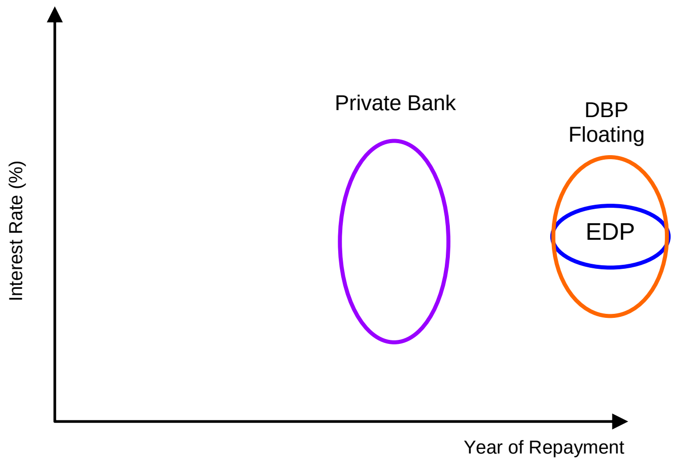
Currently, in the Philippines, the LGU-GC guarantees 85% of debt to loan for private investors with private bank loans and applies a guarantee fee of 0.02%, while the DBP provides loans for RE projects on favorable terms.

6) Current issues of EDP utilization

Interest rates for EDPs are in a relatively disadvantageous position compared to competing private banks regardless of the fact that fixed and long-term financing are offered, because they go by market rates as of 2011. In addition, time is needed for complying with the checklist required from the DBP and certification procedures.

Fig. 6.3-3 is a positioning diagram of financing for mini-HEP

The DBP approves loan for ECs regardless of the EC's rank. The DBP allows loans to low-ranked ECs via co-financing agreements with the NEA. This agreement can work effectively because the NEA can step into the EC's management. Table 6.3-4 shows the competition for capturing EC loans by rank. Loans for A-ranked ECs are highly competitive.



Note: Interest rates will fluctuate according to the market condition in the case of private bank finance and DBP floating finance.

Fig.6.3-3 Positioning Diagram of Financing for Mini-HEP

Table 6.3-4 EC Ranks and Applicable Loans

<table>
<tr><th>EC Rank
(NEA standards)</th><th colspan="4">Loan</th></tr>
<tr><td rowspan="2">A</td><td rowspan="2">World Bank</td><td colspan="2">DBP</td><td rowspan="2">Private bank
(Floating rate, 9%, 2 year of grace, 10-year repayment period)</td></tr>
<tr><td>EDP
(8-10% fixed interest rate, 5-year grace, 15-year repayment period)</td><td>Long-term loan
(Floating rate, 3-5 years of grace, 15-year repayment period)</td></tr>
<tr><td>B, C, D</td><td colspan="4">EDP</td></tr>
</table>

7) Positioning of EDP loans in financial schemes for RE in the Philippines

DBP loans (EDP) have advantages in terms of a fixed interest rate and a relatively longer period of repayment (5 years grace and 15 years repayment), compared to private financial institutions (2 years of grace and 10 years repayment). However, in last half year, private banks such as BPI (Bank of the Philippine Islands), BDO (Banco de Oro Unibank), Metrobank, Security bank etc. and Land bank, , have become strongly interested in investing in small HEP projects.

It is necessary to confirm the position of EDPs in the portfolio of business risks and project actors during the mini-HEP project. EDP loans should focus on projects with some risk yet less competitive with private banks and mini-HEP projects of public institutions (because the interest rate risk is small).

8) Relationship with special loans for CDM projects of the JBIC

The difference between EDB provided by the DBP and a special loan for CDM projects from the JBIC is that the JBIC requires registration as a CDM. An EDP is funded as a RE project and is not limited to CDMs.

(4) Renewable Energy Trust Fund

As stated in IRR Sec. 33 of the Renewable Energy Act, this fund collects 180~200 million PhP every year from the PAGCOR (Philippine Amusement and Gaming Corporation), PNOC (Philippine Oil Company) and emission fees, to maintain funds. Although it was used only for research purposes at first, it can also to be used for projects if the amount of the fund increases because it accumulates every year. The use of this fund is open to the public after getting the approval of the DOE.

