Environmental Assessment/Analysis Reports

INDONESIA - Outer Islands Power Project
EA Category A

Environmental Assessment
4 of 4
April 1994

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EA Category A

Environmental Assessment
4 of 4
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MINISTRY OF MINES AND ENERGY
PERUSAHAAN UMUM LISTRIK NEGARA

Main Report

E I A

ENVIRONMENTAL IMPACT ASSESSMENT
BESAI HYDROELECTRIC POWER PROJECT
WEST LAMPUNG
INDONESIA

1994
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INDONESIA

OUTER ISLANDS POWER PROJECT

Environmental Assessment Summary

Besai Hydroelectric Power Plant

Introduction

1. Pursuant to the objectives of the Government of Indonesia (GOI) to improve the welfare of the population and to support the growth of economic activity by meeting the electricity requirements in an efficient and reliable manner, the State Electricity Corporation (PLN) has proposed to construct a hydroelectric power plant at Besai, in the Lampung province of South Sumatra, under the Outer Islands Power Project. The proposed loan will be made to the GOI. The proceeds of the loan would be onlent to PLN, which is responsible for the implementation of the project. The project is likely to be cofinanced by the European Investment Bank, Austria and Australia, for the turbine generator and transmission components. GOI/PLN will meet the financing gap from their own internal resources.

2. The Electricity Act (Law No. 15 of 1985) defines the legal framework for the electricity subsector of Indonesia. The subsector comprises: (i) PLN, the State Electricity Corporation; (ii) captive plants; (iii) rural electric cooperatives; and (iv) a large number of informal microenterprises providing electricity to rural customers not served by PLN. The provisions of the Electricity Act are amplified in GOI Regulation No. 17/1990 for PLN and No. 10/1990 for others. PLN was established as a public corporation with responsibility for the generation, transmission, and distribution of electricity, and the planning, construction and operation of electric supply facilities. PLN is managed by a Board of Directors headed by a President Director, who is appointed by the President and is accountable to the Ministry of Mines and Energy. Operational responsibility devolves upon 17 regions, and the responsibility for major construction upon 13 project managers. PLN has already appointed a project manager for the proposed Besai hydroelectric power plant.

3. Since 1969, the Bank group has provided about $4.1 billion for the power subsector in Indonesia, through 3 IDA credits, 18 loans, and one supplemental loan. Project Performance Audit Reports and Project Completion Reports on fourteen projects have been issued. The reports have concluded that the objectives set out for these projects at appraisal have been achieved.

Project Description

4. The Besai hydroelectric power plant is proposed to be a run-of-river type development, with a daily regulating storage capacity, to be built in the upper reaches of the Besai river in the Lampung province of Sumatra. The Engineering Services Center of PLN, in
association with their Consulting Engineers, have conducted an environmental assessment (EA) of the proposed hydroelectric plant based on the feasibility study and the preliminary design reports. The plant will have the following components:

- Intake dam
- Power house, about 6 km downstream
- Tunnel and penstock connecting the intake dam and power house
- Access roads to the project site
- Quarrying for stone and gravel to be used for construction
- Construction camp
- Permanent housing colony and offices
- Transmission lines

5. The dam commands a catchment area of 415 sq.km. Located in a steep gorge, the height of the dam will be 9 meters only; however, because of the slope, the net available head at the power house 6 km downstream will be about 240 m. Two turbine-generators will be installed initially in the power house to generate 45 MW each. The headrace tunnel from the dam will run underground for a length of approximately 5 km, and connect through a surge tank, with the underground penstock for a further distance of about 0.6 km leading into the power house. There will be two access roads; one about 2.5 km from the village of Sukapura to the dam site; the other, about 2 km long, in the village of Dwikora. A double-circuit, 16 km long, 150 kV transmission line will connect the power house with the nearest PLN transmission grid to evacuate power generated at the Besai plant.

6. There are possibilities of soil erosion because of land clearing operations. There may also be some minor air and water pollution issues because of construction activities. These adverse effects will be mitigated by appropriate measures as described below in this summary report.

Baseline Data

7. Geophysical - Climate, Physiology and Hydrology. It is a high rainfall area (rains for 11 months) with a fairly strong wind (39.31 km/day) blowing from the north most of the time. There are no months of water deficit and the air quality in terms of dust content, gases and noise is considered to be pure. The catchment area is mostly mountainous even though there are some undulating plains in patches. The country rock is basically volcanic deposit. The drainage pattern is characterized by many trenches which finally appear as tributaries of the main river. A catchment area, such as this, has the advantage of having a very small flood discharge. The groundwater level is quite shallow, about 3-12 m from the land surface. The quality of water has been analyzed and found to be clean.

8. Soil. The soil has been analyzed based on the factors of chemical and physical properties and the factor of climate. The larger parts of the soil comprises of Inceptisol and is sensitive to erosion. Land is used mostly for Sawah (wet rice cultivation) and also dry
cultivation. Local farmers do not take recourse to conservational measures resulting in very high rate of erosion. Much of the forest area has disappeared; it has turned into farmland and underbrush. Future farming operations must include better land management practices.

9. Flora. There are wet-cultivated areas in the farmlands, garden and forest lands. Mainly, there are six types of vegetation consisting of stable crops, like rice and maize, root vegetables like potatoes, and other vegetables like tomatoes, chilies etc. Fruits such as durian, mahogany wood trees, flowers and bamboos also abound. Many popular varieties of wood are found in the forest.

10. Fauna. The study has recorded 20 species of mammals, 9 reptiles and 10 birds. There are domestic animals like cows, buffaloes chicken and sheep. Most of the well-known fish varieties are found in the rivers.

11. Socio-economic Study. A study of the population of the area has been conducted. The main occupation is farming (more than 80%). But it must be said that farming is not practiced seriously and most of the people go for traditional rice cultivation and unattended coffee plantation. Over the years most of the people tend to migrate towards the Trans-Sumatra Highway in search of employment in small business. People are generally healthy even though malaria and influenza have been reported. In the survey most of the people tended to support the project.

Impacts

12. The environmental impacts of the proposed project can be subdivided into 3 categories: (a) preconstruction, (b) construction and (c) post construction.

(a) Preconstruction:

Preconstruction impacts include investigation and surveys, and land acquisition.

(b) Construction:

Land clearing and preparation, movement and operation of heavy construction equipment and materials, and the concentration of a fairly large construction labor force, many of whom may come from outside the local region, are the main impacts of the construction stage.

(c) Post Construction:

The environmental impacts of the dam and the hydroelectric power plant will be insignificant, except for liquid effluent and solid wastes from the housing colony and office facilities.
13. The project will have both physical and social impacts on the environment and habitat of the area. However, the social impacts are not severe as there are no relocation issues. Most of the affected land for construction activities, comprising the two villages Sukapura and Dwikora, belongs to the Forestry Department of GOI; however, several people cultivate the land and grow coffee crops on it. The area to be inundated covers private land, where the major crop is paddy. The village, Waypetai, is close to this area. No residential homes are affected by the construction; only a few huts used for keeping crops will need to be relocated. The physical impacts can be listed as follows:

(a) Soil Erosion.
(b) Air and water pollution from construction and waste disposal.
(c) Social impact of construction.
(d) Quarrying.
(e) Water quality.
(f) Sedimentation of the reservoir.
(g) Scouring of river bed below dam.
(h) Earthquakes and floods.
(i) Loss of forest lands and wildlife.
(j) Increase of water related diseases due to impounding.
(k) Impact on drinking water.

Analysis of Alternatives

14. The run-of-river type development planned for Besai is to provide peaking power to the PLN system in South Sumatra. One of the main objectives of GOI for the electricity subsector is to meet the country’s energy requirements in a least-cost way, and conserve exportable petroleum reserves, principally by encouraging the domestic market to substitute oil consumption by alternative, more economical fuels, such as natural gas, coal, hydropower and geothermal. Indonesia’s hydroelectric resources are enormous; estimated at about 32,000 MW (out of a theoretical potential of about 75,000 MW), but their development to date has been limited by their geographic distribution relative to the load centers where there is demand for electricity. The Besai site is ideally suited for hydropower development; a dam about 9 meters high constructed at the narrowest portion of a deep gorge, helping to provide a net head of 240 m just 6 km downstream from the dam. No natural gas or geothermal energy is available in the
vicinity; also a coal-fired power plant for peaking purposes is not economical. Other forms of energy for the proposed 90 MW power plant are determined to be not feasible.

Mitigation Plans

15. The mitigation plans for the environmental impacts of the Besai hydroelectric power plant can be listed as follows:

(a) Soil erosion - The river subcatchment area of the Besai may be categorized into two groups; the volcanic group and the hilly group. More than 85% of the area is of the volcanic group. The volcanic material is tuff, covered with andesite and basalt. Soil erosion will be caused by the construction of access roads and temporary works, land clearing and cut and fill operations, disposal of tunnel excavation muck and other spoils. Soil erosion will be minimized by land reclamation, terracing, and replanting.

(b) Air and water pollution - Dust suppression and noise abatement measures, management of waste disposal (domestic and construction) in accordance with acceptable standards will help mitigate these impacts.

(c) Social impacts - The construction site will be designed such that workers have a healthy work environment, adequate recreational facilities outside working hours and living conditions with acceptable health and sanitary facilities. Potable water supply, waste disposal, health and amenities in contractors' temporary camps and facilities will be ensured.

(d) Quarrying - This environmental impact will be minimized by selecting several suitable sites, far apart from each other. Three possible sites for stone and gravel have been identified. Quarry I is 4.5 km and Quarry II is 14 km from the intake dam, while Quarry III is located near the proposed power house site. Sand will be obtained from the surrounding areas of two villages; one about 6 km, and the other about 16 km from the intake dam.

(e) Water quality - Vegetation in the reservoir area will be cleared before inundation to avoid deterioration of the water quality. Because of the daily pondage that will expose parts of the submerged land everyday, the vegetation clearing operation will be undertaken on a regular basis.

(f) Sedimentation - Scouring gates are provided to rid the reservoir of accumulated sediments by flushing on a regular basis. Regreening of the bare land areas are expected to reduce soil erosion and sedimentation.

(g) Scouring of river below dam - The flow rate in the river throughout the year varies between 11.04 and 32.01 m$^3$/s. Even though the steep slope of the river acts as a disincentive for habitation, and there is no irrigation downstream of the dam, PLN has decided that, in accordance with Japanese regulatory practices, the plant will maintain a minimum release of at least 1 m$^3$/s of water from the dam so the river bed between the dam and the power station
never goes dry and that any aquatic life in the area is sustained. No wild animals or migratory fish, however, are known to have been found in the area covered by this section of the river. The discharge of water from the power plant would amount to about 45.6 m³/s, for 4 hours a day, when running at full capacity.

(h) Earthquake and floods - The project has been designed to accommodate the seismic acceleration of the volcanic region. The weir, as stated at the outset, is only 9 m high, and the surface of the reservoir, only 140 ha. The holding capacity of this run-of-the-river type development will be small due to its limited volume. Therefore, the induced seismic effect of the dam is insignificant. A horizontal stilling basin is designed to dissipate the energy of design flood equivalent to 100 years probable peak discharge.

(i) Loss of forest lands and wild life - Most of the forest in the project area has already been converted into coffee plantation. The area to be inundated represents mostly, wild rice cultivation. However, since the area of inundation is small, the loss of land is manageable. Some farmers will lose part of their farmland and will be compensated for the loss in accordance with Bank guidelines for involuntary resettlement and the Presidential Decree, KEPRES 55/1993. This issue is discussed in detail under the Resettlement Plan for Besai. There is presence of wildlife in the vicinity of the project; the main habitat of the animal species is found to be in the adjacent forest area, very little of which is affected by the proposed project.

(j) Water related diseases due to impounding - The reservoir is planned to be of a daily pondage for power generation, which is the inherent nature of a run-of-river type development. The current in the river is expected to be too strong to support mosquito breeding. Additionally, mosquito-larvae eating fish to be stocked in the reservoir would mitigate this negative impact.

(k) Drinking water - The reservoir is relatively far from the dwelling areas. People get their drinking water from the springs or existing wells located near their houses which are not likely to be affected by the impounding of water by the dam.

Resettlement Plan

16. The Resettlement Plan of the Besai plant has the following objectives which are in keeping with the Bank’s operational directives.

- development of a timebound resettlement plan, based on replacement valuation and compensation principles of land and other assets affected by the project

- establishment of a budget and an implementation plan

- identification of organizational responsibilities for implementation.
17. The plan has been prepared after consulting the affected people and NGOs who are active in the area. The project affects lands (160 ha) in three villages primarily because of inundation, acquisition for construction of the dam and the power house and for laying roads for the project. The project affected people (PAP) comprise 129 families both in the inundated area as also the construction area. In a social survey which was specially carried out in the area, almost the entire community including the affected families supported the project. The PAPs felt that the project will bring with it improvements in the infrastructure of the area which in turn will help in the growth of both industrial and agricultural activities. PLN is committed to providing them with roads, drinking water supply, sanitation facilities, etc. Most of the PAPs also expressed a desire to get jobs in the project. In the public consultation before the preparation of the resettlement plan, which was held on 14 September 1993, some PAPs raised the question of "Replacement" principle in the matter of compensation and it was explained to them that the GOI would provide for full compensation at replacement value and also other opportunities to the PAPs so that their quality of life would positively improve after the project. A further round of consultation was held with the local NGOs on 22 December 1993 in which the NGOs seemed satisfied with the solutions offered by PLN to their concerns regarding the resettlement aspects.

18. 35% of the PAPs expressed interest in land-for-land compensation. PLN is committed to providing such PAPs with alternate land, after due consultation with them on their choice. PLN will procure the land and hand over to the PAPs who might choose this option. The compensation for land acquisition will be determined by a committee appointed by the GOI as per the relevant Presidential Decree. PLN will encourage the PAPs to take up other activities like small business, trading and will also help them in developing other skills. PLN will make counselling and credit facilities available for such people, if desired. Education and training will be provided by PLN in vocational schools to those who may opt for this option. A budget provision of Rp 660,000,000 (US$ 330,000) has been made for the implementation of the plan. The resettlement is scheduled to be completed well ahead of the start of actual construction of the project. The resettlement implementation schedule provides for monitoring by a committee over the next five years.

Monitoring and Evaluation

19. The most important area of action is the strengthening of the internal structure of PLN so that they may be in a position to monitor the implementation aspects, as well as the final results of the resettlement plan. Pending this, it has been agreed that an independent organization, such as the local university and some government agencies, would be engaged to monitor the implementation of the resettlement plan, evaluate results, and report on the progress on a periodic basis. The university will be requested to include a local NGO in their monitoring team.
Institutional Needs

20. Provision for Technical Assistance has been made under the proposed project to assist PLN to establish an environmental organization to develop PLN's capability to formulate corporate environmental policies, evaluate environmental assessments of its development projects and monitor environmental impacts and compliance with GOI guidelines for existing projects.

Public Participation

21. Public consultations have been held by PLN at the project site, with local NGO participation. During the public consultations, while 99% of those attending supported the construction of the project, a large majority of the Project Affected Persons (PAP) expressed a strong preference for cash compensation, and an opportunity to work in the construction of the project. While the amount of cash compensation will be determined by the Land Acquisition Committee in accordance with Kepres 55 guidelines, which allows for compensation at the current valuation of the land, the project proponents (PLN) have agreed to provide work to qualified PAPs in the construction of the project.
I. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

1.1 Background

Development is actually the utilization of natural and environmental resources, aiming at improving the living standard and welfare of the population. Therefore, in the implementation of development changes are likely to occur, in the biogeophysical as well as the socio-economic and socio-cultural environment.

The utilization of natural and environmental resources excessively and unwisely will in the end cause an environmental problem to arise. This means that the development undertaken will decrease the environmental quality.

In undertaking a development activity, it is necessary to minimize the negative impact and maximize the positive impact to the environment. Therefore, each activity of development and its results will not be of a temporary character, but will last and give benefit for a long term.

This is so, since in the development process the environmental aspects have been considered, i.e. the balance of the environment in one ecosystem.

The successful development undertaken by the government as of REPELITA I in 1969 has given tangible results in the various sectors. The industrial development and welfare of the population which are ever enhancing have resulted in the demand for electric energy to increase. In the effort to meet the demand for electric power, the Government, through Perusahaan Umum Listrik Negara (State Power Utility), is of intention to develop the Besai HPP (Hydro-electric Power Plant) in North Lampung. The development of this HPP will be carried out in the content of the diversification and conservation of the use of natural oil energy resources.

In accordance with the policy of the Government, the first stage will develop two units of the Besai HPP with a capacity of 2 x 45 MW (90 MW). In order to identify whether the development of the Besai HPP (Project) will bring about a major impact to the environment, a study on the Environmental Impact Assessment (EIA) will be made.

The implementation of this EIA will be in accordance with existing rules and legislation, as set forth in:

1. Act No. 4/1982 on : Basic Rules for Environmental Management;
2. Government Regulation No. 29/1986 on: Analysis on Environmental Impact;
1.2 Objective of Study

Objective

The objective of the EIA study of Besai HPP is as follows:

a. Identify the project or power plant activities, which particularly bring about environmental impact;
b. Inventory the environmental feature, which particularly is expected to be affected by project or power plant activities;
c. Predict and evaluate the environmental impact;
d. Develop basic management and monitoring plan.

Use

The use of the EIA study is to assist in decision making, the planning and management of the environment of the Besai HPP activity.

1.3 Scope of Study

(1) Area of Study

a. The project or the planned Besai HPP project to be developed has some places of activity (Annex 2) with the following locations:

- Intake dam in the Wai Besai, village of Sukapura.
- Power house in the village of Dwikora.
- Tunnel connecting the intake dam and the power house, with a distance of about 6 km.
- Access road in the village of Sukapura with a length of about 2.5 km to the intake dam and in the village of Dwikora of about 2 km.
- Quarry I, found in the village of Simpang Sari (Simpang Gadis) at a distance of about 4.5 km to the intake dam.
- Quarry II, found in the vicinity of Bukit Kemuning DPP, at a distance of about 14 km to the intake dam.
- Quarry III, found in the vicinity of the power house.
- Sand is obtained from the surroundings of the village of Wai Petai, at a distance of about 6 km to the intake dam and from the village of sindang Pagar at a distance of about 16.5 km to the intake dam.
- Base camp, in the village of Sukapura.
- Housing and offices, in the village of Sukapura.
b. **Ecological Borders**

The ecological borders are the borders of the Catchment Area which form one ecosystem unit. This HPP Project is located in the Catchment Area of the upstream part of the Tulang Bawang which forms the Sub Catchment Area of the Wai Besai, with an area of about 41,500 ha (415 km²).

Geographically the Sub Catchment Area of the Besai is situated between 4°-6° South Latitude and 104°-105° West Longitude.

c. **Administrative Borders**

The Besai HPP Project is situated in two Kecamatans (Sub-Districts), i.e. the Kecamatan of Sumber Jaya and the Kecamatan of Bukit Kemuning, Kabupaten (District) of West Lampung.

The intake dam is in the Village of Sukapura, Kecamatan of Sumber Jaya at a distance of about 60 km from Kotabumi. The power house is in the Village of Dwikora, Kecamatan of Bukit Kemuning and these two villages lie adjacent to each other.

(2) The Environmental Components Investigated/Observed

The environmental components investigated cover the Physical (soil, hydrology, air, and climate), biological (terrestrial and aquatic biota), and socio-economic and socio-cultural aspects.

1.4 **Methodology**

(1) **Method of Data Collecting**

In accordance with the objective of the EIA study, the data used are secondary data and primary data.

Secondary data are collected from the related Departments/Authorities and primary data are obtained through observation in the field, measuring or sample taking, and interviews.

a. **Geophysical**

Topographical data in the form of the obliqueness of slopes and height/elevation of places are obtained from the topographical map and the land capacity map. Geological data are obtained from the geological map and relevant reports. Data on the soil are obtained from maps, reports, supported with field observation. The spread of soil types is found in the soil map and land unit.

Data on the climate and water discharge are collected from P3SA of the Province of Lampung, the river stream pattern from the topographical map and the groundwater surface from the Health Service of Sumber Jaya.

To know the water quality, water samples are taken from the planned location of the dam site for further analysis in the laboratory.
b. Biology

b.1 Flora

Data on the flora are collected by the inventory method, i.e. by observation in the field. For terrestrial flora, observation is undertaken in each type of land use, consisting of: home garden, sawah (wet rice cultivation), tegulan/ladang (dry cultivation), garden/estate, underbrush, and forest. The data obtained for culture plants are secondary data (village and kecamatan).

The inventory of the underbrush and forest vegetation is done by making observation belts. The belt is made by the “belt transect” method with the description as follows:

- The belt is made along the length cutting the contour line with a dimension of 20 x 100 m. The belt is further divided into five parts, so that 5 belts are obtained, each of 20m x 20 m. Of each sample belt the diameter of each kind of plant at tree level is recorded and measured (DBH > 20 cm).

- To know the plants at pole level (10 < DBH < 20 cm) in the main belt a belt of 10 m x 10 m is made. The diameter of all plants of pole level is recorded and measured.

- To know the plants at pile level (1 cm < DBH < 10 Cm) in the "pole belt" a belt of 5 x 5 m is made. The diameter of all pile plants is recorded and measured.

- To know the plants at seedling and undergrowth level, in the pile belt a belt of 1m x 1m is made and the kind and number of individual seedlings and undergrowth are recorded. As for aquatic flora, observation is made of the water weeds found in sawah land and along the length of the river, in particular those having a calm stream.

b.2 Fauna

Data on terrestrial fauna in the form of domestic animal (cattle and domestic animals of the population) are obtained from secondary data and data on wild animals (mammals, reptiles, and birds) are collected from reliable sources.i.e. forest attendants, hunters, and members of the community. In addition, animal is found during flora observation.

Data on aquatic fauna, particularly fish are obtained from the population who often catches fish and from the members of the community living relatively near the river.
c. **Socio-Economic and Socio-Cultural Aspects**

Data and information on the social, economic, and cultural condition are obtained by the method of observation and interview. Interview is held with the people selected as respondents by using a set of questionnaire previously prepared. In addition, information is collected from village administrators and public figures and secondary data from the village and Sub-District Office.

In order to obtain representative data, 10 villages have been established as samples consisting of 3 villages directly affected by the impact of the project (Sukapura, Wai Petai, and Dwikora) and 7 villages lying in the upstream part of the project. These seven villages have been selected on the consideration that they are representative of other villages. The existence and activity of these villages in the upstream part of the project are expected not to be affected by the impact of the project, but on the contrary, will bring about a negative impact to the life of the project for the long term.

(2) **Method of Data Analysis**

a. Geophysical

Topographical and geological data are interpreted from the topographical map, map of land capability, and geological map. Of the information obtained from the topographical and land capability map in the form of the inclination of the slope, a tabulation is made and the proportions measured. Whereas the regional geology is interpreted descriptively.

The analysis of climatological data is made by way of tabulation. To know the type of rainfall and climate of the area of study, a calculation is made by the Koppen method and the Schmidt & Ferguson method.

Data on soil are analyzed by way of interpretation and calculation and the soil classification system. In this case the system used is Soil Taxonomy (USDA, 1975) after which the equivalent is sought according to the FAO/UNESCO system (1974) and PPT (1984). Data on the physical and chemical properties of the soil obtained from the field as well as reports are interpreted qualitatively. Gauging of sedimentation is done by the SDR (Sediment Delivery Ratio) method according to the Robinson (1979) criteria. The gauging of the sedimentation presently occurring is done by calculating the predicted total erosion by the USLE method.

The analysis of data and the use of land is made by way of tabulation, so that the spread of the use of land in various inclinations of the slope can be obtained.

Hydrological data are interpreted from the map (for river stream pattern) and the tabulation made, where as to know the water quality an analysis of the water sample is made in the laboratory.
b. Biological

b.1 Flora

Data on cultivated plants are analyzed by the tabulation method and the data on underbrush and forest vegetation, besides analyzed by way of tabulation, an IVI (Important Value Index) calculation is made of each plant level.

Frequency = Number of belts containing certain plant species.
Density = Number of individuals per belt.
Dominance = Area of basic field coverage.

Relative Frequency (RF) = Frequency of certain plant species / Frequency of all individuals x 100%
Relative Density (RD) = Density of one species / Density of all species x 100%
Relative Dominance (RDo) = Dominance of certain plant species / Dominance of all individuals x 100%

IVI (Important Value Index) = RF + RD + RDo and for undergrowth, VI = RF + RD.

The analysis of aquatic flora (water weeds) is done by way of tabulation and data interpretation.

b.2 Fauna

The analysis of data on aquatic fauna (fish) and cattle is done by way of tabulation. To know the similarity index of the existing wild animal species, the data is analyzed by using the Sorenson equation as follows:

\[ S = \frac{2C}{A+B} \]

in which:
- \( S \) = Similarity index
- \( A \) = Number of species in location A
- \( B \) = Number of species in location B
- \( C \) = Number of species found in Location A as well as location B

c. Socio-Economic and Socio-Cultural Data

The analysis of socio-economic and socio-cultural data is made by way of tabulation and continued with the interpretation of the data qualitatively and or quantitatively.
II. BRIEF DESCRIPTION OF BESAI HPP PROJECT ACTIVITY

2.1 Objective

The objective of the Besai HPP Project is to increase the power capacity in the area of Lampung in particular and Sumatera in general which according to the demand forecast that area in 1996 will need a power production of 2,894 GWh and an installed capacity of 722 MW. The Besai HPP will have a capacity of 90 MW with a total annual energy output of 396 GWh.