6.4 UTILIZATION OF CDM FOR MINI-HYDRO PROJECTS

(1) CDM Procedure in the Philippines

In the Philippines, a HEP project CDM will possibly be established.

Companies registered with the BOI benefit from a tax exemption on income generated by a CDM project. However, projects will not be economical unless the scale is larger, since upfront payment is required as a preparatory cost for application. The CDM will continue after 2013. However, whether or not its credit will have value depends on future international frameworks.

A CDM project proceeds with the following steps (Table 6.4-1).

Table 6.4-1 Flow of CDM Project

Step	Description
PDD (Preparation of project design documents)	Project participants (PPs) plan a CDM project activity, and prepare the project design documents.
Obtaining national approval from the designated national authority (DNA)	PPs obtain written approvals of voluntary participation from the designated national authority (DNA). The DNA approves this voluntary participation after validating that the CDM project meets the sustainable development criteria of the hosting country.
Validation by a designated operational entity (DOE), and registration request to the CDM executive board	PPs submit PDDs and the validation report. The PDD fee for validation is 10,000 ~ 30,000 USD.
Review by the CDM executive board	The validated CDM project activity or PoA will be marked as 'under review' on the UNFCCC CDM website and make publicly available an anonymous version of the project (F-CDM-RR). The secretariat and the RIT team shall conduct an assessment. The decision of the secretariat and the RIT Team shall become the final decision of the Board.
Registration with the United Nations (Registration is made 4 weeks after the application for a project with less than 15 MW capacity.)	Registration is the formal acceptance of a validated project as a CDM project activity.
Verification by the DOE and issuance of CERs	Verification and certification by the DOE costs 10,000 - 20,000 USD every year. PPs send data such as generation data, and the DOE verifies and certificates GHG emissions. Application for issuance of a CER is sent to the CDM executive board through the UNFCCC office, and a CER is issued.

Source : IGES(2010A)[2] and .
UNFCCC/CCNUCC CDM. Executive Board EB 66 Report Annex 64 Page 1 Annex 64 'CLEAN DEVELOPMENT MECHANISM PROJECT CYCLE PROCEDURE (Version 02.0) '

2 IGES(2010A) : CDM in charts, Sep 2010 version 11, http://enviroscope.iges.or.jp/modules/envirolib/upload/970/attach/charts11.0.pdf

(2) Mini-hydro CDM projects in the Philippines

Current status of mini-HEP CDM projects in the Philippines are shown in the following table. These projects have obtained national approval and been validated. Only one project (Hedcor HEP Project) is registered with the United Nations and is waiting for the issuance of a CER. Projects that have already obtained national approval need to be registered by the end of 2012, when the Kyoto Protocol expires.

Table 6.4-2 Current Status of CDM Mini-Hydropower Projects in the Philippines (DNA Application Status)

Status	Project
LOA with national approval, process of registration	- Pantabangan HEPP 25MW (Turbine Retrofit and Replacement) - Binga (Rehabilitation) - Ambuklao (Rehabilitation)
LOA with national approval, validated and registered (CER not yet issued)	- Hedcor Sibulan

Note 1 : LOA = Letter of Approval requirement of CDM EB (Executive Board)

Note 2 : The details of other hydro projects by the Aboitiz Group can be found at cdmdna.emb.gov.ph. However, these cannot be accessed as the website is under construction as of September 15, 2010.

Note 3 : Projects under validation : List of proposed Philippine project activities that have undergone or are currently undergoing validation by a Designated Operational Entity posted on the UNFCCC CDM website.

Projects with letters of approval : List of proposed Philippine project activities issued with Letters of Approval by the DENR as the DNA for CDM.

Projects requesting registration : List of proposed Philippine project activities submitted for registration as posted on the UNFCCC website.

Source: DOE

Three hydro projects[3] are bundled mini-HEP projects (small-scale CDM) funded by the DBP. Although letters of approval were issued, registration is still pending. They are not yet registered with the CDM executive board.

Table 6.4-3 CDM Projects Funded by DBP in the Philippines

Project	Scale	Owned and Operated by	Borrower	Debt Portion
Cantingas	900kW	Ramblon Electric Cooperative Inc.	EC	90%
Hinubasan	500kW	Municipality of Loveto, Dinagat Island	LGU	90%
Sevilla	2.5MW	Bohol Electric Cooperative (Boheco) I, municipality of Sevilla	EC	80%

Source: DOE

Among the 34 CERs issued, three cases involved RE, which were wind, heat recovery, and landfill methane capturing.