2.2 Description of Activity

1. Type of planned activity: Besai HPP Project

2. Planned location of activity

a. Village: Sukapura
Kecamatan (Sub-District): Sumber Jaya
Kabupaten (District): North Lampung
Province: Lampung

b. Village: Dwikora
Kecamatan: Bukit Kemuning
Kabupaten: North Lampung
Province: Lampung

3. Stages of Activity

The activity schedule in each stage (pre-construction, construction, operation) is as per the table hereunder.

Table 2.1. Activities schedule of Besai HPP

<table>
<thead>
<tr>
<th>Year</th>
<th>Description Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pre-Construction</td>
</tr>
<tr>
<td>2</td>
<td>- Access Road</td>
</tr>
<tr>
<td>3</td>
<td>- Base Camp</td>
</tr>
<tr>
<td>4</td>
<td>- 20 kV Distribution line</td>
</tr>
<tr>
<td>5</td>
<td>Construction</td>
</tr>
<tr>
<td>6</td>
<td>- Civil works</td>
</tr>
<tr>
<td></td>
<td>- Metal Works</td>
</tr>
<tr>
<td></td>
<td>- Turbine &amp; Generator</td>
</tr>
<tr>
<td></td>
<td>- Transmission lines &amp; Sub Station</td>
</tr>
<tr>
<td></td>
<td>Operational</td>
</tr>
</tbody>
</table>

ENVIRONMENTAL IMPACT ASSESSMENT-BESAI HPP
4. Relationship of Project with Other Activities:

- The forest area used for part of the quarry and part of the access road;
- The forest area for the tunnel from the intake dam to the powerhouse with a length of 5,842 m;
- The plantation and bushes in the planned location of the dam;
- Bridges made by the activity of the community of Sukapura and Wai Petai in the planned location of inundation (3 suspension bridges and 1 semi-permanent bridge);
- Yards in part of the access road in Sukapura;

(1). Pre-Construction Stage

a. Plan for Land Acquisition

Land acquisition is implemented pursuant to the Regulation of the KEPRES No. 55/1993 with the establishment of the Committee of Land Acquisition for the State with PLN and the related Department/Authorit; as members.

b. System of Compensation

The amount of the payment of compensation for land and plants will be based on consultation between the Committee for Land Acquisition and the population whose land is affected by the project.

(2). Construction Stage

a. Implementation of construction activities

<table>
<thead>
<tr>
<th>No</th>
<th>Type of Activity</th>
<th>Implementation of Activity</th>
<th>Equipment Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Land clearing</td>
<td>Project area cleared and levelled</td>
<td>Bulldozer, excavator</td>
</tr>
<tr>
<td>2</td>
<td>Material</td>
<td>Material transported from its source</td>
<td>Dump truck</td>
</tr>
<tr>
<td>3</td>
<td>Construction of dam</td>
<td>Manually and mechanically</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Construction of tunnel</td>
<td>Manually and mechanically</td>
<td>Excavator, drill, stone cutter</td>
</tr>
<tr>
<td>5</td>
<td>Construction of power house C supporting</td>
<td>Manually and mechanically</td>
<td></td>
</tr>
</tbody>
</table>

The implementation of the work can be explained as follows:

Intake Dam

The excavation of the intake dam foundation is carried out by the use of heavy equipment according to the above table. The product of excavation will be transported through the access road and piled up in Spoil Bank No 1.
<table>
<thead>
<tr>
<th>No.</th>
<th>Proposed use</th>
<th>Acreage (Ha)</th>
<th>Landuse</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basecamp &amp; Access road</td>
<td>15.11</td>
<td>- Coffee plantation &amp; Sawah/ricefield</td>
<td>Forestry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Access road to power house</td>
<td>4.2</td>
<td>Coffee plantation &amp; bush</td>
<td>Forestry</td>
</tr>
<tr>
<td>3</td>
<td>Spoil bank &amp; Quarry</td>
<td>12.44</td>
<td>Coffee plantation &amp; bush</td>
<td>Forestry</td>
</tr>
<tr>
<td>4</td>
<td>Power house, surge tank &amp; intake</td>
<td>12.55</td>
<td>Coffee &amp; bush</td>
<td>Forestry</td>
</tr>
<tr>
<td>5</td>
<td>Temporary building</td>
<td>12.13</td>
<td>Coffee &amp; bush</td>
<td>Forestry</td>
</tr>
<tr>
<td>6</td>
<td>Access road to dam site, work adit &amp; surge tank</td>
<td>16.71</td>
<td>Coffee &amp; bush</td>
<td>Forestry</td>
</tr>
<tr>
<td>7</td>
<td>Inundated area</td>
<td>85.35</td>
<td>- Ricefield &amp; coffee &amp; - River bed</td>
<td>Private</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16.1 *)</td>
<td></td>
<td>Government</td>
</tr>
<tr>
<td></td>
<td><strong>Total to be compensated</strong></td>
<td><strong>160.48</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*) will not be compensated
**Head Race Tunnel**

Because of the length of the headrace tunnel of ± 5 km, before the excavation work is carried out, adit tunnels No. 1, No. 2, and No.3 will be made. Through these adit tunnels, the excavation of the headrace tunnel is carried out to the left and the right. The product of excavation of the headrace tunnel transported through adit tunnel No. 1 is piled up in Spoil Bank 2 and the product of excavation transported through adit tunnel No. 2 and No. 3 is respectively piled up in Spoil Bank 3 and Spoil Bank 4. The tunnel is situated at an average of 100 m depth in the ground, so that the activity of excavation does not affect the land surface on top of it.

**Access Road**

The access road to be constructed will run along the length of the Wai Besai to the mouth of adit tunnel no.1, 2, and 3 and further to the spoil bank (see Figure I).

The access road along the tunnel is not a permanent one. After completion of the project this access road may continue to be used or replanted.

**Power house, surge tank, and penstock**

These parts will be dealt with manually and mechanically. The product of excavation of the power house will be piled up in Spoil Bank No.5 and No.6; the product of excavation of the surge tank will be piled up in Spoil Bank No. 4 and No. 5, and that of the penstock in Spoil Bank No. 4.

The construction material used in the construction stage which is likely to bring about an impact are stone and sand during mining and transportation.

End disposal of disposed material in the construction stage:

Disposed material will be piled up in layers and levelled with a thickness of maximum 20 cm for each layer and then compacted with a bulldozer.

**Manpower needed in the construction stage:**

<table>
<thead>
<tr>
<th>No</th>
<th>Type of manpower</th>
<th>Education/Expertise</th>
<th>Manpower</th>
<th>Settlement</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>New-comer</td>
<td>Local</td>
<td>Foreign</td>
</tr>
<tr>
<td>1.</td>
<td>Expert</td>
<td>University graduate</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>graduate</td>
<td>graduate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Middle/undergrad</td>
<td>University graduate, SHS</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>graduate, SHS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Labors</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>
(3) Operation Stage

a. Capacity of Service

<table>
<thead>
<tr>
<th>No</th>
<th>Type of Production / Type of Services</th>
<th>Capacity / Capacity of Services</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Electric energy</td>
<td>396 Gwh per year of an installed capacity of 90 MW.</td>
</tr>
</tbody>
</table>

b. Method/Process of Activity

In general, the operational activity of Besai HPP will cover water release, electric power generation and transmission. In the process of water release, the water of the Besai with an average discharge of 26.2 m³/sec, will be taken through the headrace tunnel of 24.4 m³/sec then to be returned to the Besai after turning the turbine, in the power house and further reunite with the remaining stream and overflow through the dam. In the downstream part of the power house the water will return to its original condition. The decrease of the discharge from the dam to the power house (± 5 km) will not disturb the environment, since there is no use of water along this trench.

The electricity produced by the generator will be conveyed to the transformer in which the voltage will be stepped up. This high voltage electricity will then enter the network system in the sub-station and from there it will be ready for distribution.

c. Human Resources

c.1 Power plant employees

<table>
<thead>
<tr>
<th>No.</th>
<th>Position in Work</th>
<th>Education</th>
<th>Origin</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>U  C   SHS  JHS ES Loc Arr For P NP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Head</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Engine operator</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>3.</td>
<td>Water gate operator</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>4.</td>
<td>Maintenance section</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>5.</td>
<td>Security officer</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Technicians</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>7.</td>
<td>Warehouse section</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Driver</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

U = undergraduate/graduate  
C = undergraduate  
SHS = Senior High School  
JHS = Junior High School  
ES = Elementary School  
Loc = Local  
For = Foreign labor  
Arr = Labor from outside area  
P = People/labor  
NP = Not applicable
c.2 Educational Facilities and Work Equipment

The education and courses given to the workers are a.o.: network maintenance, HPP basics, operation and maintenance, security guard training, and typewriting.

For the smooth execution of tasks, security and safety of the worker, work outfit will be needed, such as: work dress, safety helmet, voltage-proof shoes, voltage-proof gloves, leather/cotton gloves, raincoat, rubber shoes, safety belt, respiratory protection, eye protection, ear protection, flashlight, electricity welding mask, carbide welding eye- glasses, asbestos welding gloves, and first aid medicines.
III. ENVIRONMENTAL BASELINE

3.1 Geophysical

(1) Climate and Air Quality

a. Rainfall and Temperature

The type of the climate in the area of study is categorized according to Koppen and the type of rainfall is categorized according to Schmidt and Ferguson. In addition, the agroclimatological zone in the area of study is categorized according to Oldeman.

The area of study has a rainfall of 2,614 mm per year with an average daily air temperature of 21.2°C. The lowest average daily air temperature is in August (20.3°C) and the highest in March, April, and December of 21.7°C each.

The highest rain intensity is in December (16.1 mm/day) and the lowest in June (12.1 mm/day). The result of the processing of climatological data is presented in Table 3.1.

Based on the division of the climate type according to Koppen, the area of study has the climate type Af with the following description:

- The air temperature in the lowest month is 20.3°C (18°C).
- Much rainfall in the dry season. The data on rainfall in the area of study show that there is no dry month (month with a rainfall of < 60 mm) and that there are 11 wet months (rainfall of > 100 mm).
- The rainfall in the driest month is 93 mm (60 mm).

b. Wind

The average wind velocity in the area of study is 39.31 km/day with a variety of 27.1 km/day as the weakest wind velocity (May) and 54.1 km/day as the strongest wind velocity in December.

The wind direction in the area of study is variable. The dominant wind direction all year long is from the North, i.e. in the months of April, June, July, August, and November, and from the South-West and South-East in September and from the North and South-West in December. In the months of January, February, March, May, and October, the wind direction is dominantly from the North-East.
c. **Air Humidity**

The average daily value of the relative air humidity in the area of study is 84.3%. The lowest average daily relative air humidity is in November (82.3%) and the highest in February (85.7%).

d. **Solar Radiation**

The average daily solar radiation in the area of study is 210.42 cal/cm²/day. The lowest average daily solar radiation is in January (177.2 cal/cm²/day) and the strongest in May (227.1 cal/cm²/day).

e. **Duration of Radiation**

The average daily duration of solar radiation in the area of study is between 3.9 and 6.8 hours/day or an average of 5.2 hours/day. The shortest duration of radiation is in December and the longest in June.

f. **Evaporation**

The average daily evaporation in the area of study is 3.81 mm/day. The least average daily evaporation is in July (4.41 mm/day) and the most is in December (4.9 mm/day).

g. **Evapotranspiration**

In this study the evapotranspiration is counted by the Thornwaite method, as this method is considered quite proper for medium to wet areas. The average evapotranspiration is 7.7 cm/month.

h. **Rain Water Balance**

The water balance will give important information on the net water received by a certain area, so that it can be known when the surplus months will be and when the months of water deficit.

Adjusted to its objective, the water balance model will be drawn up in the form of a very common quantitative equation, i.e. as based on the rainfall data and the potential evapotranspiration value in that area.

Of the result of analysis as per the Table 3.2, in the area of study there are no months of water deficit, or in other words the area of study has a wet climate with high rain potential.

i. **Air Quality**

The air quality which should be observed in connection with the activity plan of Besai HPP are noise, dust, and gases. The degree of noise, dust content, and gases in the project location and surroundings is considered to be still low.
Table 3.1. Average Monthly Climatological Data In Area of Study

<table>
<thead>
<tr>
<th>Climatological Element</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall (cm)</td>
<td>31.9</td>
<td>23.9</td>
<td>30.8</td>
<td>26.9</td>
<td>20.2</td>
<td>12.9</td>
<td>13.2</td>
<td>9.3</td>
<td>17.2</td>
<td>19.1</td>
<td>23.6</td>
<td>32.4</td>
<td>21.8</td>
</tr>
<tr>
<td>Rainy days (d)</td>
<td>20.3</td>
<td>16.6</td>
<td>18.6</td>
<td>17.7</td>
<td>15.3</td>
<td>10.7</td>
<td>10.8</td>
<td>7.6</td>
<td>11.5</td>
<td>12.6</td>
<td>15.2</td>
<td>20.1</td>
<td>14.6</td>
</tr>
<tr>
<td>Rain Intensity (cm/day)</td>
<td>1.57</td>
<td>1.43</td>
<td>1.65</td>
<td>1.52</td>
<td>1.32</td>
<td>1.27</td>
<td>1.27</td>
<td>1.22</td>
<td>1.49</td>
<td>1.51</td>
<td>1.55</td>
<td>1.61</td>
<td>1.45</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>21.5</td>
<td>21.6</td>
<td>21.7</td>
<td>21.6</td>
<td>20.9</td>
<td>20.4</td>
<td>20.3</td>
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<td>20.9</td>
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<tr>
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<td>37.8</td>
<td>41.9</td>
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<td>31.5</td>
<td>27.1</td>
<td>20.9</td>
<td>20.4</td>
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<td>20.9</td>
<td>21.5</td>
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<tr>
<td>Relative Direction</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
<td>SE</td>
<td>NE</td>
<td>NE</td>
<td>NE</td>
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<tr>
<td>Relative Air Humidity (%)</td>
<td>82.7</td>
<td>85.7</td>
<td>85.4</td>
<td>83.3</td>
<td>84.9</td>
<td>84.3</td>
<td>85.5</td>
<td>85.5</td>
<td>85.8</td>
<td>85.2</td>
<td>85.2</td>
<td>85.3</td>
<td>85.3</td>
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<tr>
<td>Solar Radiation (cal/cm²/day)</td>
<td>177.2</td>
<td>210.9</td>
<td>205.3</td>
<td>203.3</td>
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<td>223.27</td>
<td>220.7</td>
<td>204.9</td>
<td>200.6</td>
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<td>4.94</td>
<td>5.5</td>
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<td>6.8</td>
<td>5.8</td>
<td>6.02</td>
<td>5.7</td>
<td>5.16</td>
<td>4.36</td>
<td>3.9</td>
<td>5.2</td>
</tr>
<tr>
<td>Evaporation</td>
<td>3.6</td>
<td>4.12</td>
<td>4.1</td>
<td>4.2</td>
<td>3.9</td>
<td>3.6</td>
<td>3.9</td>
<td>4.4</td>
<td>4.4</td>
<td>4.4</td>
<td>4.4</td>
<td>4.9</td>
<td>4.1</td>
</tr>
<tr>
<td>Potential evaporation uncorrected (cm/m)</td>
<td>7.98</td>
<td>8.07</td>
<td>8.16</td>
<td>8.16</td>
<td>8.07</td>
<td>7.48</td>
<td>7.08</td>
<td>6.99</td>
<td>7.24</td>
<td>7.49</td>
<td>7.98</td>
<td>8.16</td>
<td>7.7</td>
</tr>
<tr>
<td>Potential evaporation corrected (cm/m)</td>
<td>8.46</td>
<td>7.67</td>
<td>8.48</td>
<td>8.16</td>
<td>8.23</td>
<td>7.40</td>
<td>7.22</td>
<td>7.20</td>
<td>7.24</td>
<td>7.85</td>
<td>8.22</td>
<td>8.65</td>
<td>7.9</td>
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</tbody>
</table>

Source: PjU A Lampung Province (Data Processed by Study Team)

Table 3.2. Monthly Rain Water Balance in Area of Study

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Temperature (°C)</td>
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<td>21.6</td>
<td>21.7</td>
<td>21.7</td>
<td>20.9</td>
<td>20.4</td>
<td>20.3</td>
<td>20.6</td>
<td>20.9</td>
<td>21.5</td>
<td>21.7</td>
<td>21.6</td>
</tr>
<tr>
<td>3</td>
<td>Potential Evaporation (cm)</td>
<td>7.98</td>
<td>8.07</td>
<td>8.16</td>
<td>8.16</td>
<td>8.07</td>
<td>7.48</td>
<td>7.08</td>
<td>6.99</td>
<td>7.24</td>
<td>7.48</td>
<td>7.98</td>
<td>8.16</td>
</tr>
<tr>
<td>4</td>
<td>Correction Factor</td>
<td>9.06</td>
<td>9.05</td>
<td>1.04</td>
<td>1.00</td>
<td>1.02</td>
<td>0.99</td>
<td>1.02</td>
<td>1.03</td>
<td>1.00</td>
<td>1.05</td>
<td>1.03</td>
<td>1.05</td>
</tr>
<tr>
<td>5</td>
<td>Corrected Evapotranspiration (cm)</td>
<td>8.46</td>
<td>7.67</td>
<td>8.48</td>
<td>8.16</td>
<td>8.23</td>
<td>7.40</td>
<td>7.22</td>
<td>7.20</td>
<td>7.24</td>
<td>7.85</td>
<td>8.22</td>
<td>8.65</td>
</tr>
<tr>
<td>6</td>
<td>Rainfall (cm)</td>
<td>31.9</td>
<td>23.9</td>
<td>30.8</td>
<td>26.9</td>
<td>20.2</td>
<td>12.9</td>
<td>13.2</td>
<td>9.3</td>
<td>17.2</td>
<td>19.1</td>
<td>23.6</td>
<td>32.4</td>
</tr>
<tr>
<td>7</td>
<td>Surplus</td>
<td>23.46</td>
<td>16.23</td>
<td>22.32</td>
<td>18.74</td>
<td>11.97</td>
<td>5.5</td>
<td>5.98</td>
<td>2.1</td>
<td>9.96</td>
<td>11.25</td>
<td>15.38</td>
<td>25.75</td>
</tr>
<tr>
<td>8</td>
<td>Deficit</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Result of Calculation from Climatological Data
This is caused by the relatively limited transportation in this area, the non-existence of industry as a source of pollution, and the activity of the people which is still focused on the agricultural sector.

(2) Physiography

a. Topography and Morphology

The physiography of the Besai Sub-Catchment Area can be subdivided into 2 groups, i.e. the mountainous area and the undulating area. More than 85% of this area is mountainous area and the rest is hilly area.

The mountain area forms a natural range originating from mountain and maintaining its original form. In the area of Wai Besai, the mountain area occupies an area of 85%, divided as follows:

- The wavy mountain plain showing inclinations of 0 - 15% occupies 25% of the total area. This area lies in the main route of the upstream of the Wai Besai, or in the middle part of the catchment area. The elevation of the area is between 800 - 1,000 m above sea level.

- The lower slopes of the mountain group showing inclinations of 8 - 15% occupy 25% of the total area. This area lies in the upstream of the tributaries of the Wai Besai, such as the upstream of the Wai Kabul, Wai Campang Kanan, and Wai Hitam. The elevation is between 800 - 1,000 m above sea level.

- The eroded volcano group shows many inclinations of 30 - 70% and occupies 15% of the total area. This area lies in the northern and southern part of the main route of the upstream of Wai Besai. The elevation of this area is between 1,000 - 1,400 m above sea level.

- The middle slopes of the mountain group show many inclinations of 16 - 50% and occupy 10% of the total area. This area lies in the northern and southern part of the main route of the upstream of Wai Besai. The elevation of this area is between 1,000 - 1,500 m above sea level.

- The upper slopes of the mountain group show many inclinations of > 30% and occupy 10% of the total area. This area lies in the vicinity of the Sekincau Mountain and forms the spring of a part of the tributaries of the Wai Besai. The elevation of this area is between 1,400 - 1,800 m above sea level.
The undulating area lies in the vicinity of the planned location of the Wai Besai dam. This hilly area occupies 15% of the total area and in general consists of small hills with a wavy pattern. The inclination of this area is between 8 - 30% with an elevation of 700 - 800 m above sea level.

b. Geology

According to its geology (Puslitган 1989), the larger part of the area consists of ancient rock enwrapped in quaternary volcanic deposit. The oldest quaternary volcanic material consists of Ranau tuff with a dacitic and lycaritic structure. This Ranau tuff is in turn covered by young volcanic material varying between andesitic and basaltic. The Sekincau (Mountain) forms one of the volcanic eruption centers in this area.

(3) Hydrology

a. River Stream Pattern

The Way'Besai river is one of the tributary of Tulang Bawang River. Since the physiographical condition of the Besai catchment area is hilly to mountainous, in the drainage pattern in this area many trenches are found, in the form the tributaries of the river itself as well as small rivers of a seasonal character. From the result of the study of the topo-graphical map and observation in the field, it can be seen that the stream pattern Of the Wai Besai has the form of a bird feather.

Such a catchment area has a very small flood discharge, since the time of arrival of the flood from the tributaries is different; on the other hand, the flood lasts long. The tributaries of Besai River are Wai Petai, Wai Campang Kanan, Wai Hitam, and Wai Kabul.

The form of the main river is relatively not a straight line (winding) following the lowest topography, while the stream type is a turbulent one, due to the many large rocks found on the bottom of the river.

b. River Water Discharge

The data on the average monthly discharge can be made an indicator of the catchment area in the upstream part, or its source. The average stream discharge of the Wai Besai varies between 11.04 m3/sec to 32.71 m3/sec. The smallest average monthly discharge is in August and the largest in January (data on the average monthly discharge can be seen in Table 3.3). The small fluctuation of the average monthly discharge is probably caused by the high rainfall all year long in the area of study.
c. Groundwater Surface

The depth of the groundwater surface in the area of study is very closely correlated to the elevation of the place or topography. The shallowest groundwater surface is found in the village of Wai Petai and Purawiawan, i.e. 3 m from the land surface. These two villages lie in the lowest location, while the village of Tambak Jaya which lies in the highest location/topography has the deepest groundwater depth, i.e. about 3 m. The depth of the groundwater surface in some locations or villages in the area of study can be seen in Table 3.4.

d. Water Quality

The water quality of a water body is determined by the magnitude of the value of each parameter known from the analysis of the water sample in the laboratory. The data on the water quality of the Wai Besai, the sample of which is taken from the planned location of the dam are as presented in Table 3.6.