3 The DBP and Tricoruna Carbon Asset Management Pte Ltd. have signed an agreement to sell CERs from these 3 projects. The DBP is working to register UNFCCC projects, and a CER of 111,000 tons is expected during the 7-year crediting period.

Seven projects (ex: Cabulig River Mini-HEP Project and Sipangpang 1 MW mini-HEP project) are under PDD (Project Design Document) validation (as in Table 6.4-4).

Table 6.4-4 Mini Hydro Projects under Validation in the Philippines

Project title	Methodologies	Reductions	Period for Comments
Sipangpang	AMS-I.D. ver. 8	2,471	Aug 8 - Sep 6, 2006
Hedcor Sibulan	ACM0002 ver. 6	81,129	Oct 6 - Nov 4, 2007
Binga Hydro Electrical Power Plant (BHEPP) rehabilitation project	ACM0002 ver. 7	49,146	Dec 5 - Jan 3, 2009
Cabulig River Mini-Hydroelectric Power Project	AMS-I.D. ver. 13	32,407	Feb 27 - Mar 28, 2009
Ambuklao Hydro Electrical Power Plant (AHEPP) rehabilitation project	ACM0002 ver. 10	155,749	Aug 29 - Sep 27, 2009
Commonal-Uddiawan Mini-Hydropower Project	AMS-I.D. ver. 14	5,348	Sep 5 - Oct 4, 2009
Pantabangan Hydro Electric Power Plant Refurbishment and Upgrade Project in Nueva Ecija, Philippines	ACM0002 ver. 11	56,807	Jul 7 - Aug 5, 2010

Source: http://cdm.unfccc.int/Projects/Validation/index.html

When a CDM project is implemented in the Philippines, utilization of the small-scale CDM or program CDM are also assumed.

Small-scale CDM

With small-scale CDM, the approach is to implement several project activities together by "bundling." Simplified modalities and procedures are applicable for the following small-scale CDM project activities. Project activities using a renewable crediting period are reassessed as to their compliance with limits at the time they request renewal of the crediting period. (IGES(2010A) P.53)

Type I : Project activities remain the same, such that RE project activities have a maximum output capacity of 15 MW (or an appropriate equivalent).

Type II : Project activities or those relating to improvements in energy efficiency by reducing energy consumption, on the supply and/or demand side are limited to those with a maximum output of 60 GWh/y (or an appropriate equivalent).

Type III : Project activities, otherwise known as "other project activities," are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

The definition of small-scale CDM is an excerpt from IGES (2010A), p48, p51.

The definition of *bundling* is as follows;

Bundle is defined as, bringing together several SSC project activities to form a single CDM project activity of a portfolio without the loss of distinctive characteristics (such as technology/measure, location and application of simplified baseline methodology) of each project activity. (p.56)

Project activities within a bundle can be arranged in one or more sub-bundles.(p.56)

Each project activity retains its distinctive characteristics. Such characteristics include its technology/measure, location and application of simplified baseline methodology. (p.56)

Project activities within a sub-bundle belong to the same type. (p.56)
The sum of the size of components of a project activity belonging to the same type (capacity for Type I, energy savings for Type II and emission reductions for Type III) should not exceed the limits for SSC(Small Scale CDM) project .(p.53) This can be a "CDM bundling several sites of business feasibility". Normal-scale CDM can be bundled by defining one business and project scope of several sites and activities. All project activities in the bundle have the same crediting period. (p.56) The proposed project activity will not increase beyond 15 MW. (p.53)

CDM Program of Activities (CPA)

A CPA can be included in a registered PoA at any time during the duration of the PoA. In the case of a “Program CDM” project, the physical boundary of a PoA may extend to more than one country. Usually, this cannot be done in the case of a small-scale CDM project. Several businesses by national commitment based on a policy can be a target of the CDM program. Therefore, it is possible that mini-hydropower projects in several areas become a CDM program of activities.

The definition of *program of activities* is as follows (excerpt from p.57 IGES (2010A)).

A CPA can be included in a registered PoA at any time during the duration of the PoA. In the case of a “Program CDM” project, the physical boundary of a PoA may extend to more than one country. Usually, this cannot be done in the case of a small-scale CDM project. Several businesses by national commitment based on a policy can be a target of the CDM program. Therefore, it is possible that mini-hydropower projects in several areas become a CDM program of activities.

The definition of *program of activities* is as follows (excerpt from p.57 IGES (2010A)).

A program of activities (PoA) is a voluntary coordinated action by a private or public entity that coordinates and implements any policy/measure or stated goal (i.e. incentive schemes and voluntary programs). (p.62).

Which leads to GHG emission reductions or net removals by sinks that are additional to any that would occur in the absence of the PoA. (p.62)

There is not a limit on the number of CDM program activities (CPAs) conducted under program activities.

Via an unlimited number of CDM program activities (CPAs).(p.62) For the procedure of the CDM program, it is required to register the latest version of "program activities as one CDM project,” and to apply the procedure to issue CER from these activities.

Boundary

The physical boundary of a PoA may extend to more than one country.(p.62)

Each participating non annex I host party provides confirmation that the PoA, and thereby all CPAs, assist it in achieving sustainable development. (P.62)

For the emission factor, the CM (Combined Margin) of Luzon and Visayas is applied as baseline emissions from system power supply. In the program CDM, it takes a long time, especially for the certification process. Adequate continuous recordkeeping of HEP performance is necessary for the verification process, in order to issue a CER for each CPA. The price per ton of CER is decided through negotiation by the concerned parties. The price in the ETS (Emission Trading Scheme) market in the EU (European Union) is one price index. "CER" in the following table refers to current predictive values.

Table 6.4-5 Mini-Hydro CDM Projects in the Philippines

Project	Size	CER (tonnes equivalent annually)
Hedcor Sibulan	42.5MW	95,174
Binga	——	46,291
Ambuklao	——	172,735

Note: CER=Certified Emission Reduction Source: DOE

6.5 EXAMPLES OF INVESTMENT IN MINI-HYDRO PROJECTS

Two mini-hydro projects are being implemented by ECs.

For further development of mini-HEP projects, infrastructure development such as transmission lines (sub-marine cables) will be required.

Table 6.5-1 Mini-hydro Projects Being Carried out by ECs

	ORMECO	ANTECO
Summary of EC	NEA rank A+ Peak load 24.5 MW (2008) System loss 11% Collection efficiency 101%	NEA rank A+ Peak load 12.7 MW (2008) System loss 11% Collection efficiency 98%
Site scale	Linao-Cawayan, the lower plant is 2.1 MW, and the upper plant is 3.0 MW. Completion in January 2011.	Sebaste, 1.68MW (2 sites) Commencement of commercial operation in 2014
Financing for small hydro project	DBP (3 years of grace, 15-year floating interest rate, possibility to change to EDP, which has fixed interest rate)	CBRED 's Soft Loan of Land Bank (0% interest rate)
Current position of small hydroelectricity project	Liano-Cawayan 3MW will address a part of the adjustment to increasing demand (from 28 MW in now to 43 MW in 2016).	Purchased from an IPP (SWECO) as an alternative to PSALM's geothermal power plant in Leyte. Sibaste (1.68 MW) is to address increasing demand in the supply area.
Requirement conditions for further development of mini-hydro	Construction of sub-marine cable between Luzon island and Mindro island will enable electricity supply to Luzon island.	Capital funding for investment to address supply shortage

Source: Interview conducted in 2011

6.6 EXAMPLES OF FEASIBILITY STUDIES SUBMITTED TO THE DOE

(1) Main Preconditions employed in F/S submitted to the DOE

1) PPAs (Power Purchase Agreements)

Among 6 HEP projects concluded the operating contracts, the example PPAs of the three projects are as follows;

a) Sipangpang HEPP (1,000 kW)

5% less than the average cost of energy purchased from the NPC (basic generator rate plus transmission cost).

b) Panoon Falls HEPP (220 kW)

3.41 PhP/kWh for two years from the start of operation. GREI (GerPhil Renewable Energy Inc.) will not request for a rate increase from the ERC during the two-year contract.

c) Villasiga HEPP (8 MW)

5.4 PhP/kWh or 15% lower than the NPC effective rate to include basic generation charge and other adjustment charges, whichever is lower, during the first year of commercial operation.