Table 3.3. Average Monthly Water Discharge of Wai Besai (m³/sec)

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>15.63</td>
<td>17.58</td>
<td>18.92</td>
<td>23.82</td>
<td>14.20</td>
<td>7.57</td>
<td>6.61</td>
<td>7.58</td>
<td>5.60</td>
<td>7.87</td>
<td>18.44</td>
<td>14.72</td>
</tr>
<tr>
<td>1977</td>
<td>24.84</td>
<td>21.17</td>
<td>37.81</td>
<td>26.55</td>
<td>27.98</td>
<td>21.22</td>
<td>17.44</td>
<td>14.24</td>
<td>21.05</td>
<td>18.64</td>
<td>32.18</td>
<td>41.81</td>
</tr>
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<td>42.77</td>
<td>22.20</td>
<td>29.17</td>
<td>29.37</td>
<td>18.81</td>
<td>18.03</td>
<td>12.28</td>
<td>12.56</td>
<td>13.91</td>
<td>19.88</td>
<td>-</td>
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<tr>
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<td>29.75</td>
<td>21.87</td>
<td>22.09</td>
<td>22.94</td>
<td>17.66</td>
<td>15.17</td>
<td>10.37</td>
<td>10.35</td>
<td>12.31</td>
<td>19.82</td>
<td>33.45</td>
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<td>27.66</td>
<td>28.26</td>
<td>39.10</td>
<td>35.91</td>
<td>18.44</td>
<td>15.74</td>
<td>12.25</td>
<td>20.75</td>
<td>13.01</td>
<td>15.93</td>
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<td>31.28</td>
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<td>8.16</td>
<td>5.46</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<td>11.06</td>
<td>6.95</td>
<td>5.18</td>
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<td>23.10</td>
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<td>18.61</td>
<td>18.52</td>
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<td>19.33</td>
<td>17.72</td>
<td>18.67</td>
<td>15.56</td>
<td>22.77</td>
<td>23.82</td>
<td>32.85</td>
<td>32.17</td>
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<td>34.91</td>
<td>33.34</td>
<td>28.14</td>
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<td>14.32</td>
<td>10.35</td>
<td>8.11</td>
<td>9.54</td>
<td>14.91</td>
<td>31.06</td>
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<td>35.75</td>
<td>37.54</td>
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<td>11.66</td>
<td>7.66</td>
<td>12.26</td>
<td>28.98</td>
<td>22.56</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
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<td>330.34</td>
<td>327.64</td>
<td>274.29</td>
<td>185.25</td>
<td>165.70</td>
<td>130.66</td>
<td>146.31</td>
<td>175.30</td>
<td>247.97</td>
<td>225.23</td>
</tr>
<tr>
<td>Average</td>
<td>32.43</td>
<td>27.48</td>
<td>27.53</td>
<td>27.31</td>
<td>22.84</td>
<td>15.44</td>
<td>13.82</td>
<td>10.89</td>
<td>13.30</td>
<td>15.75</td>
<td>22.54</td>
<td>25.03</td>
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</table>
Table 3.4. Depth of Groundwater Surface in Some Locations in the Area of Study

<table>
<thead>
<tr>
<th>No.</th>
<th>Location</th>
<th>Depth of groundwater (m)</th>
<th>Surface (m)</th>
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<tbody>
<tr>
<td>1</td>
<td>Sukajaya</td>
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</tr>
<tr>
<td>2</td>
<td>Sendang Pagar</td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>Puralaksana</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Fajar Buatan</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Karang Agung</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Mutur Alam</td>
<td>5-15</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Tanjung Raya</td>
<td>15-30</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Suka Menanti</td>
<td>13-20</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Suka Raja</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Padang Tambak</td>
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<td></td>
</tr>
<tr>
<td>11</td>
<td>Tambak Jaya</td>
<td>&gt;30</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Srimenanti</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Semaran Jaya</td>
<td>12</td>
<td></td>
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<tr>
<td>14</td>
<td>Sumber Alam</td>
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<td>Simpang Sari</td>
<td>13</td>
<td></td>
</tr>
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<td>16</td>
<td>Sukapura *)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Wai Petai *)</td>
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<td></td>
</tr>
<tr>
<td>18</td>
<td>Dwikora *)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Tri Budi Syukur</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Purajaya</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Purawiwitan</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Muara Jaya</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Puramekar</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Tri Mulyo</td>
<td>8</td>
<td></td>
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<tr>
<td>25</td>
<td>Gedung Surian</td>
<td>8</td>
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</table>

*) Affected villages

Source: Puskesmas Kecamatan Sumber Jaya
Table 3.5. Result of Analysis of Water Quality of Besai, West Lampung

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
<th>Equipment/Analysis</th>
</tr>
</thead>
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<td>1.</td>
<td>pH</td>
<td>6.0</td>
<td>-</td>
<td>pH Meter</td>
</tr>
<tr>
<td>2.</td>
<td>Temperature</td>
<td>23.0</td>
<td>°C</td>
<td>Thermometer</td>
</tr>
<tr>
<td>3.</td>
<td>Color</td>
<td>40</td>
<td>Hazen</td>
<td>Aquamarck Test</td>
</tr>
<tr>
<td>4.</td>
<td>Dissolved solid</td>
<td>27</td>
<td>ppm</td>
<td>Conductivity Meter</td>
</tr>
<tr>
<td>5.</td>
<td>Suspended solid</td>
<td>120</td>
<td>ppm</td>
<td>Oven</td>
</tr>
<tr>
<td>6.</td>
<td>Turbidity</td>
<td>51</td>
<td>ppm</td>
<td>Horiba water checker/0.7</td>
</tr>
<tr>
<td>7.</td>
<td>DO (Dissolved Oxygen)</td>
<td>5.720</td>
<td>ppm</td>
<td>BOD bottle (Titration)</td>
</tr>
<tr>
<td>8.</td>
<td>BOD</td>
<td>18</td>
<td>ppm</td>
<td>BOD bottle (Titration)</td>
</tr>
<tr>
<td>9.</td>
<td>COD (K₂Cr₂O₇)</td>
<td>27</td>
<td>ppm</td>
<td>Titration</td>
</tr>
<tr>
<td>10.</td>
<td>CO₂</td>
<td>4.400</td>
<td>ppm</td>
<td>Titration</td>
</tr>
<tr>
<td>11.</td>
<td>Cyanide (Cn)</td>
<td>0.002</td>
<td>ppm</td>
<td>Aquamarck Test</td>
</tr>
<tr>
<td>12.</td>
<td>Chloride (Cl)</td>
<td>15</td>
<td>ppm</td>
<td>Aquamarck Test</td>
</tr>
<tr>
<td>13.</td>
<td>Sulphide (HS)</td>
<td>0.001</td>
<td>ppm</td>
<td>Aquamarck Test</td>
</tr>
<tr>
<td>14.</td>
<td>Conductivity</td>
<td>39</td>
<td>umhos/cm</td>
<td>Conductivity Meter</td>
</tr>
<tr>
<td>15.</td>
<td>Sulphate (SO₄)</td>
<td>205</td>
<td>ppm</td>
<td>Spectrophotometer</td>
</tr>
<tr>
<td>16.</td>
<td>Nitrate (NO₃-N)</td>
<td>0.142</td>
<td>ppm</td>
<td>Spectrophotometer</td>
</tr>
<tr>
<td>17.</td>
<td>Nitrite (NO₂-N)</td>
<td>9.070</td>
<td>ppm</td>
<td>Spectrophotometer</td>
</tr>
<tr>
<td>18.</td>
<td>Ammonium (NH₄-N)</td>
<td>0.283</td>
<td>ppm</td>
<td>Spectrophotometer</td>
</tr>
<tr>
<td>19.</td>
<td>Total hardness</td>
<td>5.354</td>
<td>ppm</td>
<td>Titration</td>
</tr>
<tr>
<td>20.</td>
<td>Ca hardness</td>
<td>0.715</td>
<td>ppm</td>
<td>Titration</td>
</tr>
<tr>
<td>21.</td>
<td>Calcium</td>
<td>0.286</td>
<td>ppm</td>
<td>Titration</td>
</tr>
<tr>
<td>22.</td>
<td>Iron (Fe)</td>
<td>0</td>
<td>ppm</td>
<td>Spectrophotometer</td>
</tr>
<tr>
<td>23.</td>
<td>Magnesium</td>
<td>1.000</td>
<td>ppm</td>
<td>Spectrophotometer</td>
</tr>
<tr>
<td>24.</td>
<td>HCO₃</td>
<td>12.200</td>
<td>ppm</td>
<td>Titration with pH Meter</td>
</tr>
</tbody>
</table>

Note: Analysis undertaken in Chemical Laboratory of Universitas Lampung, March 1990
a. Soil Classification

The larger part of the soil in this area consists of Inceptisol (87%) and the rest Entisol (8%) and Ultisol (5%). Inceptisol and Entisol for the larger part occupy volcanic area and another part hilly area, while Ultisol is for the larger part found in hilly area as per the soil map in Annex 3. In detail the division of land type is as per the following Table 3.6.

Inceptisol is soil only recently experiencing a development. The main characteristic of Inceptisol is the existence of a cambic horizon, where the translocation of clay and bases begins to take place. This Inceptisol generally develops in the landscape, which is geologically "relatively" young with a low temperature. In the Wai Besai area, Inceptisol develops from young volcanic prime material in the volcanic landscape. In this area, 4 types of Inceptisol are found, i.e.:

- Humitrpepts, Dystropepts, Dystrandepts, and Tropaquepts. This division is based on the properties found in Inceptisol, i.e. the factor of climate, the physical and chemical property of the soil.

  - Humitrpepts is Inceptisol having an iscemic temperature regime or warmer, a base saturation of > 50% and organic carbon of > 12 kg/m³ to a depth of 1 m.

Table 3.6. Spread of Soil Type in Besai Sub-Catchment Area *)

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of Soil</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Humitrpepts</td>
<td>Eutric Cambisol</td>
</tr>
<tr>
<td>2.</td>
<td>Dystropepts</td>
<td>Dystric Cambisol</td>
</tr>
<tr>
<td>3.</td>
<td>Dystropepts</td>
<td>Humic Andosol</td>
</tr>
<tr>
<td>4.</td>
<td>Tropaquepts</td>
<td>Gleyic Cambisol</td>
</tr>
<tr>
<td>5.</td>
<td>Tropotents</td>
<td>Eutric Regosol</td>
</tr>
<tr>
<td>6.</td>
<td>Rapludults</td>
<td>Ortic Acrisol</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>41,500.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

*) Interpretation of the Soil Map of Kota Agung (Center Soil Research, 1989) Supported by Field Observation.

- Dystropepts is almost the same with Humitrpepts, only with a low organic carbon requirement.

- Dystrandepts is Inceptisol characterized by a content weight of F 0.85 g/cm³, or dominated by vitric volcanic ash material with a base saturation of < 50%.
Tropaquepts is Inceptisol having an aquic humidity regime and an annual temperature difference of < 5 °C in the warm season and cold season.

Entisol is soil not having developed and the larger part of its property is determined by its prime material. No horizon development of this soil has been observed and if any, then very little. This soil develops in the eroded volcanic landscape. In the Besai Sub-Catchment Area only Tropaquepts is found, i.e. Entisol developing from young volcanoes with an upper course humidity regime and a temperature difference of < 5 °C.

Ultisol is soil having developed characterized by the existence of an argillic horizon and a base saturation of < 35%. Developing in ancient landscape in the hilly area of Wai Besai.

Hapludults is Ultisol having an upper course humidity regime and no other significant characteristics.

b. Erosion

A large part of the Besai Sub-Catchment Area is sensitive to erosion. Several factors which are of much influence in inducing erosion in this area are, a.o

- The physiography of the area is volcanic and hilly with an average inclination of more than 15%.
- The type of soil which for a large part is sensitive to erosion (Inceptisol and Ultisol).
- The high erodibility of rain (erodibility index between 1,500 - 2,500).
- The factor of land management, where a large part of the agricultural area does not take conservational actions.

From the survey undertaken by PT. Indra Karya and Nippon Koei (1984) the rate of erosion of 0.13 mm/year is obtained (equivalent to 53,950 ton/year).

c. Land Use

The use of land in Wai Besai can roughly be distinguished into two types, i.e. sawah (wet rice cultivation) land and dry land. The use of land in the Besai area can be seen in Table 3.7.

From observations in the field and interviews with farmer, it appears that most of the farmers have not taken conservational measures in their land. Coffee plants which form the main crop in the private plantation are always clear from weeds all year long (cleared/scraped intensively). This contributes to the high rate of erosion, particularly on land with an inclination of more than 15%.
The research undertaken by the RLKT Station (1989) shows that the value of "plant factor" or C is between 0.007 - 0.541, or an average of 0.226. As a comparison, the value C of a dense forest is 0.0001 and land without plants is 1 (one). Furthermore, the value of the land management factor (P) is between 0.965-2.00, or an average of 0.983.

As a comparison, at an inclination of 15% with terraces (as a conservational measure) the value of P is 0.1 and for land without management, P = one (1).

Table 3.7 Land Use at Some Inclination in the Sub-Catchment Area of the Wai Besai *)

<table>
<thead>
<tr>
<th>No.</th>
<th>Use of Land</th>
<th>Inclination (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0-8</td>
</tr>
<tr>
<td>1.</td>
<td>Wet Rice field (Sawah)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Simple Irrigation</td>
<td>1332</td>
</tr>
<tr>
<td></td>
<td>- Rainwater</td>
<td>150</td>
</tr>
<tr>
<td>2.</td>
<td>Yard</td>
<td>507</td>
</tr>
<tr>
<td>3.</td>
<td>Dry Cultivation</td>
<td>1949.9</td>
</tr>
<tr>
<td>4.</td>
<td>Pond</td>
<td>215.6</td>
</tr>
<tr>
<td>5.</td>
<td>Private Plantation</td>
<td>3663</td>
</tr>
<tr>
<td>6.</td>
<td>Underbrush</td>
<td>864</td>
</tr>
<tr>
<td>7.</td>
<td>Forest</td>
<td>1469</td>
</tr>
<tr>
<td>8.</td>
<td>Others</td>
<td>197</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>9,227.50</td>
</tr>
<tr>
<td>Percentage</td>
<td></td>
<td>22.23</td>
</tr>
</tbody>
</table>

*) Interpretation of the Land Use and Land Capacity Map of the Sub-District of Sumber Jaya

In order that erosion can be suppressed to the minimum and the productivity of the land increased, the effort to be taken is the use of land according to its capacity. The data available show that protected forest occupy an area of 23,295 ha (register No. 44 B and 45 B) and wildlife reserves an area of 6,000 ha, i.e. in Register No. 46 B (REPELITA V, District of North Lampung, Volume II, 1989). The protected forest area is in Wai Tenung and Bukit Rigis, all belonging to the Besai Sub-Catchment Area and the wildlife reserve area is on the Sekincau (Mountain), which for a large part belongs to the Besai Sub-Catchment Area.

Of the forest area (of 29,295 ha), at present only 17,412 ha is left. From the map on land use of the Kecamatan of Sumber Jaya with scale 1 : 25,000 (BPN Propinsi Lampung, 1989) can be seen that the that the forest area of Bukit Rigis for the large part has been changed into farmland and underbrush; the area of Wai Tenung has become a coffee estate, and the area of Sekincau is still underbrush.
In connection with the development plan of the Besai HPP and the reservoir for irrigation in part of the Besai HPP downstream area, it has become time to arrange the use of land in the Besai Sub Catchment Area according to its destination.

The rate of erosion in this area is naturally high due to the high rainfall, topography, and land properties. This rate of erosion is more accelerated by the people (farmers), as the farming pattern does not consider the norms of land conservation.

In order that the hydrology of the catchment area will remain fair, the following should be observed:

- The land management should adopt the norms of conservation, such as making of terraces.
- The use of land should be in accordance with its allocation.
- Part of the protected forest area which has now become farmland should be rearranged.
- Replanting and reforestation should be carried out with a priority for land having a high degree of danger of erosion.

d. Land Use Planning in the Downstream Area

From information obtained, it appears that no plan has been made for land use in the downstream area of the dam, particularly for sawah land.

e. Land Use in the project site

3.2 Biology

(1) Terrestrial Biota

a. Flora

The vegetation of the Kecamatan (Sub-District) of Sumber Jaya, which forms the Sub-Catchment Area of the Wai Tulang Bawang Hulu, can ecologically be sub-devided into six types, i.e. yard vegetation, sawah (wet rice cultivation), ladang/tegalan (dry cultivation), garden/estate, underbrush, and forest. These six types of vegetation area spread sporadically, with the exception of forest vegetation which is more concentrated in the upstream area.

a.1 Home Yard (Home Garden)

A yard is a plot of land lying adjacent to the house (dwelling place) and has usually distinct borders. Yard land in the Kecamatan of Sumber Jaya covers an area of 2.051 ha (4.90%).
This plot of land is usually planted by way of multiple cropping, combining perennial with seasonal crops, hedge plants, and herbs (spices). In addition, usually the population of Sumber Jaya, originating from West Java in particulars, makes a pond in their yard. Ponds cover an area of 216 ha (0.6%) and others (roads, squares, social facilities, etc) an area of 741 ha (1.8%).

The type of plants much grown by the village population can be seen in Table 3.8

Table 3.8. Types of Yard Plant in Area of Study

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Plant</th>
<th>Latin Name</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Kacang Panjang/Cow pea</td>
<td>Vigna sinensis</td>
<td>Vegetable</td>
</tr>
<tr>
<td>2.</td>
<td>Soy</td>
<td>Dolichos lablab</td>
<td>Vegetable</td>
</tr>
<tr>
<td>3.</td>
<td>Enyo</td>
<td>Luffa aegyptica</td>
<td>Vegetable</td>
</tr>
<tr>
<td>4.</td>
<td>Terung/Egg plant</td>
<td>Solanum spp.</td>
<td>Vegetable</td>
</tr>
<tr>
<td>5.</td>
<td>Tomato</td>
<td>Solanum tuberosum</td>
<td>Vegetable</td>
</tr>
<tr>
<td>6.</td>
<td>Chilli</td>
<td>Capsicum spp.</td>
<td>Vegetable/spice/medicine</td>
</tr>
<tr>
<td>7.</td>
<td>Kencur/Grater galingale</td>
<td>Kaemferia galanga</td>
<td>Spice/medicine</td>
</tr>
<tr>
<td>8.</td>
<td>Kunyit/Tumeric</td>
<td>Curcuma domestica</td>
<td>Spice/medicine</td>
</tr>
<tr>
<td>9.</td>
<td>Jahe/Ginger</td>
<td>Zingiber officinale</td>
<td>Spice/medicine</td>
</tr>
<tr>
<td>10.</td>
<td>Laos/Galingale</td>
<td>Pterodica indica</td>
<td>Spice/medicine</td>
</tr>
<tr>
<td>11.</td>
<td>Kecibeling</td>
<td>Sericoclyx cripus</td>
<td>Hedge plant/medicine</td>
</tr>
<tr>
<td>12.</td>
<td>Beluntas/Kind of gardenia</td>
<td>Pluchea indica</td>
<td>Ornament/medicine</td>
</tr>
<tr>
<td>13.</td>
<td>Kums Kucing/Herb with diuretic properties</td>
<td>Orthosiphon aristatus</td>
<td>Ornament/medicine</td>
</tr>
<tr>
<td>14.</td>
<td>Hibiscus</td>
<td>Hibiscus sp.</td>
<td>Food/fodder</td>
</tr>
<tr>
<td>15.</td>
<td>Cassava</td>
<td>Manihot utilissima</td>
<td>Food/fodder</td>
</tr>
<tr>
<td>16.</td>
<td>T a r o</td>
<td>Colocasia esculenta</td>
<td>Food/fodder</td>
</tr>
<tr>
<td>17.</td>
<td>Sweet potato</td>
<td>Ipomoea batatas</td>
<td>Fruit/Food</td>
</tr>
<tr>
<td>18.</td>
<td>Banana</td>
<td>Musa paradisiaca</td>
<td>Fruit</td>
</tr>
<tr>
<td>19.</td>
<td>Papaya</td>
<td>Carica papaya</td>
<td>Fruit</td>
</tr>
<tr>
<td>20.</td>
<td>Mango</td>
<td>Mangifera indica</td>
<td>Fruit</td>
</tr>
<tr>
<td>21.</td>
<td>Rambutan/Nephelium</td>
<td>Nephelium lispacenum</td>
<td>Fruit</td>
</tr>
<tr>
<td>22.</td>
<td>Duku/Lanseh tree</td>
<td>Lancium domesticum</td>
<td>Fruit</td>
</tr>
<tr>
<td>23.</td>
<td>Avocado</td>
<td>Persea americana</td>
<td>Fruit</td>
</tr>
<tr>
<td>24.</td>
<td>Jambu Air/Rose-apple</td>
<td>Eugenia aquae</td>
<td>Fruit</td>
</tr>
<tr>
<td>25.</td>
<td>Jambu Batu/Candle nut</td>
<td>Psidium guajava</td>
<td>Fruit</td>
</tr>
</tbody>
</table>
Table 3.8. Types of Yard Plant in Area of Study (continued)

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Plant</th>
<th>Latin Name</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.</td>
<td>Kemiri/Candlenut</td>
<td>Aleurites molucca</td>
<td>fruit/spice</td>
</tr>
<tr>
<td>27.</td>
<td>Coconut</td>
<td>Cocos nucifera</td>
<td>fruit/timber</td>
</tr>
<tr>
<td>28.</td>
<td>Mangga/Jackfruit</td>
<td>Artocarpus integrifolius</td>
<td>fruit/timber</td>
</tr>
<tr>
<td>29.</td>
<td>Soursop</td>
<td>Annona muricata</td>
<td>fruit</td>
</tr>
<tr>
<td>30.</td>
<td>Citrus fruit</td>
<td>Citrus sp.</td>
<td>fruit</td>
</tr>
<tr>
<td>31.</td>
<td>Durian</td>
<td>Durio zibethinus</td>
<td>fruit</td>
</tr>
<tr>
<td>32.</td>
<td>Pineapple</td>
<td>Ananas comosus</td>
<td>fruit</td>
</tr>
<tr>
<td>33.</td>
<td>Coffee</td>
<td>Coffee sp.</td>
<td>flower</td>
</tr>
<tr>
<td>34.</td>
<td>Clove</td>
<td>Eugenia aromatica</td>
<td>fruit</td>
</tr>
<tr>
<td>35.</td>
<td>Pepper</td>
<td>Piper nigrum</td>
<td>fruit</td>
</tr>
<tr>
<td>36.</td>
<td>Cocos</td>
<td>Theobroma cacao</td>
<td>Fruit</td>
</tr>
<tr>
<td>37.</td>
<td>Petel/Pungent bean</td>
<td>Parkia speciosa</td>
<td>Fruit</td>
</tr>
<tr>
<td>38.</td>
<td>Jangkai/Larger pungent bean</td>
<td>Pithecolobium lobatum</td>
<td>Fruit</td>
</tr>
<tr>
<td>39.</td>
<td>Wsrw</td>
<td>Hibiscus sp.</td>
<td>Firewood</td>
</tr>
<tr>
<td>40.</td>
<td>Binttu</td>
<td>Hibiscus sp.</td>
<td>Firewood/medicine</td>
</tr>
<tr>
<td>41.</td>
<td>Petel cina</td>
<td>Leucaena sp.</td>
<td>Firewood/fodder</td>
</tr>
<tr>
<td>42.</td>
<td>Lamtoro</td>
<td>Leucaena sp.</td>
<td>Firewood/fodder</td>
</tr>
<tr>
<td>43.</td>
<td>Kaliandra</td>
<td>Cylindrella callothirns</td>
<td>Firewood</td>
</tr>
<tr>
<td>44.</td>
<td>Sengon</td>
<td>Faraserianthes falcataaria</td>
<td>Firewood</td>
</tr>
<tr>
<td>45.</td>
<td>Camai</td>
<td>Glaricidae</td>
<td>Firewood/fodder</td>
</tr>
<tr>
<td>46.</td>
<td>Pinang/Areca nut</td>
<td>Pinanga kuhli</td>
<td>Fruit/medicine</td>
</tr>
<tr>
<td>47.</td>
<td>Areca/Sugar palm</td>
<td>Arenga pinnata</td>
<td>Fruit/sugar</td>
</tr>
<tr>
<td>48.</td>
<td>Bamboo</td>
<td>Bambusa sp.</td>
<td>Multipurpose</td>
</tr>
</tbody>
</table>

a.2 Wet Rice Cultivation (Sawah)

Rice cultivation land in the Kecamatan of Sumber Jaya occupies an area of 2,417 ha or 5.80 % of the total area. A large part of the sawah land lies in the outskirts of the Wai Besai and Wai Tenung with simple irrigation (utilizing the available water sources such as spring water) and another part depends on rainwater for irrigation.

In some places, as in Sukajadi, Wai Petai, and Sukapura, part of the sawah land sometimes is flooded by the overflow of the Wai Besai in the rainy season. In general the sawah can be planted once or twice a year with an average production of 30 - 45 quintal/ha (1 quintal = 100 kg) per harvest.
a.3 Dry Cultivation (Ladang)

Tegalan/Ladang (dry cultivation) covers an area of 4,993 ha (12%). This vegetation occupies a flat area, inclined to very inclined plane (more than 45°) and is spread sporadically between the garden/estate and underbrush.

The ladang/tegalan vegetation is generally a combination of seasonal crops and perennial with different composition of types. The types of plants mostly found are presented in Table 3.9.

a.4 Private Plantation

The private plantation vegetation covers a quite large area, i.e. 10,449 ha (25.20%). It found in the area of the Kecamatan of Sumber Jaya form small holder’s estates with coffee as the main commodity. Smallholder’s coffee estate are generally found and land with a great inclination, even in an inclination of more than 100% (45°). In order to have a high production, the ground under the coffee trees is always cleared, usually by scraping. This scraping besides clearing the undergrowth, also destroys the surface structure, so as to aggravate erosion.

From the viewpoint of land and water conservation, this vegetation is of a damaging character.

a.5 Bushes

Bushes vegetation occupies an area of 3,221 ha (7.8 %) and is seemingly a former site of ladang or coffee estate left and abandoned by the owner. In the bushes sometimes forest plants or other perennial are found growing solitair. In addition, often some coffee plants are found which spreadly wild, or neglected. The spread of bushes vegetation is almost even, one connected to each other, so as to give an impression of vastness, from the valleys, river banks to mountain slopes. The vegetation is dense with a quite high diversity (covering tress, shrubs, bushes, grasses, and ferns), Table 3.10.
Table 3.9. Types of Major Plant Much Grown in Ladang/Tegalan (Dry Cultivation) in Area of Study

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Plant</th>
<th>Scientific Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Padi Cogo (Rice from dry Cultivation)</td>
<td>Oryza Sativa</td>
<td>Food</td>
</tr>
<tr>
<td>2.</td>
<td>Maize</td>
<td>Zea mays</td>
<td>Food/fodder</td>
</tr>
<tr>
<td>3.</td>
<td>Cassava</td>
<td>Manihot utilisissima</td>
<td>Food/fodder</td>
</tr>
<tr>
<td>4.</td>
<td>Sweet Potato</td>
<td>Ipomoea batatas</td>
<td>Food</td>
</tr>
<tr>
<td>5.</td>
<td>Taro</td>
<td>Colocasia esculenta</td>
<td>Food</td>
</tr>
<tr>
<td>6.</td>
<td>Ganyong</td>
<td>Canna edulis</td>
<td>Food</td>
</tr>
<tr>
<td>7.</td>
<td>Kunyit/Tumeric</td>
<td>Curcuma domestica</td>
<td>Spice/medicine</td>
</tr>
<tr>
<td>8.</td>
<td>Serem/Citronella</td>
<td>Zingiber Officinale *</td>
<td>Spice/medicine</td>
</tr>
<tr>
<td>9.</td>
<td>Jahe/Ginger</td>
<td>Luctura indica</td>
<td>Spice/medicine</td>
</tr>
<tr>
<td>10.</td>
<td>Laos/Galingale</td>
<td>Kaemferia sp</td>
<td>Spice/medicine</td>
</tr>
<tr>
<td>11.</td>
<td>Kencur/Greater galangale</td>
<td>Solarum sp</td>
<td>Vegetable</td>
</tr>
<tr>
<td>12.</td>
<td>Terung/Egg Plant</td>
<td>Solarum sp</td>
<td>Vegetable</td>
</tr>
<tr>
<td>13.</td>
<td>Tomato</td>
<td>Capsium spp</td>
<td>Vegetable</td>
</tr>
<tr>
<td>14.</td>
<td>Chili</td>
<td>Arachis hypogaea</td>
<td>Vegetable</td>
</tr>
<tr>
<td>15.</td>
<td>Peanut</td>
<td>Cucumis sativus</td>
<td>Vegetable</td>
</tr>
<tr>
<td>16.</td>
<td>Cucumber</td>
<td>Luffa aegyptica</td>
<td>Vegetable</td>
</tr>
<tr>
<td>17.</td>
<td>Enes</td>
<td>Dolichia lablab</td>
<td>Vegetable</td>
</tr>
<tr>
<td>18.</td>
<td>Kecipir</td>
<td>Eugenia spp</td>
<td>Fruit</td>
</tr>
<tr>
<td>19.</td>
<td>Roay</td>
<td>Magnifera spp</td>
<td>Fruit</td>
</tr>
<tr>
<td>20.</td>
<td>Jambu/Rose apple</td>
<td>Nephelium lappaceum</td>
<td>Fruit</td>
</tr>
<tr>
<td>21.</td>
<td>Mango</td>
<td>Durelo zibethinus</td>
<td>Fruit</td>
</tr>
<tr>
<td>22.</td>
<td>Nangka/Jackfruit</td>
<td>Annona muricata</td>
<td>Fruit</td>
</tr>
<tr>
<td>23.</td>
<td>Rambutan/Nephelium</td>
<td>Citrus spp</td>
<td>Fruit</td>
</tr>
<tr>
<td>24.</td>
<td>Duku/Lanseh tree</td>
<td>Perssea americana</td>
<td>Fruit</td>
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<tr>
<td>25.</td>
<td>Durian</td>
<td>Carica papaya</td>
<td>Fruit</td>
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<tr>
<td>26.</td>
<td>Sourisop</td>
<td>Musa paradisiaca</td>
<td>Fruit</td>
</tr>
<tr>
<td>27.</td>
<td>Citrus fruit</td>
<td>Ananas comosus</td>
<td>Fruit/Pit</td>
</tr>
<tr>
<td>28.</td>
<td>Avocado</td>
<td>Coffea sp *)</td>
<td>Fruit/Pit</td>
</tr>
<tr>
<td>29.</td>
<td>Papaya</td>
<td>Eugenia aromatica *)</td>
<td>Flower</td>
</tr>
<tr>
<td>30.</td>
<td>Banana</td>
<td>Theobroma cacao</td>
<td>Fruit/Pit</td>
</tr>
<tr>
<td>31.</td>
<td>Pineapple</td>
<td>Piper nigrum *)</td>
<td>Fruit/Pit</td>
</tr>
<tr>
<td>32.</td>
<td>Coffee</td>
<td>Faraseraianthes falcataaria</td>
<td>Fruit</td>
</tr>
<tr>
<td>33.</td>
<td>Clove</td>
<td>Alerites moluccana</td>
<td>Fruit</td>
</tr>
<tr>
<td>34.</td>
<td>Cocoa</td>
<td>Arenga pinnata</td>
<td>Sugar/fruit/fiber</td>
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<td>35.</td>
<td>Pepper</td>
<td>Arenga pinnata</td>
<td>Construction wood</td>
</tr>
<tr>
<td>36.</td>
<td>Sengon</td>
<td>Leucania glacera</td>
<td>Construction wood</td>
</tr>
<tr>
<td>37.</td>
<td>Kemiri/Candlenut</td>
<td>Acacia sp</td>
<td>Construction wood</td>
</tr>
<tr>
<td>38.</td>
<td>Aren/Sugar Palm</td>
<td>Gliricidia sp</td>
<td>Construction wood</td>
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<td>39.</td>
<td>Manil</td>
<td>Eribrina sp</td>
<td>Shadow tree</td>
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<td>40.</td>
<td>Lamtoro</td>
<td>Swietenia sp</td>
<td>Construction wood</td>
</tr>
<tr>
<td>41.</td>
<td>Acacia</td>
<td>Tectona grandis *)</td>
<td>Construction wood</td>
</tr>
<tr>
<td>42.</td>
<td>Gomel</td>
<td>Caliandra callothrustus</td>
<td>Construction wood</td>
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<tr>
<td>43.</td>
<td>Dadap</td>
<td>Babusa sp</td>
<td>Multi purpose</td>
</tr>
<tr>
<td>44.</td>
<td>Mahogany</td>
<td>Dendrocalamus sp</td>
<td>Multi purpose</td>
</tr>
<tr>
<td>45.</td>
<td>Cinromon</td>
<td>Caliandra callothrustus</td>
<td>Multi purpose</td>
</tr>
<tr>
<td>46.</td>
<td>Jeti/Teak Wood</td>
<td>Tectona grandis *)</td>
<td>Multi purpose</td>
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<td>47.</td>
<td>Kaliandra</td>
<td>Caliandra callothrustus</td>
<td>Multi purpose</td>
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<td>48.</td>
<td>Bamboo</td>
<td>Caliandra callothrustus</td>
<td>Multi purpose</td>
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<tr>
<td>49.</td>
<td>Bamboo</td>
<td>Caliandra callothrustus</td>
<td>Multi purpose</td>
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*) of high economic value
Table 3.10  Types of Plant Found in Underbrush In the Area of Study

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<th>No.</th>
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<th>IV *1</th>
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<tbody>
<tr>
<td>1.</td>
<td>Beringin/Banyan tree</td>
<td>Ficus Benyamica</td>
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<tr>
<td>2.</td>
<td>Kiclat</td>
<td>Ficus sepitica</td>
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<tr>
<td>3.</td>
<td>Kihampelas</td>
<td>Ficus amelas</td>
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<tr>
<td>4.</td>
<td>Kemiri/Candlenut</td>
<td>Alurites moluccana</td>
<td>17.39</td>
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<tr>
<td>5.</td>
<td>Sengor</td>
<td>Paraserianthes falcatoria</td>
<td>4.34</td>
<td></td>
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<tr>
<td>6.</td>
<td>Kluiw/Breadfruit</td>
<td>Arthocarpus comune</td>
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<td>7.</td>
<td>Bayur</td>
<td>Pterosperum javanicum</td>
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<tr>
<td>8.</td>
<td>Laban</td>
<td>Vitex pebesca</td>
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<td>9.</td>
<td>Coffee</td>
<td>Coffea sp.</td>
<td>19.56</td>
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<td>10.</td>
<td>Kiriinguh</td>
<td>Euphororium inulifolium</td>
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<td>11.</td>
<td>Saliara</td>
<td>Lantana camara</td>
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<td>12.</td>
<td>Karendong</td>
<td>Malatoma malabathricum</td>
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<td>Temus</td>
<td>Achaescocinnun sp</td>
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<td>Putri malu</td>
<td>Mimosa pudica</td>
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<td>Mimosa invisa</td>
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<td>16.</td>
<td>Alang-alang/Tall grass</td>
<td>Imperatie cylindrica</td>
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</tr>
<tr>
<td>17.</td>
<td>Jukut paat</td>
<td>Anonopus comresus</td>
<td>6.51</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Gtagah/Wild sugarcanes</td>
<td>Saccharum spontaneum</td>
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<tr>
<td>19.</td>
<td>Mikania</td>
<td>Nicotia sp</td>
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<td>Babedutan</td>
<td>Ageratum coryzoides</td>
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<td>Ferma</td>
<td>Nepheolepis exaltata</td>
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<td>22.</td>
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<td>Pteris ensi formis</td>
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<td>23.</td>
<td>Ferma</td>
<td>Stenochlaena palustris</td>
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</table>

*) IV (Important Value), counted on the basis of RF (Relative Frequency) - RD (Relative Density)

a.6 Forest

Forest vegetation occupies the most extensive area, i.e. 17.412 ha (41.9%) of the area of the Kecamatan of Sumber Jaya. From the viewpoint of its function, the forest is sub-divided into two groups, i.e. the South Bukit Barisan National Park and Reserved Forest. The Reserved Forest is recorded in Register 45 B of Wai Tenung.

In the village of Tambak Jaya a private forest is found of about 300 ha and the people managing the forest has been given the Kalpataru Award (1987) for their outstanding performance in the preservation of the forest. The detailed data on the types of plant growing in the primary and secondary forest area in the area of study are presented respectively in Table 3.11 and 3.12.
<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Plant</th>
<th>Latin Name</th>
<th>I VI</th>
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<tr>
<td>1.</td>
<td>Kayu Pasang</td>
<td>Quercus sp.</td>
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<td>Hedang</td>
<td>Aliseodaphne sp.</td>
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<td>Sungkai</td>
<td>Peronema canescens</td>
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<td>Keruing</td>
<td>Dipterocarpus sp.</td>
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<td>Kemang/Merantai</td>
<td>Anisoptera sp.</td>
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<td>7.</td>
<td>Meranti/Merantai</td>
<td>Shorea sp.</td>
<td>15.61</td>
</tr>
<tr>
<td>8.</td>
<td>Sungkai</td>
<td>Peronema canescens</td>
<td>4.90</td>
</tr>
<tr>
<td>9.</td>
<td>Kelau</td>
<td>Shorea superaniana</td>
<td>5.32</td>
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<tr>
<td>10.</td>
<td>Haru</td>
<td>Schima sp.</td>
<td>15.61</td>
</tr>
<tr>
<td>11.</td>
<td>Durian</td>
<td>Durio sp.</td>
<td>5.38</td>
</tr>
<tr>
<td>12.</td>
<td>Kemuning/ Yellow wood tree</td>
<td>Shorea superaniana</td>
<td>3.42</td>
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<tr>
<td>13.</td>
<td>Black</td>
<td>Ptery-pernum javanicum</td>
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<td>14.</td>
<td>Bayur</td>
<td>Calophyllum sp.</td>
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<tr>
<td>15.</td>
<td>Hyampung</td>
<td>Lagerstroemia sp.</td>
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<td>Dryobalanops sp.</td>
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<tr>
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<td>Kapur</td>
<td>Canarium sp.</td>
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<tr>
<td>18.</td>
<td>Canari</td>
<td>S Stercia sp.</td>
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<td>Hatoa</td>
<td>Eugenia sp.</td>
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<td>Gelam</td>
<td>Shorea superaniana</td>
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<tr>
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<td>Beringin/Banyan tree</td>
<td>Ficus benjamina</td>
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<td>Zityphus sp.</td>
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<td>Anthoccephalus cadamba</td>
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<td>Manggis/Hangsteen</td>
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<tr>
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<td>Sawa</td>
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<td>Lanclum spp.</td>
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**Table 3.11.** Types and Important value Index (I VI) of Forest Plant and Vegetation Indigenous in the Area of Study

**I VI = Important Value Index**
Table 3.11. Types and Important value Index (IVI) of Forest Plant and Vegetation Indigenous in the Area of Study (continued)

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<td>Lancium sp.</td>
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<td>Alstonia schoris</td>
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<td>Sondoricum Murrays paniculata</td>
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<td>Murrays paniculata</td>
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<td>Casuarina sp.</td>
<td>28.70</td>
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<td>Pepper</td>
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Table 3.11. Types and Important value Index (IVI) of Forest Plant and Vegetation indigenous in the Area of Study (continued)

<table>
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<td>Plectronia gleba</td>
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<td>Gliek</td>
<td>Shorea sp.</td>
<td>26.92</td>
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<tr>
<td>6.</td>
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<td>Dillenia sp.</td>
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<td>Calamus sp.</td>
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</tr>
<tr>
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<td>Pulai</td>
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<td>Anisopera sp.</td>
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<td>Ficus ampeles</td>
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<td>Kereling</td>
<td>Diperocarpus sp.</td>
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<td>Cemara/Casuarine tree</td>
<td>Casuarina sp.</td>
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<td>Sondericum rutjape</td>
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<td>Sirih hutan/Wild betel</td>
<td>Piper retrofactum *)</td>
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<td>Pakufern</td>
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<td>33.</td>
<td>Paceing</td>
<td>Costus specious *)</td>
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*) Undergrowth
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<td>Johar</td>
<td>Casia siamea</td>
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<td>Wild kedondong</td>
<td>Spondias dulcis</td>
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<td>4</td>
<td>Kemiri/Candlenut</td>
<td>Aleurites moluccana</td>
<td>21.39</td>
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<td>Pulai</td>
<td>Alstonia scholaris</td>
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<td>8</td>
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<td>Durio zibethinis</td>
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<td>Marsaw</td>
<td>Anisoptera sp.</td>
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<td>Pithocollodium labatum</td>
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<td>Farasarlanthes faicaefaria</td>
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<td>21</td>
<td>Petal/Pungent bean</td>
<td>Parkia speciosa</td>
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<tr>
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<td>Randu/Silk-cotton tree</td>
<td>Ceiba pentandra</td>
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<td>23</td>
<td>Jatob</td>
<td>Antidesma bunius</td>
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<tr>
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<td>Meranti/Morante</td>
<td>Shores sp.</td>
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<td>Lancium sp.</td>
<td>1.69</td>
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<tr>
<td>28</td>
<td>Jambu/Rose-apple</td>
<td>Eugenia jambolana</td>
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<tr>
<td>29</td>
<td>Cemara/Casuarina tree</td>
<td>Casuarina sp.</td>
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<td>Pangi</td>
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<td>Kiara</td>
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<td>33</td>
<td>Wild rambutan</td>
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**Pole Level**

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<td>Ficus sp.</td>
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<tr>
<td>14.</td>
<td>Jambu/Rose-apple</td>
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<tr>
<td>18.</td>
<td>Beringin/Banyan tree</td>
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<tr>
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<td>Casuarina tree</td>
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Table 3.12. Types and Important value index (IVI) of Secondary Forest Vegetation in the Area of Study (continued)

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<tr>
<td>3.</td>
<td>Alang-alam/Tall grass *)</td>
<td>Imperata cylindrica</td>
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<tr>
<td>4.</td>
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<td>Helostoma malabathricum</td>
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<td>5.</td>
<td>Harendong bulu **)</td>
<td>Clidemia hyrs</td>
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<td>Ficus sp.</td>
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<td>Banana</td>
<td>Musa sp.</td>
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<td>8.</td>
<td>Pacing</td>
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<td>Jambu/Guava</td>
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<td>Paspalum conjugatum *)</td>
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<td>Saccharum spontaneum *)</td>
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<td>Helostoma sp. *)</td>
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<td>Tapak liman</td>
<td>Elephantopus scaber *)</td>
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<td>Ipomoea sp. *)</td>
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<td>Pakis wiles</td>
<td>Dipsaziun sp. *)</td>
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<td>Pulutan</td>
<td>Urena lobata *)</td>
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<td>Babadatan</td>
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<td>Pandanus sp. *)</td>
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<td>Jukutjut</td>
<td>Himose invisa *)</td>
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</table>

*) Undergrowth
**) Counted according to RF + RD

b. Fauna

b.1 Wild animals

From the information collected, the wild animals of the area of the Kecamatan of Sumber Jaya consist of 20 species of mammals, 9 species of reptilians, and 10 species of birds (aves). These animals generally live in the forest, underbrush, agricultural field (ladang), and on the banks of Wai Besai. Among these animals some are protected by law. The wild animals found in the area of study can be seen in the Table 3.13 and those found in the planned location of the project on Table 3.14.

By comparing Table 3.13 with Table 3.14 and based on the formula of Sorensen, it is known that similarly index of mammals is 0.46, reptilians 1, and birds 0.66. Whereas the similarity index of all wild animal species in total is 0.7.
### Table 3.13. Wild Animal Found in Kecamatan Sumber Jaya

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<thead>
<tr>
<th>No.</th>
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<td>Fo, RB</td>
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<tr>
<td>2.</td>
<td>Monkey</td>
<td>Macaca sp.*</td>
<td>a</td>
<td>Fo, RB</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Hog/Wild boar</td>
<td>Sus sp.</td>
<td>b</td>
<td>Fo, Bu, Fi</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Tiger</td>
<td>Panthera tigris sumatrensis*</td>
<td>a</td>
<td>Fo, RB</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Beruk/Macaque</td>
<td>Macaca sp.*</td>
<td>a</td>
<td>Fo, RB</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Kijang/Kind of small antelope</td>
<td>Ruthicus muncak</td>
<td>a</td>
<td>Bu, Th</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Deer</td>
<td>Cervus sp.</td>
<td>a</td>
<td>Fo, Th</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Wild goat</td>
<td>Capricornus sumatrensis*</td>
<td>a</td>
<td>Fo, Bu</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Kancil/Mouse deer</td>
<td>Tragulus javanicus*</td>
<td>a</td>
<td>Fo, Bu</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Tapir</td>
<td>Tapirus indicus*</td>
<td>a</td>
<td>Fo</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Bear</td>
<td>Helarctus malayanus*</td>
<td>a</td>
<td>Fo, Th</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Water civet</td>
<td>Cynogale bennettii*</td>
<td>a</td>
<td>RB</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Scaly ant eater</td>
<td>Hystrix javanicus*</td>
<td>a</td>
<td>Fo, Bu, Th</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Sipung</td>
<td>Hystrix brachyura*</td>
<td>a</td>
<td>Fo, Bu, RB</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Porcupine</td>
<td>Neofelis nebulosa*</td>
<td>a</td>
<td>SF, Bu</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Macan akar</td>
<td>Lariscus insignis*</td>
<td>b</td>
<td>RR, Sa</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Otter</td>
<td>Varanus salvator</td>
<td>a</td>
<td>RB</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Ground squirrel</td>
<td>Python reticulatus*</td>
<td>a</td>
<td>RB</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Flying squirrel</td>
<td>Pytes muscosus</td>
<td>a</td>
<td>Sw, RB</td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Tree squirrel</td>
<td>Dryophis prasinus</td>
<td>a</td>
<td>Bu, Fo, RB</td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>Blauak/monitor lizard</td>
<td>Ophidhus hannah*</td>
<td>a</td>
<td>Ft, RB</td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Python</td>
<td>Bungarus fasciatus*</td>
<td>a</td>
<td>RB</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Keros snake</td>
<td>Bungarus candidus*</td>
<td>a</td>
<td>RB</td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>Tree snake</td>
<td>Habouya multifasciata</td>
<td>b</td>
<td>RR, Sa</td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td>Totog snake</td>
<td>Gallus gallus*</td>
<td>b</td>
<td>Bu, SF</td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td>Welang snake</td>
<td>Buceros sp.*</td>
<td>a</td>
<td>Fo</td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>Welang snake</td>
<td>Stroptopelia cinensis*</td>
<td>b</td>
<td>SF, Fi</td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td>Welang snake</td>
<td>Oriolus danensis</td>
<td>a</td>
<td>Fo, Th</td>
<td></td>
</tr>
<tr>
<td>29.</td>
<td>Turtle</td>
<td>Geopelia striata</td>
<td>a</td>
<td>Fo, Th</td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td>Lizard</td>
<td>Gallus gallus*</td>
<td>a</td>
<td>Fo</td>
<td></td>
</tr>
<tr>
<td>31.</td>
<td>Rankong/Hornbill</td>
<td>Lonchura javanica</td>
<td>a</td>
<td>Bu, Fi</td>
<td></td>
</tr>
<tr>
<td>32.</td>
<td>Belib’s/Teal</td>
<td>Loxura fasciatus</td>
<td>b</td>
<td>Sa, Bu, Es</td>
<td></td>
</tr>
<tr>
<td>33.</td>
<td>Tekukur/Turtule dove</td>
<td>Sphenomis complanatus*</td>
<td>a</td>
<td>Fo, Th</td>
<td></td>
</tr>
<tr>
<td>34.</td>
<td>Binangur</td>
<td>Hirundo tahitica</td>
<td>b</td>
<td>Sa, Bu, Es</td>
<td></td>
</tr>
<tr>
<td>35.</td>
<td>Titiiran</td>
<td>Gallus gallus*</td>
<td>b</td>
<td>Bu, SF</td>
<td></td>
</tr>
<tr>
<td>36.</td>
<td>Puyuh/Quail</td>
<td>Gallus gallus*</td>
<td>b</td>
<td>Bu, SF</td>
<td></td>
</tr>
<tr>
<td>37.</td>
<td>Pipit/Sparrow</td>
<td>Spilornis complanatus*</td>
<td>a</td>
<td>Fo, Th</td>
<td></td>
</tr>
<tr>
<td>38.</td>
<td>Elang/Eagle</td>
<td>Gallus gallus*</td>
<td>b</td>
<td>Sa, Bu, Es</td>
<td></td>
</tr>
<tr>
<td>39.</td>
<td>Bondol</td>
<td>Gallus gallus*</td>
<td>b</td>
<td>Sa, Bu, Es</td>
<td></td>
</tr>
</tbody>
</table>

| *: | Protected | Fo: | Forest | Sa: | Sawah | RB: | River Bank |
| Ab: | Abundance | Bu: | Bush | Fi: | Field | SF: | Secondary Forest |
| a: | scarce | Th: | Thicket | Es: | Estate | FT: | Forest Tree |
| b: | abundant | |

#### b.2 Domestic Animals

Domestic animals much raised by the local people are chicken (Gallus sp.), goat (Capra hircus), sheep (Boven sp.), and water buffalo (Bubalus sp.). Other domestic/pet animals are cat (Felis sp.), bird, and dog (Cuon sp.). Many of the population of Sumber Jaya keeps dogs as a “guard” when going to the field or as a helper when hunting.
Table 3.14. Wild Animal Found in around Project Location

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Animal</th>
<th>Latin name</th>
<th>Ab</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Siamang/Gibbon</td>
<td>Hylobates syndactilus*</td>
<td>a</td>
<td>Fo, RB</td>
</tr>
<tr>
<td>2.</td>
<td>Monkey</td>
<td>Macaca sp.*</td>
<td>a</td>
<td>Fo, RB</td>
</tr>
<tr>
<td>3.</td>
<td>Hog/Wild boar</td>
<td>Sus sp.</td>
<td>b</td>
<td>Fo, Sa, F1</td>
</tr>
<tr>
<td>4.</td>
<td>Water civet</td>
<td>Cynopelis bennetti*</td>
<td>a</td>
<td>RB</td>
</tr>
<tr>
<td>5.</td>
<td>Porcupine</td>
<td>Histrus brachyura*</td>
<td>a</td>
<td>Fo, Bu, RB</td>
</tr>
<tr>
<td>6.</td>
<td>Otter</td>
<td></td>
<td>b</td>
<td>Sa, RB</td>
</tr>
<tr>
<td>7.</td>
<td>Bawak/ Monitor lizard</td>
<td>Varanus salvator</td>
<td>a</td>
<td>RB</td>
</tr>
<tr>
<td>8.</td>
<td>Python</td>
<td>Python reticulatus*</td>
<td>b</td>
<td>RB</td>
</tr>
<tr>
<td>9.</td>
<td>Koros snake</td>
<td>Ptyas mucosus</td>
<td>a</td>
<td>Sa, RB</td>
</tr>
<tr>
<td>10.</td>
<td>Totog snake</td>
<td>Ophiophagus hannah*</td>
<td>a</td>
<td>FT, RB</td>
</tr>
<tr>
<td>11.</td>
<td>Welang snake</td>
<td>Bungarus fasciatus*</td>
<td>a</td>
<td>RB</td>
</tr>
<tr>
<td>12.</td>
<td>Weling snake</td>
<td>Bungurus candidus*</td>
<td>b</td>
<td>RB</td>
</tr>
<tr>
<td>13.</td>
<td>Turtle</td>
<td></td>
<td>a</td>
<td>RB</td>
</tr>
<tr>
<td>14.</td>
<td>Lizard</td>
<td>Mabouya multifascilata</td>
<td>b</td>
<td>RB, Sa</td>
</tr>
<tr>
<td>15.</td>
<td>Jungle fowl</td>
<td>Gallus gallus*</td>
<td>b</td>
<td>SF, Bu</td>
</tr>
<tr>
<td>16.</td>
<td>Belibs/Teal</td>
<td></td>
<td>a</td>
<td>Sa</td>
</tr>
<tr>
<td>17.</td>
<td>Tekukur/Turtledove</td>
<td>Strotopelia cinemastregina</td>
<td>b</td>
<td>SF, FI</td>
</tr>
<tr>
<td>18.</td>
<td>Puyuh/Guail</td>
<td>Casturnix javanica</td>
<td>a</td>
<td>Sa, FI</td>
</tr>
<tr>
<td>19.</td>
<td>Piplu/Sparrow</td>
<td>Lonchura leucogastroides</td>
<td>b</td>
<td>Sa, Bu, Es</td>
</tr>
<tr>
<td>20.</td>
<td>Bondol</td>
<td>Hirundo tahitica</td>
<td>b</td>
<td>Sa, Bu, Es</td>
</tr>
</tbody>
</table>

* : Protected  Fo : Forest  Sa : Sawah  RB : River Bank
Ab : Abundance  Bu : Bush  F1 : Field  SF : Secondary Forest
a : scarce  Th : Thicket  Es : Estate  FT : Forest Tree
b : abundant  

(2) Aquatic Biota

a. Fish

Types of fish found in the Wai Besai, according to information from the people, are ikan semah (kind of goldfish), catfish (Clarias batrachus), gabus/snakehead (Ophiocephalus gachua), keting, baung, wader, sisili, gurami, goldsifh (Cyprinus carpio), tawes (Ophinitius javanicus), mujair (Tilapia mosambica), and ikan nila (Tilapia nilotica). None of them are endanger nor of migratory species.

b. Aquatic Weeds

Some types of Aquatic weeds inventoried are: kayambang (Salvinia molesta), genjer (Limnocharis flava), eceng lembut (Monochoria vaginalis), semanggi (Marsilea crenata), and teki sawah (Cyperus sp.). These plants live as weeds in the sawah. Other plants are kangkung (Ipomoea aquatica) and kakangkungan (I. fistulosa) living on the shallow banks of calmly streaming rivers.
3.3 Socio-Economic and Socio-Cultural

3.3.1. Socio-Economic

(1) Demography

The population of the Kecamatan of Sumber Jaya are originated from West Java, Central Java, South Sumatra (Samendo and Ogan), and Lampung (from Krui and Liwa). In board outline, the population coming from West Java (Sundanese) are 55%, Central Java 12%, Samendo and Ogan 27%, and others 2% of the total population.