The PPA of each project has different conditions.

For reference, Table 6.6-1 shows the costs of generation, transmission and distribution in 3 areas of the Philippines, and Table 6.6-2 shows those costs for MERALCO (Manila Electric Company). It shows that the generation cost in Luzon is 4.38 PhP/kWh, while the generation cost in Villasiga, for example, is 5.4 PhP/kWh, which is higher than that in Luzon.

Table 6.6-1 Generation, Transmission and Distribution Costs in 3 Areas in the Philippines Summary of Residential Effective Unbundled Power Rates (June 2010 Effective Power Rates)

Bill Subgroup	Electric Cooperatives							
	Luzon		Visayas		Mindanao		National	
	PhP/kWh	%	PhP/kWh	%	PhP/kWh	%	PhP/kWh	%
Generation	4.3806	47.91	4.0224	46.03	2.9944	35.44	3.7992	43.28
Transmission	0.9688	10.60	1.1993	13.73	2.1943	25.97	1.4541	16.57
System Loss	0.7769	8.50	0.6642	7.83	0.6832	8.09	0.7148	8.14
Distribution	2.2045	24.11	2.2463	25.71	1.9648	23.25	2.1385	24.36
Subsidies	0.0277	0.30	0.0567	0.65	0.0253	0.30	0.0366	0.42
Government Taxes	0.7855	8.59	0.5292	6.06	0.5875	6.95	0.6340	7.22
Total	**9.1441**	**100.00**	**8.7381**	**100.00**	**8.4494**	**100.00**	**8.7772**	**100.00**

Source: DOE

Table 6.6-2 Generation, Transmission and Distribution Costs by MERALCO Summary of MERALCO Residential Unbundled Power Rates

(As of June 2010)

Bill Subgroup	0 to 200 kWh* (PhP/kWh)	%	201 to 300 kW (PhP/kWh)	%	301 to 400 kWh (PhP/kWh)	%	Over 400 kWh (PhP/kWh)	%
Generation	5.5740	62	5.5740	60	5.5740	57	5.5740	54
Transmission	0.6201	7	0.6201	7	0.6201	6	0.6201	6
System Loss	0.6911	8	0.6911	7	0.6911	7	0.6911	7
Distribution	1.8555	21	2.2306	24	2.5844	27	3.2006	31
Subsidies**	0.1487	2	0.1487	2	0.1487	2	0.1487	1
Universal Charges	0.1003	1	0.1003	1	0.1003	1	0.1003	1
Total * **	**8.9897**	**100**	**9.3648**	**100**	**9.7186**	**100**	**10.3348**	**100**

* Consumption per month
** Lifeline Rate Charges applicable to 101-200 kWh consumption
*** Excluding Government Taxes (VAT)
Note: Numbers were rounded-off. Source: DOE

2) Main Preconditions

The main preconditions of projects of private investors are shown in Table 6.6-3. Each private investor hires a consultant to prepare the F/S report, but the applied preconditions vary.

Preconditions in the simulation model used in the respective projects are slightly different in their project period, handling of interest during construction and handling of ITH as well as the grace period of the loan.