The number of population is 78,567. An agrarian density = 78,569/19,662 = 3,999 population/ha (399.9 population/km²) and a geographical density = 78,567/41,500 = 1.89 population/ha (189 population/km²). The number of population of each village can be seen in Table 3.15 and the number of population according to age group in the villages directly affected by the Project (Sukapura, Way Petai, and Dwikora) can be seen in Table 3.16.

Table 3.15. Number of Population of Kecamatan of Sumber Jaya

<table>
<thead>
<tr>
<th>No.</th>
<th>Village</th>
<th>Population</th>
<th>&lt; 12 yr</th>
<th>12-15 yr</th>
<th>&gt; 55 yr</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>1</td>
<td>Purawiwiti</td>
<td>1,055</td>
<td>1,002</td>
<td>1,887</td>
<td>1,933</td>
<td>252</td>
</tr>
<tr>
<td>2</td>
<td>Simpangsanri</td>
<td>1,789</td>
<td>1,610</td>
<td>2,504</td>
<td>2,610</td>
<td>51</td>
</tr>
<tr>
<td>3</td>
<td>Sukapura</td>
<td>265</td>
<td>352</td>
<td>760</td>
<td>703</td>
<td>122</td>
</tr>
<tr>
<td>4</td>
<td>Puralaksana</td>
<td>564</td>
<td>592</td>
<td>615</td>
<td>467</td>
<td>144</td>
</tr>
<tr>
<td>5</td>
<td>Muara Jaya</td>
<td>444</td>
<td>445</td>
<td>1,535</td>
<td>1,546</td>
<td>123</td>
</tr>
<tr>
<td>6</td>
<td>Suka Menanti</td>
<td>427</td>
<td>324</td>
<td>1,445</td>
<td>1,437</td>
<td>32</td>
</tr>
<tr>
<td>7</td>
<td>Suka Jaya</td>
<td>343</td>
<td>269</td>
<td>552</td>
<td>583</td>
<td>33</td>
</tr>
<tr>
<td>8</td>
<td>Gunung Terang</td>
<td>264</td>
<td>244</td>
<td>434</td>
<td>434</td>
<td>64</td>
</tr>
<tr>
<td>9</td>
<td>Suka Raya</td>
<td>196</td>
<td>183</td>
<td>722</td>
<td>557</td>
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</tr>
<tr>
<td>10</td>
<td>Way Petai</td>
<td>685</td>
<td>832</td>
<td>856</td>
<td>1,123</td>
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<tr>
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<td>Pusat Alam</td>
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<td>733</td>
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<td>1,435</td>
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<td>377</td>
<td>337</td>
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<td>Pedang Tambak</td>
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<td>676</td>
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<td>735</td>
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<td>Tanjung Raya</td>
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<td>634</td>
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<td>17</td>
<td>Sindang Raya</td>
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<td>501</td>
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<tr>
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<tr>
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<td>Purw Nekar</td>
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<td>575</td>
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<td>1,133</td>
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<tr>
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<td>Tambak Jaya</td>
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<td>200</td>
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<td>Cipta Maras</td>
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<td>267</td>
<td>451</td>
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<tr>
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<td>Tri Mulia</td>
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<td>231</td>
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<td>967</td>
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<td>102</td>
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<td>223</td>
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<td>Semarang Jaya</td>
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<td>474</td>
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<td>Sidodadi</td>
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<td>72</td>
<td>416</td>
<td>525</td>
<td>11</td>
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<td>164</td>
<td>129</td>
<td>444</td>
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<td><strong>Total</strong></td>
<td></td>
<td>11,816</td>
<td>11,724</td>
<td>26,060</td>
<td>25,493</td>
<td>1,678</td>
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</table>

*1 Village development: Muara Jaya Dua

ENVIRONMENTAL IMPACT ASSESSMENT-BESAI HPP
Table 3.16. Number of Population According to Age group

<table>
<thead>
<tr>
<th>Age Group (Year)</th>
<th>M</th>
<th>F</th>
<th>Total</th>
<th>M</th>
<th>F</th>
<th>Total</th>
<th>M</th>
<th>F</th>
<th>Total</th>
</tr>
</thead>
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<td>100</td>
<td>203</td>
<td>137</td>
<td>101</td>
<td>238</td>
<td>350</td>
<td>333</td>
<td>683</td>
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<tr>
<td>5 - 9</td>
<td>107</td>
<td>102</td>
<td>209</td>
<td>112</td>
<td>161</td>
<td>273</td>
<td>290</td>
<td>305</td>
<td>695</td>
</tr>
<tr>
<td>10 - 14</td>
<td>125</td>
<td>120</td>
<td>254</td>
<td>92</td>
<td>109</td>
<td>201</td>
<td>165</td>
<td>345</td>
<td>510</td>
</tr>
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<td>324</td>
<td>88</td>
<td>92</td>
<td>180</td>
<td>146</td>
<td>183</td>
<td>329</td>
</tr>
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<td>106</td>
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<td>61</td>
<td>69</td>
<td>130</td>
<td>131</td>
<td>163</td>
<td>294</td>
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<td>25 - 29</td>
<td>80</td>
<td>81</td>
<td>161</td>
<td>52</td>
<td>51</td>
<td>103</td>
<td>124</td>
<td>172</td>
<td>296</td>
</tr>
<tr>
<td>30 - 34</td>
<td>55</td>
<td>58</td>
<td>113</td>
<td>73</td>
<td>65</td>
<td>138</td>
<td>95</td>
<td>141</td>
<td>236</td>
</tr>
<tr>
<td>35 - 39</td>
<td>55</td>
<td>71</td>
<td>126</td>
<td>54</td>
<td>92</td>
<td>146</td>
<td>92</td>
<td>124</td>
<td>216</td>
</tr>
<tr>
<td>40 - 44</td>
<td>70</td>
<td>65</td>
<td>144</td>
<td>209</td>
<td>367</td>
<td>576</td>
<td>84</td>
<td>98</td>
<td>182</td>
</tr>
<tr>
<td>45 - 49</td>
<td>67</td>
<td>56</td>
<td>123</td>
<td>86</td>
<td>62</td>
<td>148</td>
<td>81</td>
<td>76</td>
<td>157</td>
</tr>
<tr>
<td>50 - 54</td>
<td>37</td>
<td>35</td>
<td>72</td>
<td>104</td>
<td>55</td>
<td>159</td>
<td>84</td>
<td>53</td>
<td>137</td>
</tr>
<tr>
<td>55 - 59</td>
<td>52</td>
<td>42</td>
<td>94</td>
<td>96</td>
<td>107</td>
<td>203</td>
<td>84</td>
<td>68</td>
<td>152</td>
</tr>
<tr>
<td>Total</td>
<td>595</td>
<td>595</td>
<td>1,190</td>
<td>2,038</td>
<td>2,038</td>
<td>4,076</td>
<td>2,900</td>
<td>2,900</td>
<td>5,800</td>
</tr>
</tbody>
</table>

Source: Potensi Desa (Village Potensi), 1989

The average rate of growth of the population in the area of study is 2.68% (Table 3.17)

Table 3.17. Population Growth

<table>
<thead>
<tr>
<th>No.</th>
<th>Year</th>
<th>Total</th>
<th>Growth (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1981</td>
<td>65,255</td>
<td>-0.53</td>
</tr>
<tr>
<td>2.</td>
<td>1982</td>
<td>64,907</td>
<td>1.9</td>
</tr>
<tr>
<td>3.</td>
<td>1983</td>
<td>66,131</td>
<td>1.4</td>
</tr>
<tr>
<td>4.</td>
<td>1984</td>
<td>67,055</td>
<td>5.5</td>
</tr>
<tr>
<td>5.</td>
<td>1985</td>
<td>70,779</td>
<td>6.7</td>
</tr>
<tr>
<td>6.</td>
<td>1986</td>
<td>75,589</td>
<td>1.2</td>
</tr>
<tr>
<td>7.</td>
<td>1987</td>
<td>76,519</td>
<td>2.6</td>
</tr>
<tr>
<td>8.</td>
<td>1988</td>
<td>78,567</td>
<td>18.77</td>
</tr>
</tbody>
</table>

Average 2.68

(2) Education

The level of education in the area of study is depicted by the sample villages investigated (Table 3.18), as follows: no school-education (NS) 16.29%, not passing Elementary School (NES) 27.67%, Elementary School (ES) 35.68%, Junior High School (JHS) 5.88%, Senior High School (SHS) 3.51%, Higher Education (HE) 0.50%, and illiterate (IL) 10.37%.
Table 3.18. Level of Education each Villages

<table>
<thead>
<tr>
<th>No.</th>
<th>Village</th>
<th>NS</th>
<th>NES</th>
<th>SHB</th>
<th>HE</th>
<th>IL</th>
<th>Population</th>
<th>HF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Sukapura</td>
<td>378</td>
<td>423</td>
<td>726</td>
<td>105</td>
<td>13</td>
<td>247</td>
<td>2,069</td>
</tr>
<tr>
<td>2.</td>
<td>Way Petal</td>
<td>962</td>
<td>748</td>
<td>1,500</td>
<td>300</td>
<td>100</td>
<td>62</td>
<td>74</td>
</tr>
<tr>
<td>3.</td>
<td>Dukora</td>
<td>244</td>
<td>17</td>
<td>468</td>
<td>159</td>
<td>63</td>
<td>7</td>
<td>1,137</td>
</tr>
<tr>
<td>4.</td>
<td>Tribudi Syukur</td>
<td>275</td>
<td>527</td>
<td>689</td>
<td>80</td>
<td>58</td>
<td>26</td>
<td>246</td>
</tr>
<tr>
<td>5.</td>
<td>Purawirtan</td>
<td>870</td>
<td>2,560</td>
<td>1,836</td>
<td>431</td>
<td>229</td>
<td>-</td>
<td>383</td>
</tr>
<tr>
<td>6.</td>
<td>Tanjung Raya</td>
<td>375</td>
<td>769</td>
<td>600</td>
<td>40</td>
<td>18</td>
<td>3</td>
<td>152</td>
</tr>
<tr>
<td>7.</td>
<td>Sukajaya</td>
<td>271</td>
<td>755</td>
<td>542</td>
<td>39</td>
<td>15</td>
<td>2</td>
<td>174</td>
</tr>
<tr>
<td>8.</td>
<td>Semarang Jaya</td>
<td>254</td>
<td>458</td>
<td>198</td>
<td>27</td>
<td>12</td>
<td>-</td>
<td>129</td>
</tr>
<tr>
<td>9.</td>
<td>Karang Agung</td>
<td>384</td>
<td>286</td>
<td>2,063</td>
<td>114</td>
<td>52</td>
<td>7</td>
<td>77</td>
</tr>
<tr>
<td>10.</td>
<td>Suka Raja</td>
<td>358</td>
<td>850</td>
<td>526</td>
<td>170</td>
<td>327</td>
<td>16</td>
<td>267</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4,366</td>
<td>7,403</td>
<td>9,566</td>
<td>1,575</td>
<td>941</td>
<td>136</td>
<td>2,866</td>
</tr>
</tbody>
</table>

AVERAGE 16.25 27.60 35.58 5.87 3.51 0.51 10.68 100

1) HF = Head of Family

(3) Employment categories

The result of data collection in 10 villages show that the main occupation of the population is as follows: farmer (88.33%), trader (2.22%), laborer (2.22%), and others (workshop, civil servant, driver, and other services) (7.23%).

Whereas the secondary means of support, or side jobs are: farmer 13.21%, trader 22.64%, laborer 37.73%, and others 26.43% as can be seen in Table 3.19.

Table 3.19. Main and Secondary Occupation in Area of Study

<table>
<thead>
<tr>
<th>Village</th>
<th>Main Farmer</th>
<th>Main Trader</th>
<th>Main Laborer</th>
<th>Others</th>
<th>Secondary Farmer</th>
<th>Secondary Trader</th>
<th>Secondary Laborer</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sukapura</td>
<td>23</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Way Petal</td>
<td>21</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dukora</td>
<td>17</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Tribudi Syukur</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Purawirtan</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>Tanjung Raya</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Sukajaya</td>
<td>13</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Semarang Jaya</td>
<td>15</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Karang Agung</td>
<td>10</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Suka Raja</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>159.00</td>
<td>4.00</td>
<td>4.00</td>
<td>13.00</td>
<td>7.00</td>
<td>12.00</td>
<td>20.00</td>
<td>14.00</td>
</tr>
<tr>
<td>Percentage</td>
<td>86.33</td>
<td>2.22</td>
<td>2.22</td>
<td>7.22</td>
<td>13.21</td>
<td>22.64</td>
<td>37.74</td>
<td>26.42</td>
</tr>
</tbody>
</table>

(4) Manpower Labor Potensial

The data on manpower are obtained by grouping the population according to age, i.e. productive manpower (age 10-55 years) and unproductive manpower (age less than 5 years and over 55 years). The data collected show that productive manpower accounts for 6.22% of the total population and unproductive manpower 32.78%. Unproductive manpower forms a burden for productive manpower with an average rate of dependability of 0.49 (as can be seen in Table 3.20).
Table 3.20. Ratio of Dependency According to Age of population

<table>
<thead>
<tr>
<th>No.</th>
<th>Village</th>
<th>Number of Population According to Age</th>
<th>Rate of Dependability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt; 10 year</td>
<td>10-55 year</td>
</tr>
<tr>
<td>1.</td>
<td>Suakpura</td>
<td>422</td>
<td>1541</td>
</tr>
<tr>
<td>2.</td>
<td>Wat Petai</td>
<td>1325</td>
<td>2330</td>
</tr>
<tr>
<td>3.</td>
<td>Dwikora</td>
<td>502</td>
<td>1425</td>
</tr>
<tr>
<td>4.</td>
<td>Tribud Syukur</td>
<td>480</td>
<td>1361</td>
</tr>
<tr>
<td>5.</td>
<td>Purawiletan</td>
<td>1629</td>
<td>4216</td>
</tr>
<tr>
<td>6.</td>
<td>Tanjungreya</td>
<td>427</td>
<td>1393</td>
</tr>
<tr>
<td>7.</td>
<td>Sukajaya</td>
<td>450</td>
<td>1300</td>
</tr>
<tr>
<td>8.</td>
<td>Semonang Jaya</td>
<td>327</td>
<td>709</td>
</tr>
<tr>
<td>9.</td>
<td>Karang Agung</td>
<td>537</td>
<td>2261</td>
</tr>
<tr>
<td>10.</td>
<td>Sukaraja</td>
<td>641</td>
<td>1473</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6,650</td>
<td>17,018</td>
<td>2,086</td>
</tr>
<tr>
<td><strong>Percentage</strong></td>
<td>24.95</td>
<td>67.22</td>
<td>7.83</td>
</tr>
</tbody>
</table>

Note: Dependency ratio = 

\[
\text{Dependency} = \frac{\text{<10yr> + 55yr}}{\text{10-54yr}}
\]

The dependency ratio is the number of unproductive population divided by the number of productive population. A ratio of 0.49 means that every 49 unproductive population become the dependents of 100 productive population. In the other words, one productive manpower assumes liability for 0.49 unproductive manpower.

(5) Settlement

In general, the settlement of the population is spread on the side of the (asphalted) highway, or at least can be reach by four-wheel motor vehicles.

The result of observation shows that no population settlement is found along the length of the river. This is indication that the pollution of the Way Besai caused by domestic waste is relatively small. The condition of housing of the population in the area of study can be seen in Table 3.21.

(6) Transportation Network

The provincial road connecting the city of Liwa and the city of Kotabumi pass the Kecamatan Sumberjaya. All villages in the Kecamatan of Sumber jaya can already be reached by four-wheel motor vehicles, although some villages are difficult to be passed by four-wheel vehicles in the rainy season.

The length and condition of the roads can be seen in the Table 3.22 and the number of motor vehicles and the distance from the village to the Kecamatan capital in Table 3.23. The condition of the road leading to Bukit and Kotabumi (district’s capital) is very good asphalted.
Table 3.21 Condition of Housing of the Population

<table>
<thead>
<tr>
<th>No.</th>
<th>Village</th>
<th>Permanent</th>
<th>Semi-permanent</th>
<th>Simple</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Simpangsiari</td>
<td>304</td>
<td>1,218</td>
<td>213</td>
<td>8</td>
<td>1,743.00</td>
</tr>
<tr>
<td>2</td>
<td>Sukapura</td>
<td>57</td>
<td>47</td>
<td>126</td>
<td>238</td>
<td>468.00</td>
</tr>
<tr>
<td>3</td>
<td>Way Petal</td>
<td>106</td>
<td>594</td>
<td>24</td>
<td>-</td>
<td>724.00</td>
</tr>
<tr>
<td>4</td>
<td>Suka Jaya</td>
<td>25</td>
<td>124</td>
<td>68</td>
<td>164</td>
<td>361.00</td>
</tr>
<tr>
<td>5</td>
<td>Sindang Pagar</td>
<td>10</td>
<td>305</td>
<td>8</td>
<td>-</td>
<td>323.00</td>
</tr>
<tr>
<td>6</td>
<td>Puraikasana</td>
<td>20</td>
<td>587</td>
<td>28</td>
<td>-</td>
<td>635.00</td>
</tr>
<tr>
<td>7</td>
<td>Pajar Bulan</td>
<td>76</td>
<td>536</td>
<td>417</td>
<td>-</td>
<td>759.00</td>
</tr>
<tr>
<td>8</td>
<td>Karang Apung</td>
<td>10</td>
<td>111</td>
<td>310</td>
<td>-</td>
<td>431.00</td>
</tr>
<tr>
<td>9</td>
<td>Mutar Alam</td>
<td>12</td>
<td>338</td>
<td>522</td>
<td>20</td>
<td>892.00</td>
</tr>
<tr>
<td>10</td>
<td>Tanjung Raya</td>
<td>10</td>
<td>188</td>
<td>165</td>
<td>-</td>
<td>353.00</td>
</tr>
<tr>
<td>11</td>
<td>Sukaragi</td>
<td>12</td>
<td>468</td>
<td>236</td>
<td>-</td>
<td>736.00</td>
</tr>
<tr>
<td>12</td>
<td>Sukra Reja</td>
<td>4</td>
<td>323</td>
<td>-</td>
<td>-</td>
<td>327.00</td>
</tr>
<tr>
<td>13</td>
<td>Pedang Tambak</td>
<td>3</td>
<td>278</td>
<td>378</td>
<td>-</td>
<td>659.00</td>
</tr>
<tr>
<td>14</td>
<td>Tambak Jaya</td>
<td>10</td>
<td>269</td>
<td>263</td>
<td>-</td>
<td>542.00</td>
</tr>
<tr>
<td>15</td>
<td>Tri Budi Syukur</td>
<td>12</td>
<td>358</td>
<td>95</td>
<td>-</td>
<td>453.00</td>
</tr>
<tr>
<td>16</td>
<td>Putra Jaya</td>
<td>12</td>
<td>358</td>
<td>95</td>
<td>-</td>
<td>453.00</td>
</tr>
<tr>
<td>17</td>
<td>Purawijitan</td>
<td>10</td>
<td>269</td>
<td>263</td>
<td>-</td>
<td>542.00</td>
</tr>
<tr>
<td>18</td>
<td>Muara Jaya</td>
<td>12</td>
<td>358</td>
<td>95</td>
<td>-</td>
<td>453.00</td>
</tr>
<tr>
<td>19</td>
<td>Muara Jaya Dua</td>
<td>3</td>
<td>154</td>
<td>59</td>
<td>-</td>
<td>216.00</td>
</tr>
<tr>
<td>20</td>
<td>Pura Mekar</td>
<td>3</td>
<td>154</td>
<td>59</td>
<td>-</td>
<td>216.00</td>
</tr>
<tr>
<td>21</td>
<td>Cipta Varas</td>
<td>5</td>
<td>202</td>
<td>79</td>
<td>-</td>
<td>286.00</td>
</tr>
<tr>
<td>22</td>
<td>Tri Hulyo</td>
<td>6</td>
<td>241</td>
<td>269</td>
<td>-</td>
<td>496.00</td>
</tr>
<tr>
<td>23</td>
<td>Tri Budi Syukur</td>
<td>12</td>
<td>358</td>
<td>95</td>
<td>-</td>
<td>453.00</td>
</tr>
<tr>
<td>24</td>
<td>Sido Dadi</td>
<td>2</td>
<td>184</td>
<td>33</td>
<td>-</td>
<td>219.00</td>
</tr>
<tr>
<td>25</td>
<td>Gunung Terang</td>
<td>4</td>
<td>202</td>
<td>79</td>
<td>-</td>
<td>286.00</td>
</tr>
<tr>
<td>26</td>
<td>Gedung Suryan</td>
<td>3</td>
<td>184</td>
<td>82</td>
<td>-</td>
<td>271.00</td>
</tr>
<tr>
<td>27</td>
<td>Sumber Alam</td>
<td>3</td>
<td>191</td>
<td>41</td>
<td>-</td>
<td>235.00</td>
</tr>
<tr>
<td>28</td>
<td>Semarang Jaya</td>
<td>4</td>
<td>202</td>
<td>15</td>
<td>-</td>
<td>221.00</td>
</tr>
</tbody>
</table>

**Total** | **1,028.00** | **9,658.00** | **4,551.00** | **560.00** | **15,259.00**

**Percentage** | 6.58 | 40.65 | 29.18 | 3.59 | 100.00

Source: Data of Kecamatan of Sumber Jaya

---

Table 3.22. Length and Condition of Road

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of Road</th>
<th>Length of Road (km)</th>
<th>Condition of Road</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fair (km)</td>
<td>Inadequate (km)</td>
<td>Very Poor (km)</td>
</tr>
<tr>
<td>1</td>
<td>Asphalted</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td>Gravel/Sub-stratum</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Earth</td>
<td>-</td>
<td>10</td>
</tr>
</tbody>
</table>

**Total** | 15.00 | 29.00 | 33.00 | 77.00

ENVIRONMENTAL IMPACT ASSESSMENT-BESAI HPP
Table 3.23  Number of Motor Vehicles per Village and the Distance of Village to Kecamatan Capital

<table>
<thead>
<tr>
<th>No.</th>
<th>Village</th>
<th>Jeep</th>
<th>Sedan</th>
<th>Pick-up</th>
<th>Bus</th>
<th>Truck</th>
<th>Motor-</th>
<th>Distant Village-Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Simpangseri</td>
<td>3</td>
<td>4</td>
<td>25</td>
<td>4</td>
<td>18</td>
<td>42</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Sukapura</td>
<td>1</td>
<td>-</td>
<td>16</td>
<td>5</td>
<td>8</td>
<td>32</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
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</tr>
<tr>
<td>4</td>
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<td>-</td>
<td>5</td>
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<tr>
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<td>-</td>
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<td>32</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>19</td>
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<tr>
<td>11</td>
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<td>-</td>
<td>58</td>
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<td>-</td>
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<td>22</td>
<td>20</td>
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<tr>
<td>12</td>
<td>Suka Raja</td>
<td>-</td>
<td>11</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>21</td>
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<td>6</td>
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<td>2</td>
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<td>21</td>
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<tr>
<td>14</td>
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<td>2</td>
<td>-</td>
<td>2</td>
<td>17</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>15</td>
<td>Tribudi Syukur</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>16</td>
<td>Pura Jaya</td>
<td>-</td>
<td>14</td>
<td>5</td>
<td>13</td>
<td>115</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>17</td>
<td>Puralawatan</td>
<td>-</td>
<td>7</td>
<td>1</td>
<td>2</td>
<td>42</td>
<td>-</td>
<td>12</td>
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<tr>
<td>18</td>
<td>Huara Jaya</td>
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<td>6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>19</td>
<td>Huara Jaya Dua</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>20</td>
<td>Pura Nekar</td>
<td>-</td>
<td>14</td>
<td>-</td>
<td>-</td>
<td>36</td>
<td>-</td>
<td>23</td>
</tr>
<tr>
<td>21</td>
<td>Cipta Warna</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>-</td>
<td>23</td>
</tr>
<tr>
<td>22</td>
<td>Tri Hujo</td>
<td>-</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>16</td>
<td>-</td>
<td>26</td>
</tr>
<tr>
<td>23</td>
<td>Sri Menanti</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>-</td>
<td>27</td>
</tr>
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<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>25</td>
<td>Gunung Terang</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>13</td>
<td>-</td>
<td>29</td>
</tr>
<tr>
<td>26</td>
<td>Gedung Sutan</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>14</td>
<td>-</td>
<td>24</td>
</tr>
<tr>
<td>27</td>
<td>Sumber Alam</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>-</td>
<td>27</td>
</tr>
<tr>
<td>28</td>
<td>Semang Jaya</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>6.00</td>
<td>10.00</td>
<td>261.00</td>
<td>25.00</td>
<td>78.00</td>
<td>603.00</td>
<td></td>
</tr>
</tbody>
</table>

(7) Public's Health

Medical officials serving the population consist of 3 physicians, 16 medical aides/nurses, 2 midwives, and 199 traditional midwives.

The disease most striking the population is malaria (20.29%) and least the disease of the oral cavity (3.20%). The types of disease and the number of population stricken can be seen in Table 3.24 and types of disease according to age can be seen in Table 3.25.

Table 3.24 Types of Disease and Number of Population Stricken

<table>
<thead>
<tr>
<th>No.</th>
<th>Disease</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Malaria</td>
<td>2,859</td>
<td>20.30</td>
</tr>
<tr>
<td>2</td>
<td>Disease of the upper respiratory tract</td>
<td>1,480</td>
<td>10.60</td>
</tr>
<tr>
<td>3</td>
<td>Disease of the skin and lower skin tissue</td>
<td>1,456</td>
<td>10.44</td>
</tr>
<tr>
<td>4</td>
<td>Influenza</td>
<td>967</td>
<td>6.92</td>
</tr>
<tr>
<td>5</td>
<td>Diarrhoea</td>
<td>753</td>
<td>5.39</td>
</tr>
<tr>
<td>6</td>
<td>Side ulcer</td>
<td>703</td>
<td>5.03</td>
</tr>
<tr>
<td>7</td>
<td>Disease of the bone muscle</td>
<td>624</td>
<td>4.47</td>
</tr>
<tr>
<td>8</td>
<td>Infection of the intestine</td>
<td>575</td>
<td>4.12</td>
</tr>
<tr>
<td>9</td>
<td>Disease of the oral cavity</td>
<td>446</td>
<td>3.21</td>
</tr>
<tr>
<td>10</td>
<td>Mishap</td>
<td>354</td>
<td>2.53</td>
</tr>
<tr>
<td>11</td>
<td>Others</td>
<td>3,709</td>
<td>26.99</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>13,906</td>
<td>100.00</td>
</tr>
</tbody>
</table>
Table 3.25. Types of Disease According to Age Group

<table>
<thead>
<tr>
<th>No.</th>
<th>Age Group</th>
<th>Type of Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 - 4</td>
<td>Diarrhoea, Influenza, Aer and Mastoiditis</td>
</tr>
<tr>
<td>2</td>
<td>5 - 9</td>
<td>Malaria, Diarrhoea, Influenza, Aer and Mastoiditis</td>
</tr>
<tr>
<td>3</td>
<td>10 - 14</td>
<td>Influenza, Malaria and Rabies</td>
</tr>
<tr>
<td>4</td>
<td>15 - 24</td>
<td>Influenza, Malaria and Rabies</td>
</tr>
<tr>
<td>5</td>
<td>24 - 49</td>
<td>Malaria, Thypoid Fever, Bronchitis, and Diarrhoea</td>
</tr>
<tr>
<td></td>
<td>&gt; 50</td>
<td>Malaria, Thypoid Fever, Bronchitis, and Ear</td>
</tr>
</tbody>
</table>

Source: Puskesmas (Community Health Center), Fajar Bulan.

(8) Agricultural Production

Farmland in the area of study consists of home garden, sawah (wet rice cultivation), tegalan/field (unirrigated cultivated), and private plantation. In general, home garden and tegalan/field are planted with plantation crops or food crops (palawija). In village of which the majority of the population originates from West Java (Sundanese), the yards are usually used for ponds to raise fish. Almost the whole land area is planted with coffee and small part is used as a mixed crop of coffee and clove or pepper.

The farming activity of the population is mainly focused on sawah rice and coffee with an average production of 4.04 ton unhulled riced per hectare and 0.90 ton coffee beans per hectare (Table 3.26) respectively.

Table 3.26. Average Rice and Coffee Production

<table>
<thead>
<tr>
<th>No.</th>
<th>Village</th>
<th>Production (Ton/ha)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(Unhulled Rice)</td>
<td>Coffee Beans</td>
</tr>
<tr>
<td>1</td>
<td>Sukapura</td>
<td>4.15</td>
<td>0.92</td>
</tr>
<tr>
<td>2</td>
<td>Way Petai</td>
<td>4.24</td>
<td>0.90</td>
</tr>
<tr>
<td>3</td>
<td>Dwikora</td>
<td>-</td>
<td>0.78</td>
</tr>
<tr>
<td>4</td>
<td>Tribudi Syukur</td>
<td>4.12</td>
<td>0.96</td>
</tr>
<tr>
<td>5</td>
<td>Purawijitan</td>
<td>4.08</td>
<td>0.83</td>
</tr>
<tr>
<td>6</td>
<td>Tanjungraya</td>
<td>3.62</td>
<td>0.79</td>
</tr>
<tr>
<td>7</td>
<td>Suka Jaya</td>
<td>3.47</td>
<td>0.91</td>
</tr>
<tr>
<td>8</td>
<td>Semarang Jaya</td>
<td>.</td>
<td>0.87</td>
</tr>
<tr>
<td>9</td>
<td>Karang Agung</td>
<td>4.03</td>
<td>1.15</td>
</tr>
<tr>
<td>10</td>
<td>Suk Raia</td>
<td>4.61</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>32.32</td>
<td>9.04</td>
</tr>
</tbody>
</table>

(9) Land Price

Land Price in the affected villages varies from Rp. 6 millions to Rp. 7 millions depends on the land type and the crop. The price of the land is depends on the distance to the road, kind and age of the crop.

Table: 3.26a Land Price in the affected village

<table>
<thead>
<tr>
<th>No</th>
<th>Villages</th>
<th>Price of Land (x Rp.1,000,000-)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ricefield (simple irrigation)</td>
</tr>
<tr>
<td>1</td>
<td>Sukapura</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>Way Petai</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>Dwikora</td>
<td>6</td>
</tr>
</tbody>
</table>
3.3.2. Socio-Cultural

(1) Community perception

Social survey conducted in April 1993 to find out the perception of the people who live in the area. About hundred families were asked specific question by the consultant and findings are based on survey. These families included the PAP's and others. Almost the entire community (99.0%) came out strongly in support of the project. The only person who gave the "floating answer" said that he believed in whatever the Government would do, as shown in table 3.27.

Table 3.27. Community Perception in the Surrounding Besai HPP Project

<table>
<thead>
<tr>
<th>Villages</th>
<th>Agree (n)</th>
<th>Normal (n)</th>
<th>Against (n)</th>
<th>Total (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n) (%)</td>
<td>(n) (%)</td>
<td>(n) (%)</td>
<td>(n) (%)</td>
</tr>
<tr>
<td>Dwikora</td>
<td>25</td>
<td>100.0</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Sukapura</td>
<td>25</td>
<td>100.0</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Way Petai</td>
<td>25</td>
<td>100.0</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Suka Jaya</td>
<td>12</td>
<td>100.0</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>Simpang Sari</td>
<td>12</td>
<td>99.0</td>
<td>1</td>
<td>13</td>
</tr>
</tbody>
</table>

The existence of HPP will create positive impact in harmony with perception and expectation of community in the vicinity of project. The concerned people stated that it will bring a significant changes or life improvement in the life of the village community. The availability various infrastructure such as road, transportation, and electric energy would create new activities in agriculture sector and industrial sectors.

The expectation of community regarding the existence of HPP, and utilization of land compensation received from PLN will be utilized as a capital for productive activities. Table 3.28 indicated that 35 % stated that they would use the compensation money for buying land in other places and 33 % would run small or carry on business activities. There is no utilization for consumptive purposes, except only small portion approximately 4.0% for houses improvement, and another 18.0% will be utilized mostly for school expense and saving.

Another expectation of community in regard to project construction stage is the willingness of local community to get jobs in the project activity.
### Table 3.28. Utilization of Land Compensation, Perception and Expectation of Community

<table>
<thead>
<tr>
<th>Villages</th>
<th>Buy land</th>
<th>Build/improve house</th>
<th>Carry on trade</th>
<th>Buy consumptive product</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n) (%)</td>
<td>(n) (%)</td>
<td>(n) (%)</td>
<td>(n) (%)</td>
<td>(n) (%)</td>
<td>(n) (%)</td>
</tr>
<tr>
<td>Dwikora</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sukapura</td>
<td>9 36.0</td>
<td>2 8.0</td>
<td>14 56.0</td>
<td>-</td>
<td>-</td>
<td>25 100.0</td>
</tr>
<tr>
<td>Way Patni</td>
<td>10 40.0</td>
<td>1 4.0</td>
<td>11 44.0</td>
<td>-</td>
<td>3 12.0</td>
<td>25 100.0</td>
</tr>
<tr>
<td>Suka Jayu</td>
<td>8 32.0</td>
<td>1 4.0</td>
<td>11 44.0</td>
<td>-</td>
<td>5 20.0</td>
<td>25 100.0</td>
</tr>
<tr>
<td>Simpang Sari</td>
<td>4 33.0</td>
<td>-</td>
<td>4 33.0</td>
<td>-</td>
<td>4 33.0</td>
<td>12 100.0</td>
</tr>
<tr>
<td></td>
<td>4 31.0</td>
<td>-</td>
<td>3 23.0</td>
<td>-</td>
<td>6 46.0</td>
<td>13 100.0</td>
</tr>
<tr>
<td></td>
<td>35 35.0</td>
<td>4 4.0</td>
<td>43 43.0</td>
<td>-</td>
<td>18 18.0</td>
<td>100 100.0</td>
</tr>
</tbody>
</table>

(1) School budget and saving

(2) **Conflict**

Surrounding Besai Project was forest which belong to State Land when the people gradually moved in from other places and converted the forest to be agriculture areas, it happened in early 1950's. When the Forestry Department conducted the reformation of the status of the forest category, this area was included into the category of protected area.

In 1985 the Forest Authority undertook the reforestation in the settlement of the population in the village of Sukapura, with an area of 350 ha to be reforested. Before implementation of reforestation was continued, the population lodged a protest and a physical clash almost occurred between the population and the reforestation officials. As a result of this protest, finally the reforestation has not been carried out until the present.

Out of 50.1 ha project affected forest there is 15.2 ha of planted land by about 40 people. Conflict will not be provoked by this project, since the Compensation Committee will give the fair compensation price on the affected land which planted by the people.

Ministry of Forestry, on August 31 1993, issued approval letter to use the protected area (hutan lindung). Based on this letter project proponent (PLN) should provide a Plan of Reforestation and Land Rehabilitation on upper catchment area. To response of this letter PLN will provide a fund for the study which will be carried out by the consultant. The consultant will prepare the plan which may be accepted by the both parties the people and the Forestry Agency.

(3) **Public consultation**

Public consultation has been held on September 14, 1993 at the project site. 125 people attended the meeting minutes of the meeting are enclosed at annexure and several questions expressed in the meeting. The local peoples who live around the

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ENVIRONMENTAL IMPACT ASSESSMENT-BESAI HPP
project, stated that they agree to the plan of government to develop the Besai Hydro Electric Power Plant Project.

The important questions asked in that meeting were as follows:

1. Explanation of the basic principle of compensation that will be fixed for the land, plants, and buildings.
2. When will the compensation be given?
3. The details of the area especially for Dwikora village which will be affected by the Besai HEPP Project.
4. What is the status of the land which will be affected by the construction activity of the project despite the fact that the land has not been acquired yet?
5. Can the acquired land be used by the people before it is inundated by the water.
6. Can the people who live around the project get work in the construction activities?
7. Someone just bought some bush land. Can he ask for the compensation of it?

The response of the project proponent (PLN and the members of the compensation committee were as follows to the above question:

1. The land acquisition for the Government/public services is according to Keppres (President Decree No. 55/1993) which provides deliberation between the land Acquisition Committee and the owner of land.
2. The compensation will be given after the stacking out, cadastral survey, and the inventory of the land, plants, and other temporary structures are done completely. The compensation will be on principle of replacement costs.
3. To know the exact area that will be affected by the project one must go through these following steps:
   a. Stacking out : to define the area’s border
   b. Cadastral survey : to make the detailed border of each piece of land
   c. Inventory : to Collect the data of all the land, plants, and buildings.

This activity has already started at the local level and a time-schedule in annexed
4. Once the acquisition proceeding has been initiated, land holder can continue to use the same but cannot sell it to others.

5. The acquired land will belong to the PLN, so it may not be used by the people anymore.

6. PLN will encourage the Contractor to employ as many eligible local workers as possible.

7. All types of land holdings, irrespective of legal ownership will get compensation. But it must follow the procedure such as the inventory of the land and its status, number of plants and the size and condition of temporary structures. The presidential decree provides for full compensation at a replacement value.
IV. ENVIRONMENTAL IMPACT

1. Negative environmental effects of construction:

   a). Air and water pollution from construction and waste disposal.

   Air quality in the village might be affected by the construction traffic such as dust or noise. To overcome those problems, several measures will be applied. The dust from the access road will be suppressed by the water spraying especially during the dry season. Noise will be suppressed by enforcement to use noise abatement in every construction vehicles. The exhaust gas emitted by the construction vehicles will disperse and the ambient concentration can be neglected in the village. So the impact of construction on air quality is considered a minor one if those measures are taken properly.

   The waste produce from the project activities can be divided into two categories, i.e. domestic waste and construction waste.

   The domestic waste will be collected and disposed in the special disposal area far from the village.

   The construction activities will produce several type of waste such as metal, paper, wood, soil or concrete aggregate. Metal, paper and wood will be recycled (collected and sold or re-use) so no waste on this categories will be disposed. Soil and concrete aggregate will be used for land reclamation or disposed in the soil disposal area. Reclamation of soil disposal area will be conducted such as terracing and replanting of trees and grasses.

   b). Soil Erosion

   Land clearing, cut and fill and soil disposal area can increase the rate of soil erosion if not carefully managed.

   The erosion rate will be suppressed by several measures:

   * Soil trap such as land holes if applicable in such area will be developed to trap the soil transported by the run off.

   * Terracing and land reclamation on soil disposal area and on bare land area will be adopted

   * Grasses or trees will be planted on the bareland caused by construction activities and on disposal area after the work finished.
c). The impact of construction worker camps.

There is several base camps which will be develop for the construction labors and employees. PLN will develop the camps for the PLN Project's employees and for the project engineers. The contractors will develop their own camp after the design being approved by the project engineers. Project proponent will ask that the camps should be provided with the health care facilities, standard sanitation facilities and sport/entertainment facilities. The polyclinic develops by the project proponent and the health care facilities developed by the contractors will support with each other. The local people may use those facilities as emergency besides the Health Center (PUSKESMAS) which exists on that area.

There are also benefit opportunities for local people to get the contract of lodging facilities for the outside construction workers.

2. Dislocation of people living in inundation zone.

No families living in the inundation zone.

The project will pay the fair compensation of land, crop/vegetation and houses/building based on negotiation between the people and land compensation committee.

After the project they will get better access road and electricity. They may use the polyclinic developed by the project. Priority of employment in the project will also be given to the affected people.

3. Lost of agricultural and forest land by inundation to form reservoir.

Besai HEPP is a run off river type power plant, the reservoir is designed to hold water for daily power generation, so the acreage of land for reservoir is only 140 ha and the impact is considered medium.

The land which belong to the people (agriculture land) will be compensated according to the President Republic of Indonesia Decree No. 15 of June 17, 1993. The owner and the compensation committee will sit together to negotiate the compensation value. The compensation payment will account for land, building and vegetation (crops).

The land which belong to Forestry agency will be replaced with such kind of land to be reforested in ratio of replacement of 1 : 1. The area of replacement has not decided yet, the Forestry Agency will give the condition of replacement land. The compensation of the replacement land will be proceeded according the regulation and the procedure as well as above.

4. Loss of historic, cultural or aesthetic features by inundation.

No historic, cultural and aesthetic features in the reservoir area. So this project will give no impact on these objects.
5. Loss of wildlands and wildlife habitat.

The project will use part of agriculture converted land, forest or bushes forest land. The acreage of forest land to be used will be small compared those the adjacent forest area. Most of the forest area used by the project has been converted into coffee plantation.

The impact on wildlands and wildlife habitat is not considered to be significantly adverse for the following reasons. Although there are several protected animals such as gibbon, Monkey, water civet, porcupine and several snake sometime reported show up in the proposed project area, the main habitat of those animals area in adjacent forest area. Construction activity might disturb those animals, but they will naturally avoid the construction area. The habitat will be insignificantly reduced, so the impact is considered insignificant.

6. Proliferation of aquatic weeds in reservoir and downstream impairing dam discharge, irrigation, navigation and fisheries and increasing water loss through transpiration

Vegetation in the reservoir area prior inundation will be cleared to reduce the nutrient source for future aquatic weeds. The area of reservoir is relatively small, so aquatic weeds can be removed easily in regular basis so it will not grow out of control.

7. Deterioration of water quality in reservoir

The vegetation in reservoir area if it is let uncleared, when it is inundated, it might cause eutrophication. The area of future reservoir consist of agriculture area and secondary forest (shrub, brush etc.) it relatively contains few trees. Total vegetation clearing will be conducted to avoid deterioration of water quality in future reservoir area.

8. Sedimentation of reservoir and loss of storage

Erosion in upper catchment area will affect the storage of reservoir. To overcome the problem several measures will be taken:

- The Agency for Soil Conservation and Rehabilitation will make extension information to the farmer for better agriculture practice. Regreening will also be conducted in the bare land area.

- Flushing of sediment in reservoir will be conducted regularly.

9. Formation of sediment deposit at reservoir entrance creating backwater effect and flooding and waterlogging upstream.

Besai HEPP is a run off river type power plant, the reservoir is designed to hold water for daily power generation, so the volume of reservoir is relatively small and the current of water is also relatively high. It is considered that it will not cause the formation of sediment deposit at reservoir so much. During the high discharge
scouring effect of sediment in reservoir will make the balance of it. There is no dwelling areas or agricultural area which might be affected by the back water of Besai HEPP.

10. Scouring of riverbed below dam

The power plant has been designed to overcome the potential scouring effect of the water release through the sluiceway. The horizontal stilling basin of 33.5 m wide and 16.0 m long is designed to dissipate the energy of design flood equivalent to 100 years probable peak discharge. The scouringway of 16.5 m wide and 25.4 m long is facilitated with each two numbers of upper and lower-scouring gates, for the purpose of flushing out bed loads through the lower scouring gates and suspended loads through the upper ones. each gate is 6.0 m wide and 1.5 high. The size of scouringway is designed so as to ensure at least the same scouring capacity as existing river.

The impact of scouring of riverbed below the dam is considered insignificant.

11. Decrease in floodplain (recession) agriculture

There is no irrigation downstream of the dam.

12. Salinization of floodplain lands

Besai River is small tributaries of Tulang Bawang River.

There is no anticipated impact of Besai HEPP on salinization of floodplain lands.

13. Salt water intrusion in estuary and upstream

There is no impact of Besai HEPP on salt water intrusion in estuary and upstream.

14. Disruption of riverine fisheries due to changes in flow, blocking migration, and changes in water quality and limnology.

River flow will be greatly reduced in the approximately 5 Km section of river between the diversion weir and the power station outlet, particularly during the dry season. This will reduce the available habitat for aquatic organisms in the following ways.

- The volume of water and hence aquatic habitat, will be less.
- Reduce water velocity may render the river less suitable for species adapted to fast flowing waters.

These impacts will be long term and to a large extent irreversible, but it does not consider to be significant for the following reasons:

- The fish species and major invertebrate groups found in the affected river section are also found in abundance both upstream and downstream of project area.
The river does not support an important economic, subsistence or recreational fishery.

The fish species within the Besai River do not appear to be unique or endemic or migratory one to the Tulang-Bawang river and are found throughout Sumatra.

15. Snagging of fishing nets in submerged vegetation in reservoir.

The area of future reservoir consist of agriculture area and secondary forest (shrub, brush etc.) it contains few trees. Total vegetation clearing will be conducted to avoid snagging of fishing nets in submerged vegetation in reservoir area.

16. Increase of water related diseases.

The addition of water surface might provide the habitat of mosquito to breed, in other hand the rate of malaria incidence in the area is relatively high. So there is a potential of new habitat for malaria mosquito to breed.

Fortunately, reservoir of Besai HEPP is a daily pondage for daily generation, so the current of the reservoir will be too strong for the mosquito to breed. In case that the mosquito successfully breed in the reservoir, it will be overcome by restocking of fish that will eat mosquito larae.

The Health center will elaborate to dismiss the rate of malaria prevalence and mosquito.

17. Conflicting demands for water use.

There is no conflicting demands for water use since there are no river water usages along the river down stream of the dam (riparian people, navigation, irrigation and other).


Lost of agricultural land might result the decreasing of income and in turn it will decrease the standard of living as well.

For the Besai people, this condition will likely be happened for temporary basis. More than 78% of affected people expressed their willingness that they will use their compensation money for productive use (purchase agriculture land, open new business etc.) and none of them will use their money to buy consumptive goods. To dismiss the using money unwisely, extension of information will be conducted by project proponent to affected people.

To minimize the negative impact and to enhance the positive impact the project proponent (PLN) will also initiate several measures, such as:

a. To give priority to local people (affected people) to work on project.
b. To provide services such as: electricity, access to polyclinic developed by the project.

c. To provide the training on several skills such as:
   - Home industries
   - Carpenter, masonry, mechanical technicians etc.
   - Fisheries, animal husbandry
   - Small trading

19. Environmental degradation from increased pressure on land.

To overcome the problem the sectoral agency such Agricultural Agency, Plantation Agency and Soil Conservation and Rehabilitation Station and will elaborate to extend the information regarding better practice of agriculture work.

20. Disruption/destruction of tribal/indigenous groups.

There is no tribal/indigenous groups in the affected area of Besai HEPP.

21. Increase in humidity and fog locally, creating favorable habitat for insect disease vectors (mosquitos).

The climate in the surrounding Besai area is humid. Reservoir surface of Besai HEPP of 101 Ha is considered too small to change the humidity in the area. Reservoir of Besai HEPP is a daily pondage for daily generation, so the current of the reservoir will be too strong for the mosquito to breed. In case that the mosquito successfully breed in the reservoir, it will be overcome by restocking of fish that will eat mosquito larvae.

22. Impact of reservoir on drinking water pumped from shallow well.

Reservoir of Besai HEPP is relatively far from the dwelling area. Most of the dwelling area are located along the high way of Liwa - Kotabumi or along the village road. The people get the drinking water from the spring water or shallow water near their houses, so no impact of future reservoir on existing drinking water.

23. Impact of dry river bed between dam to the power house.

During the dry season the river bed between dam to the power house will be regularly dry for several days or weeks, especially when the incoming flow lower than the power generation outflow.

There are no people living in that area, since that area is very steep. There are no wild animal which will be affected by those condition. There is no migratory fish found in the river.

24. Impacts of earthquakes and floods

The project has been designed to accommodate the seismic acceleration for this area. The weir of Besai HEPP is only 8 m high and the surface area of the reservoir is only 101 Ha, so the induced seismic of the reservoir can be neglected and it will
not likely cause the hazard to environment.

The holding capacity of the reservoir to reduce the floods water from upstream will be small due to its capacity. Most of the floods will be passed through the sluiceway. The sluiceway is designed as a wholly gated concrete overflow weir of 33.5 m wide, 25.2 m long and 6.5 m high which is provided with four numbers of sluice gates. It is sufficiently to release not only 100 years probable peak discharge of 800 m³/sec but also 10,000 years probable peak discharge of 1,400 m³/sec.

25. Impact of waste lubricant oil

The waste of lubricant oil will come from several sources such as:
- Vehicles used for construction and operation activities
- Bearing of the movement part of the power plant.

The waste lubricant oil will be managed in environmentally acceptable manner, it will be collected in drums and will be sent to PERTAMINA (the agency who have the authority to collect the waste lubricant oil).