Table 6.6-3 Examples of Main Preconditions in FS of Private Investors

Item		Case A	Case B
kW		1,895	2,200
Total project cost (PhP)		180,365,778	340,800,000
Type (Run-of-River, Storage)		Run-of-river	Run-of-river
Assumptions on Energy Production (kWh)			
	Primary energy	$10{,}126 \times 10^3$	$9{,}966 \times 10^3$
	Hydropower secondary energy	N/A	N/A
	Annual energy production	$10{,}126 \times 10^3$	$9{,}966 \times 10^3$
kW cost (USD)		95,180 PHP/kW (2,064 USD/kW)	3,361 USD/kW
Plant factor		61.0%	51.70%
Electricity tariff in PPA		4.5 PHP/kWh Annual 5% escalation	5.7 PHP/kWh No escalation
Project period		30 years	30 years
Debt-Equity ratio		Equity 20%, Debt 80%	Equity 30%, Debt 70%
Dividend payout ratio		0%	0%
Depreciation methods		Straight line 30 years	Straight line 15 years
Annual inflation		5%	4.5%
Physical contingency {(A) + (B)}×( )%		10% of civil works and MEE	5% of civil works and MEE
Construction period		1 year	2 years
Tax rate			
	Income tax (% of net income before tax)	After ITH 35%	After ITH 10%
	Privilege tax (% of gross revenue)	2%	N/A
Tax incentives regarding “Renewable Energy Act of 2008” to be awarded			
	Income tax holiday	7 years	7 years
	Net operating loss carry over	Not Applied	Not Applied
	Tax credit	Not Applied	Not Applied
Loan condition			
	Repayment period	15 years	15 years
	Grace period	3 years	0
	Loan interest rate	10%	12%
Assumptions on annual			
	Administration cost (% of revenue)	30% of revenue	16% of revenue
	Annual O&M cost (% of total cost)	3.40% of total project cost	0%
Project cost composition		100%	100%
	Civil and building costs (A)	36.89%	54.8%
	Mechanical and electric equipment (B)	39.48%	22%
	Physical contingency {(A) + (B)}×( )%	7.64%	3.84%
	Price contingency (Price escalation rate)	0.00%	0%
	Interest during construction (Capitalized)	0.00%	11.2%
	Engineering service	7.60%	8.22 (Commissioning & Engineering)
	VAT	8.40%	0.00%
Result (From F/S Report)			
	FIRR	22.35%	13.13%
	EIRR	61.39%	27.71%
	Discount rate (EIRR)	15%	15%
	B/C (Economic)	2.305	8.52

6.7 FINANCIAL EVALUATION OF THE MINI-HYDRO PROJECTS USING FINANCIAL MODELS

(1) Outline of the Economic Financial Model

This model is linked with 3 financial statements to note the B/S, I/S (Income Statement) and C/F (Cash Flow), and it automatically calculates FIRR from input preconditions. Overages and shortages are adjusted in the retained earnings reserve in the B/S.

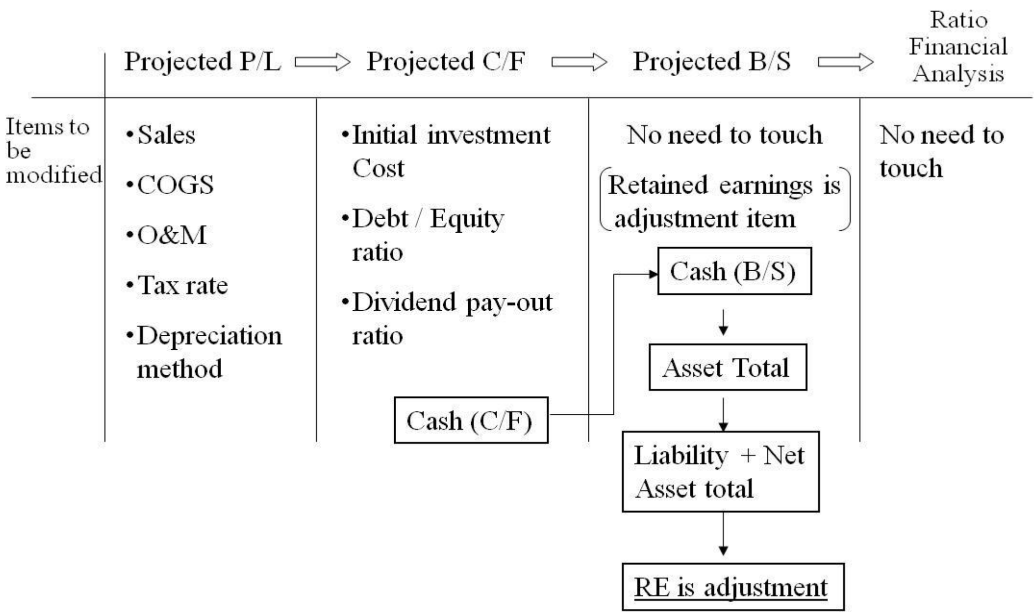


Fig. 6.7-1 Financial Model

Note 1: The commissioning cost before operation is the cost for completion of the power plant. This cost is not incurred after operation. In addition, the management cost before operation is a general management cost including administration cost during construction. The cost during construction is generally higher than that after operation since more administration staff is needed during this period.