26. Impact of transmission lines

The Electric power generated by this project will be transmitted through 150 KV high voltage to Bukit Kemuning Sub station. The distance of the Besai powerhouse to Bukit Kemuning is 16 Km. It pass the bushes and agriculture area, and no houses will be passed by the transmission lines. The impact of the transmission lines is considered insignificant.

INDIRECT

27. Uncontrolled migration of people into the area made possible by access roads and transmission lines.

The project area is located between the city of Liwa and Kotabumi, and have smooth surfaced asphalt high way, so this area is relatively an open area. The access road of the project is relatively short (2 Km) and it through agriculture area. The uncontrolled migration of people into the area will likely not be happened.

The transmission line will be built in parallel with the existing high way to Bukit Kemuning High way. Based on experience on the recent transmission that there is no uncontrolled migration of people along the transmission lines.

28. Environmental problems arising from development made possible by dam (irrigated agriculture, industries, municipal growth).

Due to topographic condition there is no possibility to develop irrigation in this area. Electric energy from Besai HEPP will stimulate the industrial growth in this region, especially near the city of Bandar Lampung, but it is unlikely in the surrounding of Besai HEPP.
29. Poor land use practices in catchment areas above reservoir resulting in increased siltation and changes in water quality.

The agriculture practice in the catchment area that might share the major erosion rate is private coffee plantation. The habit of people to clear all of the weed under the coffee tree will increase the erosion rate.

To overcome the problem of erosion, the Agency for Soil Conservation and Rehabilitation and other involved agencies will make extension information to the farmer for better agriculture practice and regreening in the critical land.
V. ANALYSIS OF ALTERNATIVES

5.1. Background

PLN’s Region IV is the largest of its fourteen regions in terms of the geographic area covered. It includes four provinces in Sumatra, viz., South Sumatra, Bengkulu, Lampung and Jambi.

The total installed generating capacity in the region is 620 MW, of which 454 MW is in the South Sumatra and Lampung provinces. In addition to the central generating stations at Kramasan (2 x 12.5 MW oil-fired steam turbines and 3 x 14.7 MW oil-fired gas turbines), Bukit Asam (2 x 65 MW coal-fired units), and the central plant at Tarahan (77.7 MW), there are about 400 diesel units, operating in over 150 independent generating centers. The Region IV has about 1,500 km of 150 kV and 70 kV Transmission lines, 4,800 km of medium voltage (20 kV and 12 kV) lines and about 6,400 km of low voltage lines.

In addition to PLN’s generating facilities, there are about 487 captive generating installations totalling 790 MVA; none of them connected to the PLN network. Two major captive installations in Palembang are owned by Pusri Fertilizer (60 MW), and Pertamina (40 MW).

Bukit Asam coal-fired thermal power plant 2 x 65 MW units 3 and 4 are under construction at the unit 3 is due for commissioning in January 1994. Another 60 MW of gas turbines will be commissioned at Palembang in 1993/94.

5.1 Necessity of the Project

The population of the region is about 16 million, i.e., approximately 3.2 million households. The region has 5,734 villages. The total number of electrified households is about 690,000 (22%) and electrified villages is 1,749 (30.5%). Since 1991, the region has been declared as "critical" in terms of supply capacity and new industrial connections are not provided. Also, new residential consumers have to restrict their connected load under 2.2 kVA.

The major power sources planned to be developed by PLN for the system are as follows:
<table>
<thead>
<tr>
<th>Power source</th>
<th>Installed capacity (MW)</th>
<th>Accumulation (MW)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Installation</td>
<td>483.3</td>
<td>483.3</td>
<td>Calculated up to the year of 1991</td>
</tr>
<tr>
<td>Diesel</td>
<td>-3.9</td>
<td></td>
<td>Retirement in 1992</td>
</tr>
<tr>
<td></td>
<td>20.0</td>
<td>499.4</td>
<td>Installed in 1992</td>
</tr>
<tr>
<td>Diesel</td>
<td>-5.0</td>
<td></td>
<td>Retirement 1993</td>
</tr>
<tr>
<td>Mini hydro</td>
<td>0.2</td>
<td></td>
<td>Installed in 1993</td>
</tr>
<tr>
<td>Bukit Asam #3</td>
<td>65.0</td>
<td>559.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Coal fired-Steam power)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>-4.4</td>
<td></td>
<td>Retirement in 1994</td>
</tr>
<tr>
<td></td>
<td>4.0</td>
<td>624.2</td>
<td>Installed in 1994</td>
</tr>
<tr>
<td>Bukit Asam #4</td>
<td>65.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Coal fired-Steam power)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mini hydro</td>
<td>1.1</td>
<td></td>
<td>Installed in 1995</td>
</tr>
<tr>
<td>Diesel</td>
<td>-5.1</td>
<td></td>
<td>Retirement in 1995</td>
</tr>
<tr>
<td></td>
<td>21.0</td>
<td>706.2</td>
<td>Installed in 1995</td>
</tr>
<tr>
<td>Tarahan #1</td>
<td>65.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Steam power)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>-5.7</td>
<td></td>
<td>Retirement in 1996</td>
</tr>
<tr>
<td></td>
<td>5.0</td>
<td>690.5</td>
<td>Installed in 1996</td>
</tr>
<tr>
<td>Gas turbine</td>
<td>-15.0</td>
<td></td>
<td>Retirement in 1996</td>
</tr>
<tr>
<td>Diesel</td>
<td>-7.1</td>
<td></td>
<td>Installed in 1997</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tarahan #2</td>
<td>65.0</td>
<td>754.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Coal fired-Steam power)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>-9.1</td>
<td></td>
<td>Retirement in 1998</td>
</tr>
<tr>
<td></td>
<td>8.5</td>
<td>829.8</td>
<td>Installed in 1998</td>
</tr>
<tr>
<td>Gas turbine</td>
<td>-14.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Besai HEPP</td>
<td>90.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The integrated power supply systems of Lampung and South Sumatera provinces has been completed in 1992, connecting with each interconnected power supply system through a 150 kV transmission line. In order to send the produced electric power to the major load centers of Lampung and South Sumatera provinces, the Besai project has about 16 km long 150 kV transmission line to connect it with the 150 kV integrated transmission line system around Bukit Kemuning.

According to the power demand forecast made by PLN for the whole system of PLN Region-IV, the required energy production and the peak load demand will be 3,450 GWH and 650 MW in 1998, the expected commissioning year of the Project, as shown in tabel below.
Judging from the power demand forecast and the planned power sources mentioned above, e.g. the required installed capacity of 930 MW and the planned installed capacity of 830 MW in 1998, it is recommended to implement the Besai Hydro electric Power Project as early as possible taking its construction period into consideration. The Project will be able to come on stream in 1998 due to a lead time necessary for design, tendering and construction.

Implementation of the project is also along the policy of the Indonesian government, namely, the oil resources would be preserved for improving balance of payment by developing hydropower potential with the highest development priority.

5.2 Optimization Development of Besai Scheme

5.2.1. Alternative scheme

In addition to the upstream reservoir scheme with a power plant of 90 MW installed capacity (Alternative 1), two more conceivable alternative schemes are newly prepared and compared respectively with the Alternative 1; the intermediate pondage scheme with a power plant of 90 MW installed capacity (Alternative 2) and the pumped storage scheme with a power plant of 180 MW installed capacity (Alternative 3), of which reservoir intake and intermediate pondage are connected by a free flow headrace tunnel or a pressurized headrace tunnel.

**Alternative 1**:

Upstream reservoir scheme which is a run-of-river type development scheme with a daily regulation storage capacity in the upstream reservoir; with a power plant of installed capacity at 90 MW.

**Alternative 2**:

Intermediate pondage scheme which is also a run-of-river type development scheme with a daily regulating capacity in the intermediate pondage instead of the upstream reservoir; with a power plant of installed capacity at 90 MW.

This scheme has two kinds of schemes as follows:
The upstream reservoir intake and the intermediate pondage are connected with a free flow headrace tunnel.

ii) Alternative 2-B

They are connected with a pressurized headrace tunnel.

Alternative 3:

Pumped storage scheme which is a multiple-use type pumped storage and is planned to double turbine flow from 48 m³/sec (equivalent to that of Alternatives 1 and 2) to 96 m³/sec by use of pumping back power water from the lower pondage to the upper pondage in the minimum power demand period; with a power plant of installed capacity at 180 MW.

This scheme has also two kinds of schemes as follows:

i) Alternative 3-A

The upstream reservoir intake and the upper pondage are connected with a free flow headrace tunnel.

ii) Alternative 3-B

They are connected with a pressurized head-race tunnel.

5.2.2. Examination on economic viability

The result of examination on economic viability for the five alternative schemes is summarized as follows:

<table>
<thead>
<tr>
<th>Upstream Reservoir Scheme</th>
<th>Intermediate Pondage Scheme</th>
<th>Pumped Storage Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1</td>
<td>Alternative 2-A</td>
<td>Alternative 3-A</td>
</tr>
<tr>
<td>(Pressurized H/T)</td>
<td>(Free flow H/T)</td>
<td>(Pressurized H/T)</td>
</tr>
<tr>
<td>i) Installed capacity (MW)</td>
<td>96 (45 MW x 2 nos.)</td>
<td>96 (45 MW x 2 nos.)</td>
</tr>
<tr>
<td>ii) Generation mode (h)</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>iii) Annual energy output (GWh)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Primary</td>
<td>136</td>
<td>136</td>
</tr>
<tr>
<td>- Secondary</td>
<td>234</td>
<td>254</td>
</tr>
<tr>
<td>Total</td>
<td>366</td>
<td>390</td>
</tr>
<tr>
<td>iv) Annual benefit (10^6 US$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Primary</td>
<td>23.23</td>
<td>23.50</td>
</tr>
<tr>
<td>- Secondary</td>
<td>17.40</td>
<td>19.12</td>
</tr>
<tr>
<td>Total</td>
<td>40.63</td>
<td>42.62</td>
</tr>
<tr>
<td>v) Annual cost (10^6 US$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Primary</td>
<td>16.29</td>
<td>18.00</td>
</tr>
<tr>
<td>- Secondary</td>
<td>15.29</td>
<td>18.80</td>
</tr>
<tr>
<td>Total</td>
<td>31.58</td>
<td>36.80</td>
</tr>
</tbody>
</table>

As seen in the table above, net benefit of the Alternative 1 (upstream reservoir scheme) is the biggest among the five alternatives.
As seen in the table above, net benefit of the Alternative 1 (upstream reservoir scheme) is the biggest among the five alternatives.

5.3 Conclusion

As stated above in Sections 5.2, the Alternative 1 of the upstream reservoir scheme with a plant of 90 MW installed capacity is the best in economical comparison among the five conceivable alternative schemes.

Judging from the power demand forecast and the required installed capacity, it is recommended to implement the Besai Hydro electric Power Project as early as possible taking its construction period into consideration.
VI. MITIGATION PLAN

1. Negative environmental effects of construction:

The construction impacts need to be mitigated are as follows:

a). Impact on air quality such as dust, noise etc.

Air quality in the village might be affected by the construction traffic such as dust or noise. To overcome those problems, several measures will be applied. The dust from the access road will be suppressed by the water spraying especially during the dry season. Noise will be suppressed by enforcement to use noise abatement in every construction vehicles. The exhaust gas emitted by the construction vehicles will disperse and the ambient concentration can be neglected in the village. So the impact of construction on air quality is considered a minor one if those measures are taken properly.

b). Impact of waste disposal.

The waste produce from the project activities can be divided into two categories, i.e. domestic waste and construction waste.

The domestic waste will be collected and disposed in the special disposal area far from the village.

The construction activities will produce several type of waste such as metal, paper, wood, soil or concrete aggregate. Metal, paper and wood will be recycled (collected and sold for re-use) so no waste on this categories will be disposed. Soil and concrete aggregate will be used for land reclamation or disposed in the soil disposal area. Reclamation of soil disposal area will be conducted such as terracing and replanting of trees and grasses.

c). Impact on soil erosion

The erosion rate will be suppressed by several measures:

- Soil trap such as land holes if applicable in such area will be developed to trap the soil transported by the run off.

  The water embankment will be avoided to prevent mosquito breeding area.

- Terracing and land reclamation on soil disposal area and on bare land area will be adopted.

- Grasses or trees will be planted on the bareland caused by construction activities and on disposal area after the work finished.
d). The impact of construction worker camps.

There is several base camps which will be develop for the construction labors and employees. PLN will develop the camps for the PLN Project’s employees and for the project engineers. The contractors will develop their own camp after the design being approved by the project engineers. Project proponent will ask that the camps should be provided with the health care facilities, standard sanitation facilities and sport/entertainment facilities. The polyclinic develops by the project proponent and the health care facilities developed by the contractors will support with each other. The local people may use those facilities as emergency besides the Health Center (PUSKESMAS) which exists on that area.

There are also benefit opportunities for local people to get the contract of lodging facilities for the outside construction workers.

Since most of the construction work will be carried out by the contractors, so most of the mitigation of construction impact will be conducted by the assigned contractor. PLN as project proponent will enforce the impact mitigation through development of several precautions such as:

- To develop the sound design and contracts to accommodate the necessity mitigation.
- To conduct regular coordination among Contractors, Consultants and Project Proponent.
- To conduct monitoring
- To enforce the sanction to the neglected contractors.

2. Dislocation of people living in construction area and inundation area.

No families living in the inundation zone and construction area. There are 129 families which will be affected because part of their land will be used for the construction and inundation areas.

The mitigation of the impact to the affected people is described on the resettlement plan as presented on chapter 7.

3. Lost of agricultural and forest land by inundation to form reservoir.

The land which belong to Forestry agency will be replaced with such kind of land to be reforested in ratio of replacement of 1 : 1. The area of replacement has not decided yet, the Forestry Agency will provide the condition of replacement land.
4. **Loss of historic, cultural or aesthetic features by inundation.**

No mitigation measures will be anticipated because there is no historic, cultural and aesthetic features in the reservoir area.

5. **Loss of wildlands and wildlife habitat.**

The restriction to disturb the wildlife if exist or show up will be enforced by the project proponent. The Sign Board and announcement will be provided by the project proponent. The project has been designed to use the forest land as efficient as possible.

6. **Proliferation of aquatic weeds in reservoir and downstream impairing dam discharge, irrigation, navigation and fisheries and increasing water loss through transpiration**

Vegetation in the reservoir area prior inundation will be cleared to reduce the nutrient source, the aquatic weeds grow less. This will be conducted by the project.

During the power plant operation period the aquatic weeds will be removed in regular basis by the Plant Operation Division in regular basis.

7. **Deterioration of water quality in reservoir**

Total vegetation clearing will be conducted by Project Proponent to avoid deterioration of water quality in future reservoir area.

8. **Sedimentation of reservoir and loss of storage**

To overcome the problem of erosion several agencies will be involved:

- Ministry of Forestry on August 31 1993 issued approval letter to use the protected area (hutan lindung). Based on this letter project proponent (PLN) should provide a Plan of Reforestation and Land Rehabilitation on upper catchment area. To response of this letter PLN will provide a fund for the study which will be carried out by the consultant. Close collaboration will be conducted with the involved agencies such as Forestry Agency, The Agency for Soil Conservation and Rehabilitation, Plantation Agency, Food Crop Agency and Local Government.

- The plan of Reforestation and Land Rehabilitation on upper catchment area to be approved to BAPPEDA Lampung Province for erosion abatement in the Besai Catchment area. The basic plan will be used for several agencies such as Forestry Agency, Plantation Agency, Agriculture Agency, Food Crop Agency, Public Work etc. to develop further plan.

Forestry Agency basically will be responsible in regreening the critical areas belong to Forestry agency. Plantation agency will be responsible in providing extension information to the coffee farmer which abundant in the upstream catchment area. The Agriculture Agency will be responsible in the extension information on dry land farmer. The farmer will be taught on developing friendly soil conservation agriculture. The Public Work Agency will develop checks dam to control erosion, if necessary.
9. Formation of sediment deposit at reservoir entrance creating backwater effect and flooding and waterlogging upstream.

It is anticipated that this problem will not be significant, since no agricultural or dwelling area near the backwater of reservoir. Relatively high flow of water in those area will prevent of sediment deposition and it also will provide natural scouring effect of the sediment deposited during low flow. The power plant has been designed to have the sediment trap and flushing facility. Flushing of sediment in reservoir will be conducted regularly. This work will be carried out by the Power Plant Operation Division.

10. Scouring of riverbed below dam

The power plant has been designed to overcome the potential scouring effect of the water release through the sluiceway.

11. Decrease in floodplain (recession) agriculture

There is no irrigation downstream of the dam. No mitigation will be conducted.

12. Salinization of floodplain lands

There is no anticipated impact of Besai HEPP on salinization of floodplain lands. No mitigation will be conducted.

13. Salt water intrusion in estuary and upstream

There is no impact of Besai HEPP on salt water intrusion in estuary and upstream. No mitigation will be conducted.

14. Disruption of riverine fisheries due to changes in flow, blocking migration, and changes in water quality and limnology.

Although the fisheries activities conducted by the people is insignificant, to enhance the positive impact, the fisheries agency will restock the fish in future reservoir.

15. Snagging of fishing nets in submerged vegetation in reservoir.

Total vegetation clearing will be conducted to avoid snagging of fishing nets in submerged vegetation in reservoir area. This will be conducted by the project.
16. Increase of water related diseases.

In case that the mosquito successfully breed in the reservoir, it will be overcome by restocking of fish that will eat mosquito larvae. This work will be conducted by Fisheries Agency.

The Public Health center will elaborate to dismiss the rate of malaria prevalence and educate the people how to control mosquito.

17. Conflicting demands for water use.

No mitigation is necessary since there is no conflicting demands for water use.


To minimize the negative impact and to enhance the positive impact the project proponent (PLN) will also initiate several measures as discussed on chapter 7.

19. Environmental degradation from increased pressure on land.

To overcome the problem on possibility of environmental degradation such, the sectoral agency such Agricultural Agency, Plantation Agency and Soil Conservation & Rehabilitation Station and will elaborate to extend the information regarding better practice of agriculture work.

20. Disruption/destruction of tribal/indigenous groups.

There is no tribal/indigenous groups in the affected area of Besai HEPP. No mitigation will be conducted.

21. Increase in humidity and fog locally, creating favorable habitat for insect disease vectors (mosquitos).

In case that the mosquito successfully breed in the reservoir, it will be overcome by restocking of fish that will eat mosquito larvae. This kind of work will be conducted by the Fisheries Agency.

22. Impact of reservoir on drinking water pumped from shallow well.

Since no impact of future reservoir on existing drinking water, no mitigation is anticipated.

23. Impact of dry river bed between dam to the power house.

Since no impact is anticipated, so no mitigation will be conducted.

24. Impacts of earthquakes and floods

The induced seismic of the reservoir can be neglected and it will not likely cause the hazard to environment. No mitigation is anticipated.

The holding capacity of the reservoir to reduce the floods water from upstream will be small due to its capacity. Most of the floods will be passed through the sluiceway. No mitigation is anticipated.
25. Impact of waste lubricant oil

The waste lubricant oil will be managed in environmentally acceptable manner, it will be collected in drums and will be sent to PERTAMIMA (the agency who have the authority to collect the waste lubricant oil).

26. Impact of transmission lines

The Electric power generated by this project will be transmitted through 150 KV high voltage to Bukit Kemuning Sub station. The distance of the Besai powerhouse to Bukit Kemuning is 12.5 Km. It pass the bushes and agriculture area, and no houses will be passed by the transmission lines. Although the impact of the transmission lines is considered insignificant, the extension information will be conducted by the project proponent. The impact check list is presented on annex 1 & 2.

INDIRECT

27. Uncontrolled migration of people into the area made possible by access roads and transmission lines.

The project area is located between the city of Liwa and Kotebumi, and have smooth surfaced asphalt high way, so this area is relatively an open area. The access road of the project is relatively short (2 Km) and it through agriculture area. The uncontrolled migration of people into the area will likely not be happened.

The transmission line will be built in parallel with the existing high way to Bukit Kemuning High way. Based on experience on the recent transmission that there is no uncontrolled migration of people along the transmission lines. No mitigation is anticipated.

28. Environmental problems arising from development made possible by dam (irrigated agriculture, industries, municipal growth).

Due to tophographic condition there is no possibility to develop irrigation in this area. Electric energy from Besai HEPP will stimulate the industrial growth away of this region, especially near the city of Bandar Lampung. No mitigation measure is anticipated.
29. Poor land use practices in catchment areas above reservoir resulting in increased siltation and changes in water quality.

The plan of Reforestation and Land Rehabilitation on upper catchment area prepared by the project proponent is to be approved by BAPPEDA Lampung Province for erosion abatement in the Besai Catchment area. The basic plan will be used for several agencies such as Forestry Agency, Plantation Agency, Agriculture Agency, Public Work etc. to develop further plan.

Forestry Agency basically will be responsible in regreening the critical areas belong to Forestry agency. Plantation agency will be responsible in providing extension information to the coffee farmer which abundant in the upstream catchment area. The Agriculture Agency will be responsible in the extension information on dry land farmer. The farmer will be taught on developing friendly soil conservation agriculture. The Public Work Agency will develop checks dam to control erosion, if necessary.
VI. RESettlement Plan

1. OBJECTIVE

a. The Resettlement plan of affected people at Besai HEPP will be useful for providing the input of parties involved:
   - To develop a timebound resettlement plan, based on the valuation and compensation principles of land and other assets affected by the project
   - To establish a budget and an implementation schedule
   - To identify organizational responsibilities for implementation

b. To collate the people’s desire and develop other alternatives which may be acceptable to the affected people, this can be developed by the project proponent and involved agencies.

2. THE AFFECTED PEOPLE

There are 129 families which will be affected by the Besai Project: 88 families will be affected by the inundation area and the rest (41 families) will be affected by the construction area. The construction area belongs to the Forestry Agency and several people have planted coffee trees on it.

The list of affected people is presented on Table 7.1 - 7.4.

3. RESETTLEMENT OPTIONS

The suggested options which may be chosen by the affected people:

a). Purchase other agriculture land

The land compensation money may be used to buy other agriculture land in other locations, because the land compensation money is considered appropriate to buy other land in other location. So by this option, the affected people may still continue with agricultural activities. PLN will buy the alternative land, with the concurrence of PAPs who might exercise this option, and hand it over to them.

b). Trading.

After receiving the compensation money, the people may use their money for the small trading capital as follows:
• Trade in agriculture commodity abundant in that area such as coffee bean, and other annual crops.

• Open small shop

• Open small restaurant

PLN will ensure appropriate counselling for those who want it on their endeavor.

c). Small business

Besides acting as farmer on the remaining land, the other option is to open small business. The land compensation money may be used as a capital for following business activities:

• Transportation business: Motor bike transportation, small vehicle transportation.

• Workshop

• Tailors

• Home industry such as: handicraft, coffee bean processing, other agriculture commodity processing.

• Catering.

• Animal husbandry: Chicken, goat, sheep, dairy cow.

PLN will ensure appropriate counselling is available for those who want it.

d). Transmigration.

This option will be given to the people who occupy the Forestry land who may wish to transmigrate. In case the people are willing to move to other location through local transmigration or even to other island, it may be implemented. The local government of Lampung province through the Department of Transmigration and Resettlement of Forest Encroacher has a program to resettle of 2000 families per year.

e). Working at Besai HEPP Project

If the affected/local people meet the qualification stated by the project, they are welcome to send the application to work on the Besai Project. There are three parties which would need/employees i.e.:

- PLN (Perusahaan Umum Listrik Negara) as project proponent consists of two parties.
PLN Besai Project (Under the coordination of Project Principal of Generation and Transmission of Southern Part of Sumatra at Palembang). This PLN unit is responsible in the construction of Besai Project. There are few positions which may be available for the local people if they are qualified. Most of the PLN Besai project employees will come from other PLN offices.

PLN Besai Sector (Under the coordination of PLN Region I at Palembang).
This PLN Unit will be responsible on operation and maintenance of Besai HEPP. There are few position which may be available to the local people if they are qualified. Most of the PLN Besai project employees will come from other PLN offices.

PLN Besai Sector in operation and maintenance work will need cooperation of several maintenance contractors, supplier and cleaning service. Those companies will need the skilled, semiskilled and unskilled employees which may be recruited from the local people.

Contractors and suppliers of Besai HEPP project.

All of the Besai project work will be entrusted to contractors. Various contractors of civil, electrical and mechanical works will need skilled, semiskilled and unskilled labor. The people may apply for positions according to their qualifications. Most of the work and positions will be provided by those contractors.

Consultant of Besai HEPP Project.

Most of position of consultant employee will be dominated by the high education skill; in other word the position for the unskilled/semiskilled employee will be very limited here.

Education and training

PLN encourages PAPs to improve their standard of living by learning new skills. Training for new skills in vocational training schools will be made available to these PAPs who might opt for such education and training. This effort will facilitate complete restoration of the income level PAPs. PLN will ensure this.

4. LAND COMPENSATION PLAN

4.1. Land Compensation Implementation

Land acquisition is implemented pursuant to the Regulation of the KEPPRES (President Decree) No. 55/1993 with the establishment of the Committee of Land Acquisition for the public uses. The amount of the payment of compensation for
land and plants will be decided during consultation between the Committee for Land Acquisition and the population whose land is affected by the project.