Note 2: For a table of tariff rates in the Philippines, refer to http://www.mofa.go.jp/region/asia-paci/philippine/epa0609/index.html.

(1) Water Turbine and Generator
Description of goods: Chapter 84 "Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof" refer to 84.10

(2) Electrical and Mechanical BOP: Balance of Plant

(3) 11kV Distribution Lines (5kM)
Description of goods: Chapter 74 "Copper and articles thereof" refer to 7413.00 00 (P443 323/400)

(2) Simulation using the Economic Financial Model

Simulation using the model mentioned above is done in some cases.
Table 6.7-1 below shows the major assumptions made in sensitivity analysis.

Table 6.7-1 Financial Model Simulation Major Assumptions (Project)

Project size	1,895KW
Total project cost	188,838,000(peso), 2,162USD/KW
Project life	30 years
Plant factor	60%

Note 1: Total project cost includes IDC (interest during construction).
Note 2: Physical Contingency: 10%, Price Contingency: 10%
Note 3: Other assumptions: Depreciation: Straight Line (30 years)
Note 4: Debt-to-Equity ratio: 80% : 20%
Note 5: O&M cost each year is 10% of total project cost

The case classification is as provided below.

Table 6.7-2 Sensitivity Analysis – Case Assumption

	Original case (No FIT)	Case1 (FIT with private bank)	Case2 (FIT with DBP Loan)	Case3 (FIT with DBP Loan/decrease in LF)	Case 4 (FIT with DBP Loan/cost overrun 20%)	Case 5 (FIT with DBP Loan/cost overrun (20%) & decrease in LF
Tariff		○	○	○	○	○
Finance			○	○	○	○
LF				○		○
cost					○	○

Note: ○= Assumptions where changes are made

Fig. 6.7-2 shows that the total revenue and profit rates in case 2.

In the first 7 years, the corporate tax is zero (due to ITH). After that, 10% of the taxable amount is to be paid.

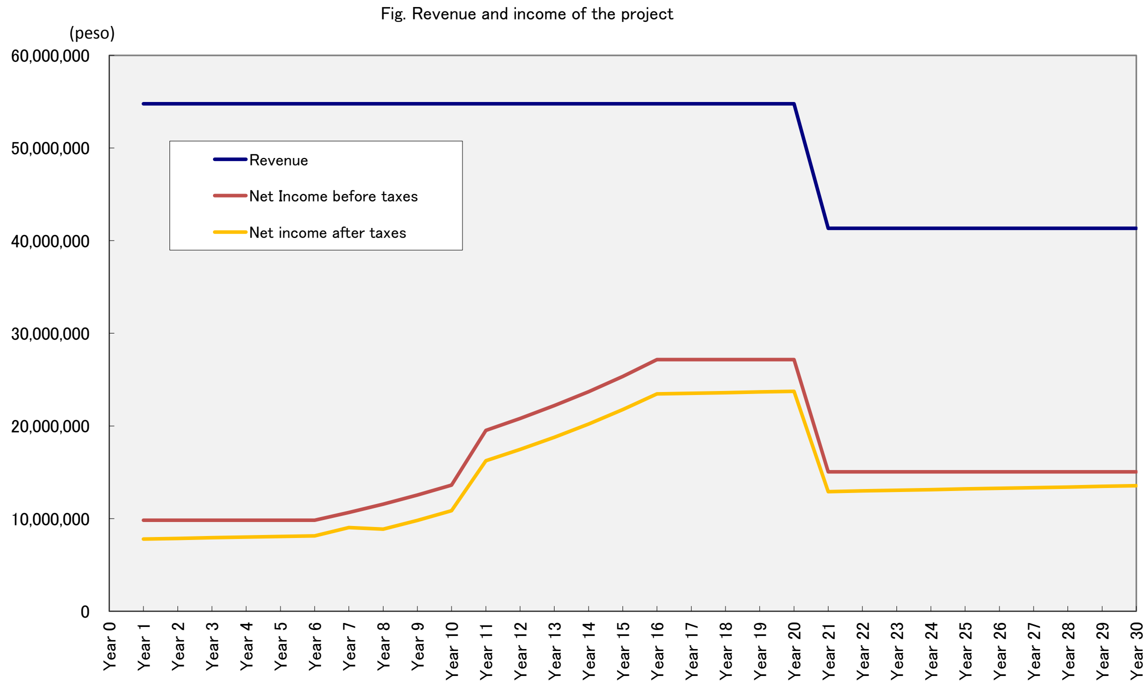


Fig. 6.7-2 Forecast of Revenue and Profit under the FIT System(case2)

Sensitivity analysis results are shown in Table 6.7-3.
The results show that only 0.55% FIRR is achieved in 30 years in case 5.

Table 6.7-3 Results of Sensitivity Analysis

	Original case (No FIT)	Case1 (FIT with private bank)	Case2 (FIT with DBP Loan)	Case3 (FIT with DBP Loan/decrease in LF)	Case 4 (FIT with DBP Loan/cost overrun 20%)	Case 5 (FIT with DBP Loan/cost overrun (20%) & decrease in LF
Tariff	4.5 (Peso/kWh)	5.5(Peso/kWh) (1-20 years) After 20 years 4.5 (Peso/kWh)	5.5(Peso/kWh) (1-20 years) After 20 years 4.5 (Peso/kWh)	5.5(Peso/kWh) (1-20 years) After 20 years 4.5 (Peso/kWh)	5.5(Peso/kWh) (1-20 years) After 20 years 4.5 (Peso/kWh)	5.5(Peso/kWh) (1-20 years) After 20 years 4.5 (Peso/kWh)
Load factor	60%	60%	60%	40%	60%	40%
KW cost	2,146 USD	2,146 USD	2,146 USD	2,146 USD	2,575 USD	2,575 USD
Corporate tax rate	7 years ITH 0% After 7years 10%	7 years ITH 0% After 7years 10%	7 years ITH 0% After 7years 10%	7 years ITH 0% After 7years 10%	7 years ITH 0% After 7years 10%	7 years ITH 0% After 7years 10%
Finance (Loan)	9% 2years grace 10years repayment period	9% 2years grace 10years repayment period	EDP Loan 9%, 5 years grace 15 year repayment period	EDP Loan 9%, 5 years grace 15 year repayment period	EDP Loan 9%, 5 years grace 15 year repayment period	EDP Loan 9%, 5 years grace 15 year repayment period
FIRR (30 years)	10.05%	14.78%	14.67%	4.5%	10.7%	0.55%

6.8 PROPOSALS FOR INVESTMENT IN MINI-HYDRO PROJECTS

Proposals for investment for mini-HEP projects are as follows.

(1) Further cooperation with the DBP for information provision from the database

In the interview with the DBP, applications for EDP were thought to be increasing after deciding the official FIT price. Since F/S costs will be funded, cooperative activities for EDP promotion (especially F/S part) are encouraged in utilizing EDP loans. For this purpose, participation by the DBP's local branches will be necessary.

(2) Encouraging partnership between ECs and LGUs

Joint ventures between LGUs and ECs can be beneficial to both parties, as it makes it easier for ECs to obtain project approval and LGUs can corporate with in-kind contributions like access roads.

(3) Possible cooperative activities with the CDA

Some ECs with good performance are considering joining the CDA (Cooperative Development Authority) in order to get exemptions from VAT, franchise tax, etc. The CDA should also consider to cooperating in EDP promotion activities that target ECs. At present, 12 ECs have joined the CDA. The CDA has 16 local branches.

(4) Cooperation with other government institutions

The DOE reduces investor risk by sharing information in cooperation with those institutions that are related to water resource development such as the DPWH (Department of Public Works and Highways), PAGASA (Philippine Atmospheric, Geophysical and Astronomical Services Administration, DOST), NAMRIA (National Mapping and Resource Information Authority, DENR), NIA (National Irrigation Administration) and DENR (Department of Environment and Natural Resources). They also aim at economical development via the effective use of irrigation plants.

At the same time, this HEP database should be advertised in collaboration with other governmental offices and local consultants.

(5) Need for capacity-building capability for evaluating FS

The DOE currently uses the cash flow model of revenues and expenses to calculate profit and loss, along with the projected generation assumed by the project proponent. The DOE examines the validity of IRR solely based on the data obtained from the applicants. A tariff is the only precondition used for simulation (as of 2011). The DOE should be able to replicate and simulate the feasibility study outputs, using financial programs with original data.