The land compensation will be implemented as per the following procedure:

a. Extension of information to the affected people will be conducted prior to the payment of compensation. These activities will be conducted by the project proponent and the land compensation committee.

b. The next step is conducting the stacking out of the boundary of the needed land. This activity is being conducted by the project proponent.

c. The detailed mapping of the land holding is being done. This activity will be conducted by the land compensation committee.

d. After the maps are ready then the inventory of crop, vegetation, building or other asset will be conducted. These activities will be conducted by the land compensation committee.

e. The next step is preparing the list of the acreage of land holding, lists of affected crops and temporary structures. These activities will be conducted by the land compensation committee.

f. The last step is the payment of compensation. The payment will be given directly to the land owner through the Bank. Price negotiation will be conducted by the Land compensation Committee and will invite the project proponent and the affected people. Compensation payment will be conducted through the local Bank.

The implementation of the procedure stated above will be conducted in several stages. It depends on the priority of the land requirement or construction priorities. For example, the land for the access road and base camp will be the first priority and inundated area will be the last priority.

The compensation stages will be conducted as follows:

a. Access road and Base camp
b. Access road to Powerhouse
c. Spoil bank No. 1 - 7
d. Powerhouse, Surge tank, Intake dam
e. Temporary building yard
f. Access road to work audit No 1-3, Dam site and Surge Tank
g. Inundated area
h. Forestry replacement land.

4.2 Land compensation organization/supervision

The Land Compensation Committee has been established by The Governor of Lampung Province. The committee will be chaired by Bupati (Head of District) West Lampung and North Lampung. The committee consists of:
1. Bupati (Head of West Lampung and North Lampung District)
2. The Head of Agrarian Affairs
3. The Head of Land & Building Tax Services
4. The Agency of Local Government which responsible on Building aspects.
5. The Agency of Local Government which responsible on Agriculture services
6. The Head of Sub Districts
7. The Head of Villages

The secretary of the committee but not as a member:
1. The Head of Subdivision of District Administration
2. The Head of Agrarian Affairs Sections

4.3. Allocated budget for Land Compensation

The expenditures of land compensation budget can be divided into three categories:

a. Land compensation payment.

The compensation payment of the land asset will be three categories:
- Land.
- Vegetation/crop
- Building

The payment will follow the standard issued by the Bupati Decree.

The allocation money for this payment is approximately Rp. 2,261,510,000.-. This money will come from PLN.

b. Honorarium and expenditures of the Land Compensation Committee.

The allocation money for this expenditures is approximately Rp.73,005,000. This money will come from PLN.

c. Replacement land of the Forestry Land

The allocation money for this expenditures is approximately Rp.1,925,500,000. This money will come from PLN.

d. Land Boundary stacking out

The allocation money for this expenditures is approximately Rp.660,000,000. This money will come from PLN.

The semi detailed land compensation cost is presented in the end of this chapter.

4.4. Schedule of Land Compensation

The Land compensation schedule is presented in the following of this page (Figure 7.1).
<table>
<thead>
<tr>
<th>NO</th>
<th>ACTIVITIES</th>
<th>YEAR 1993</th>
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<th></th>
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<td>NOVEMBER</td>
<td>DECEMBER</td>
<td>JANUARY</td>
<td>FEBRUARY</td>
</tr>
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<td>2</td>
<td>Forest land area mapping</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Asset Inventory (Crop and others)</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Land Negotiation</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Land Compensation payment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. **RESETTLEMENT PLAN**

The resettlement plan will help the affected people to improve the condition of their source of income which may be disturbed by the project because part of their land or even entire land in some cases will be compensated.

5.1. Implementation of the Resettlement Plan:

a). Purchase other agriculture land

The implementation of this option will be assisted by the Resettlement Implementation Team. Based on the last negotiation between the Land Compensation Committee and the PAP's, there is no PAP's who opt for land. All of the PAP's prefer to arrange the purchasing of the new land by themselves. But the project proponent through the Land compensation Committee will solve to entertaining such request of PAP's if anybody from them should change their mind and ask for land compensation.

b). Transmigration.

Transmigration will be encouraged to the affected people who belong to the category of *forest encroacher*. The implementation agency will be the Department of Transmigration and Forest Encroacher Resettlement and it will be coordinated by the Resettlement Implementation Team.

c). Training on several skills

The training will be encouraged to the people who lost partly or totally of their income, because of land compensation. The implementation agency will be conducted by the Department of Manpower (Industrial Training Station and Agricultural Training Station) and it will be coordinated by the Resettlement Implementation Team.

Implementation of the resettlement plan is already in progress. PLN will ensure that it is completed in a phased manner well ahead of the actual construction of the proposed hydroelectric project.

5.2. Resettlement organization/supervision.

The resettlement work will be implemented by The Resettlement Implementation Team. The team will chaired be by Bupati (Head of District) West Lampung and North Lampung. The team will consist of:

1. The Agrarian Affairs
2. The Department of Transmigration and Resettlement of forest encroacher
3. The Head of Subdivision of Governmentation
4. The Department of Man Power
5. The Industrial agency
6. The Food Crop Agency
7. The Plantation Agency
8. The Forestry Agency
9. The Department of Social
10. The Head of Sub Districts
11. The Head of Villages

Because the Resettlement Implementation Team will consist of two districts, it will be coordinated by the Provincial Authorities (Chief of Governor of Development Affairs) or Head of Planning Coordinating Board (BAPPEDA) of Lampung provinces.

5.3. The counselling/assistance and grievance mechanism

The implementation team will provide the counselling facilities for the PAP's. The sectoral agencies which involved in the Resettlement Implementation Team will assist the PAP's in developing of their desire program. The implementation team will provide the limited/emergency financial assistance for the PAP's. The credit assistance to get the capital to run the business will also be provided by the Resettlement Implementation Team.

The grievance of the PAP's will be channelled through the informal leader of the PAP's or the head of the village and it will be conveyed to the Resettlement Implementation Team and Land Compensation Committee. The committee will sit together with PLN as project proponent and discuss to solve the problem. If the Resettlement Implementation Team and Land Compensation Committee can not solve the problem, it will be handed over by the Provincial Government level (Governor of Lampung Province). If the result of the problem solving is not satisfactorily for the PAP's, it will be discuss in the interdepartmental level which will be coordinated by the National Coordinating Board (BAPPENAS).

5.4. Allocated budget for Resettlement

The allocated budget for resettlement will be as follows:

a. Training cost for about 120 persons.

The allocation money for this expenditures is approximately Rp. 244,000,000,-. This money will be provided by PLN.
b. Transmigration cost

The allocation money for this expenditures is approximately Rp. 435,000,000,-. This money will be provided by Department of Transmigration and Forest Encroacher Resettlement.

c. Resettlement Implementation Team

Resettlement Implementation Team will be in duty for approximately 7 years (5 years during construction stages and 2 years during operation stage). The allocation money for this expenditures is approximately Rp. 518,000,000. This money will be provided by PLN.

d. Monitoring of Resettlement and Land Compensation implementation

Monitoring of Resettlement and Land Compensation Implementation will be carried out for approximately 7 years (5 years during construction stages and 2 years during operation stage).

The allocation money for this expenditures is approximately Rp. 75,000,000,-. This money will be provided by PLN.

The semi detailed resettlement cost is presented in the end of this chapter.

5.4. Resettlement Implementation Schedule

The resettlement implementation schedule is presented in the following of this page (Figure 7.2).

6. PLN's COMMITMENTS

To ensure that the former living standards, including the earning capacity of the PAPs are improved, PLN is committed to do the following:

- Arrange for land compensation to those who opt for it before the start of actual construction. In case a suitable and acceptable land cannot be found before the land is required for construction, PLN will provide for adequate transition allowance;
- Counselling and credit facilities will be made available to those wishing to engage in small business and other trade activities;
- Education and training will be provided in vocational schools to those who may opt for such schemes.
7. **MONITORING**

Monitoring of the resettlement and land compensation processes and impacts will be carried out by independent agency, i.e. local university in cooperation with local Non Government Organization (NGO). Reporting will be made twice a year during construction stage (5 years) and two years after the project completion. PLN should send the monitoring Reports to the World Bank, Washington (with copy to the Resident Mission of the Bank at Jakarta) within two weeks of the relevant period.
## Figure 7.2

**RESETTLEMENT IMPLEMENTATION SCHEDULE**

**BESAI HYDROELECTRIC POWER PROJECT**

<table>
<thead>
<tr>
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<th></th>
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<tr>
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<td>Land compensation payment</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Purchase new agricultural land (if necessary)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Training of several skill</td>
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<td></td>
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</tr>
<tr>
<td>4</td>
<td>Open new business</td>
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<td></td>
</tr>
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<td>5</td>
<td>Transmigration/Forest encroacher resettlement</td>
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<tr>
<td>6</td>
<td>Monitoring</td>
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</tr>
<tr>
<td>7</td>
<td>Resettlement committee activities</td>
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<td></td>
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</tr>
</tbody>
</table>
Table 7.1. Number of Owners and Area of Land for Access Road

Location: Dusun Dwikora Barat (Ds.5)

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Head of Family</th>
<th>Affected (Ha)</th>
<th>Not Affected (Ha)</th>
<th>Total (Ha)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Masnan</td>
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<td>1.70</td>
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<tr>
<td>2</td>
<td>Gunawan</td>
<td>0.28</td>
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<tr>
<td>3</td>
<td>Yazid</td>
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<td>1.07</td>
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<tr>
<td>4</td>
<td>Suhaimi</td>
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<td>5</td>
<td>Junaidi</td>
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<td>6</td>
<td>Saini</td>
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<td>7</td>
<td>Muis</td>
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<td>8</td>
<td>Ramsi</td>
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<td></td>
<td>Sub total</td>
<td>2.75</td>
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<td>6.80</td>
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</table>

Sub total | 9.55

Note: The acreage stated in this table is rough estimation not intended to be used for land compensation.
**Location: Dusun Lubuk Laban**

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Head of Family</th>
<th>Affected (Ha)</th>
<th>Not Affected (Ha)</th>
<th>Total (Ha)</th>
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<td>12</td>
<td>Supli</td>
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<td>Tasan</td>
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<td>1.00</td>
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<td>Hairin</td>
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<td>Syahril</td>
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</table>

**Sub. Total**  | 7.98               | 20.52          | 28.50           

**Total**       | 12.27              | 31.28          | 43.55           

Note: The acreage stated in this table is rough estimation not intended to be used for land compensation.
Table 7.2. List of affected people whose own land at Power House & Spoil bank Besai HEPP
Dusun Dwikora Barat (Dusun 5 and Dusun 1)

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Head of Family</th>
<th>Estimation affected land (Ha)</th>
<th>Estimation non-affected land (Ha)</th>
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<td>Estimation affected land (Ha)</td>
<td>Estimation non-affected land (Ha)</td>
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<tr>
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Note: Land acreage stated in this table is rough estimation not intended to be used for land compensation.
Table 7.3. List of Land owners Affected by the Besai HPP Project,
Village of Sukapura, Sub-District (Kecamatan) of Sumber Jaya, West Lampung
(INUNDATED AREA)

<table>
<thead>
<tr>
<th>No</th>
<th>NAME</th>
<th>TOTAL AREA TO BE INUNDATED (Ha)</th>
<th>LAND USE</th>
<th>NON AFFECTED LAND (Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>Fajri</td>
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<td>Wet rice</td>
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<tr>
<td>43</td>
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</tr>
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<td>Julik</td>
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<td>Cecak</td>
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<td>Wet rice</td>
<td>1.00</td>
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<td>47</td>
<td>Kasman</td>
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<td>Ruhadi</td>
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</tr>
<tr>
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<td>Sarmad</td>
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<tr>
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<td>Sadiman</td>
<td>1.00</td>
<td>Wet rice</td>
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<tr>
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<tr>
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<td>Sahalik</td>
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<td>Sulaiman</td>
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<tr>
<td>60</td>
<td>Bahrudin</td>
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<td>Bare land</td>
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<tr>
<td>61</td>
<td>Darman</td>
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<tr>
<td>62</td>
<td>Misman</td>
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<tr>
<td>63</td>
<td>Ipun Sulaeman</td>
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<tr>
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<tr>
<td>68</td>
<td>Juhana</td>
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<td>Wet rice</td>
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</table>

Sub-Total 23.125 31.175

Note: The acreage stated in this table is rough estimation is not intended for land compensation.
<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Total Area To Be Inundated (Ha)</th>
<th>Land Use</th>
<th>Non Affected Land (Ha)</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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<td>Panarman</td>
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</tr>
<tr>
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<td>Oji Rosidi</td>
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<tr>
<td>72</td>
<td>Taryan</td>
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<td>0.25</td>
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<tr>
<td>73</td>
<td>Kholid</td>
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</tr>
<tr>
<td>74</td>
<td>Jamad</td>
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</tr>
<tr>
<td>75</td>
<td>Sajak</td>
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<td>Wet rice</td>
<td>1.50</td>
</tr>
<tr>
<td>76</td>
<td>Somantri</td>
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<td>Bare land</td>
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<tr>
<td>77</td>
<td>Saspan</td>
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<tr>
<td>78</td>
<td>Madnan</td>
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<td>0.25</td>
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<tr>
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<td>Jaman</td>
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<td>Oma</td>
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<td>Suladin</td>
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Sub-Total 16.04 16.00

Note: The acreage stated in this table is a rough estimation and is not intended for land compensation.
Table 7.3. List of Land owners Affected by the Besal HPP Project,
Village of Sukapura, Sub-District (Kecamatan) of Sumber Jaya, West Lampung
(INUNDATED AREA)

<table>
<thead>
<tr>
<th>No</th>
<th>NAME</th>
<th>TOTAL AREA TO BE INUNDATED (Ha)</th>
<th>LAND USE</th>
<th>NON AFFECTED LAND (Ha)</th>
</tr>
</thead>
<tbody>
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<td>95</td>
<td>Sarja</td>
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<td>Ujuk</td>
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<td>Wet rice</td>
<td>0.75</td>
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<tr>
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<td>Ganda</td>
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<td>Wet rice</td>
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</tr>
<tr>
<td>98</td>
<td>Zarkasih</td>
<td>0.75</td>
<td>Wet rice</td>
<td>0.00</td>
</tr>
<tr>
<td>99</td>
<td>Sarjan</td>
<td>0.50</td>
<td>Dry Cultivation</td>
<td>0.00</td>
</tr>
<tr>
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<td>Sajar</td>
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<tr>
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<td>Dry Cultivation</td>
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<td>Tatak</td>
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<td>103</td>
<td>Omin</td>
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<td>Wet rice</td>
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</tr>
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<td>104</td>
<td>Sutarman</td>
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<td>1.00</td>
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<td>Sabar</td>
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<td>Alijan</td>
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</table>

Sub-Total 7.81 4.65

Note: The acreage stated in this table is rough estimation is not intended for land compensation.
Table 7.4. List of Land owners Affected by the Besal HPP Project,
Village of Waypetal, Sub-District (Kecamatan) of Sumber Jaya, West Lampung
(INUNDATED AREA)

<table>
<thead>
<tr>
<th>No</th>
<th>NAME</th>
<th>TOTAL AREA TO BE INUNDATED (Ha)</th>
<th>LAND USE</th>
<th>NON AFFECTED LAND (Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>108</td>
<td>Umar Nawi</td>
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<td>Estate</td>
<td>1.00</td>
</tr>
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<td>109</td>
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<tr>
<td>110</td>
<td>Nangsina</td>
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<td>Ridl</td>
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<td>112</td>
<td>Nurdik</td>
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<td>1.00</td>
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<td>Mawi</td>
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<tr>
<td>124</td>
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<tr>
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<tr>
<td>129</td>
<td>Urmen</td>
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</table>

Sub-Total 19.25 13.25

Total 66.23 65.08

Note: The acreage stated in this table is rough estimation is not intended for land compensation.
## ESTIMATION OF LAND ACQUISITION, COMPENSATION AND RESETTLEMENT COST BESAI HYDROELECTRIC POWER PROJECT

### LAND ACQUISITION/COMPENSATION COST

#### PROJECT AREA

#### 1.1 ACCESS ROAD AND BASE CAMP (15.11 HA COFFEE, 2 HA PADDY)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area (ha) x Rate (Rp)</th>
<th>Cost (Rp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.11</td>
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<tr>
<td>2.00</td>
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#### 1.2 ACCESS ROAD TO POWER HOUSE

<table>
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<th>Area (ha) x Rate (Rp)</th>
<th>Cost (Rp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.20</td>
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</table>

#### 1.3 SPOIL BANK NO 1-7

<table>
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<th>Cost (Rp)</th>
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<tr>
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#### 1.4 POWER HOUSE, SURGE TANK, INTAKE DAM

<table>
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<tr>
<th>Crop</th>
<th>Area (ha) x Rate (Rp)</th>
<th>Cost (Rp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.55</td>
<td>5,000,000</td>
<td>62,750,000</td>
</tr>
</tbody>
</table>

#### 1.5 TEMPORARY BUILDING YARD

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area (ha) x Rate (Rp)</th>
<th>Cost (Rp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.13</td>
<td>5,000,000</td>
<td>60,650,000</td>
</tr>
</tbody>
</table>

#### 1.6 ACCESS ROAD TO WORK ADIT NO. 1-3, DAM SITE AND SURGE TANK

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area (ha) x Rate (Rp)</th>
<th>Cost (Rp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.71</td>
<td>5,000,000</td>
<td>83,550,000</td>
</tr>
</tbody>
</table>

#### 1.7 INUNDATED AREA

<table>
<thead>
<tr>
<th>Crop/Land</th>
<th>Area (ha) x Rate (Rp)</th>
<th>Cost (Rp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85.34</td>
<td>20,000,000</td>
<td>1,706,800,000</td>
</tr>
<tr>
<td>85.34</td>
<td>6,500,000</td>
<td>554,710,000</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>2,261,510,000</td>
</tr>
</tbody>
</table>

### TOTAL 1.1.1 - 1.1.7

<table>
<thead>
<tr>
<th>Cost (Rp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,540,210,000</td>
</tr>
</tbody>
</table>

VII - 19
1.1.8 COMMITTEE HONORARIUM Rp. 7,000,000
1.1.9 COMMITTEE ADMINISTRATION (1.5%) Rp. 39,603,150
1.1.10 MAPPING AND ASSET INVENTORY (1%) Rp. 26,402,100

TOTAL 1.1.1 - 1.1.10 Rp. 2,713,215,250

1.2 FOREST REPLACEMENT LAND

1.2.1 LAND COMPENSATION

<table>
<thead>
<tr>
<th>Land</th>
<th>60 ha x Rp</th>
<th>15,000,000 = Rp</th>
<th>900,000,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop</td>
<td>60 ha x Rp</td>
<td>4,000,000 = Rp</td>
<td>240,000,000</td>
</tr>
</tbody>
</table>

= Rp 1,140,000,000

1.2.2 REVEGETATION 60 ha x Rp 10,000,000 = Rp 600,000,000

1.2.3 STUDY OF REFORESTATION & LAND REHABILITATION = Rp 150,000,000

1.2.4 COMMITTEE HONORARIUM Rp. 7,000,000
1.2.5 COMMITTEE ADMINISTRATION Rp. 17,100,000
1.2.6 MAPPING AND ASSET INVENTORY Rp. 11,400,000

TOTAL 1.2.1 - 1.2.6 Rp. 1,925,500,000

1.3 LAND BOUNDARY STACKING OUT

1.3.1 PROJECT AREA 160 ha x Rp 3,000,000 = Rp 480,000,000

1.3.2 FORESTRY REPLACEMENT LAND 60 ha x Rp 3,000,000 = Rp 180,000,000

TOTAL 1.3.1 - 1.3.2 Rp. 660,000,000

TOTAL LAND COMPENSATION Rp. 5,298,715,250
## II. RESETTLEMENT COST

### II.1 TRAINING (120 PERSONS)

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>Rp. 10,000,000</td>
</tr>
<tr>
<td>Living accommodation</td>
<td>Rp. 90,000,000</td>
</tr>
<tr>
<td>Living allowance</td>
<td>Rp. 60,000,000</td>
</tr>
<tr>
<td>Instructor</td>
<td>Rp. 24,000,000</td>
</tr>
<tr>
<td>Training facilities</td>
<td>Rp. 50,000,000</td>
</tr>
<tr>
<td>Hand outs</td>
<td>Rp. 10,000,000</td>
</tr>
<tr>
<td><strong>TOTAL II.1</strong></td>
<td>Rp. 244,000,000</td>
</tr>
</tbody>
</table>

### II.2 TRANSMISSION (40 FAMILIES)

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recruitment</td>
<td>Rp. 10,000,000</td>
</tr>
<tr>
<td>Site Visit</td>
<td>Rp. 25,000,000</td>
</tr>
<tr>
<td>Living allowance &amp; Moving</td>
<td>Rp. 400,000,000</td>
</tr>
<tr>
<td>cost 40 x Rp. 10,000,000</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL II.2</strong></td>
<td>Rp. 435,000,000</td>
</tr>
</tbody>
</table>

### II.3 RESETTLEMENT COMMITTEE

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational cost (7 years)</td>
<td>Rp. 350,000,000</td>
</tr>
<tr>
<td>7 x Rp. 50,000,000</td>
<td></td>
</tr>
<tr>
<td>Honorarium (7 years)</td>
<td>Rp. 168,000,000</td>
</tr>
<tr>
<td>7 x Rp. 24,000,000</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL II.3</strong></td>
<td>Rp. 518,000,000</td>
</tr>
<tr>
<td><strong>TOTAL II.1 - II.3</strong></td>
<td>Rp. 1,197,000,000</td>
</tr>
</tbody>
</table>
### III MONITORING COST OF RESETTLEMENT AND LAND COMPENSATION

Monitoring by the local University & NGO (7 years)

$7 \times \text{Rp. 50,000,000} = \text{Rp. 350,000,000}$

Monitoring by the local government (7 years)

$7 \times \text{Rp. 30,000,000} = \text{Rp. 210,000,000}$

**TOTAL III**

$\text{Rp. 560,000,000}$

**TOTAL I + II + III**

$\text{Rp. 7,055,715,250}$

**EQUIVALENT**

$\text{US $} 3,345,526$

Price level is October 01, 1993 (1 US $ = \text{Rp. 2109} = 105.02 \text{Yen})
I. MANAGEMENT INSTITUTIONAL

Project proponent of Besai Hydro Electric Power is Perusahaan Umum Listrik Negara (PLN) an Agency of Mines and Energy Ministry. There are two bodies in Mines and Energy Ministry which handle the Environmental Impact Assessment i.e. The first one is Central Commission of Environmental Impact Assessment Ministry of Mines and Energy (Komisi Pusat AMDAL). The commission consists of senior officials and environmental experts from various ministry involved and chaired by the General Secretary of Mines and Energy Ministry. The second one is Division of Environmental which is developed to handle daily environmental problem.

Under The Ministry of Mines and Energy, there is a Directorate General Electric and Energy Development which provide the authority to perform the supervision to the PLN. The Environmental Sub Division in this directorate provides assistance and to evaluate the environmental management and monitoring report of the project. Technical Team of Environmental Impact Assessment in this Directorate is developed to provide the technical assistance to the Central Commission. The Technical Team is chaired by the Director of Electricity planning.

The PLN head quarter which is responsible all of the Besai Project located in Jakarta a Capital City of Republic Indonesia, about 300 Km from the project site. There are several Divisions and Office in Hebu quarter will be involved in Project environmental related, namely:

1. System Planning Division (c.q. Survey Sub Division), under the Director of Planning is responsible on feasibility study of the project (including Environmental Impact Assessment).
2. Hydro Project Controlling and Supervision Division, under the Director of Development is responsible on controlling and supervision during project implementation.
3. Hydro operation Controlling and Supervision Division, under the Director of Operation is responsible on controlling and supervision during power plant generation and maintenance.
4. Engineering Service Center is responsible on engineering design of Besai Project, including the environmental management and monitoring plan.
5. PLN's AMDAL Team comprises senior officials and experts in environmental aspects, responsible on Environmental Impact assessment procedures.

The PLN units which will be responsible to coordinate daily implementation of the project is Principal project of Generation and Transmission of South part of Sumatra, which located in Palembang about 500 Km from the site. The daily implementation will be conducted by Besai Hydro Electric Power Project office located in Besai site. The environmental management and monitoring during construction will be conducted by the Public Relation and Environmental Sub Division.
After the project completed the management of power plant will be shifted to PLN Region IV which cover Lampung, Bengkulu, South Sumatra and Jambi Provinces. The management office at site will be formed namely PLN Sector Besai. The environmental management and monitoring during power plant operation will be conducted by the Environmental Section.

According to law and Government regulation, PLN as a project proponent has specific authority in dealing with environmental aspect of project related. Several environmental impact mitigation and management should be conducted by the involved sectoral agencies, although it is project impact related such as:

- Management of Impact on Fisheries Should be conducted by Fisheries Agencies
- Erosion control in the upper catchment area will be conducted by several agencies such as:
  - Department of Forestry to rehabilitate the bald/critical area of land under their jurisdiction.
  - Department of Agriculture (Food Crop Agency) to supervise and provide information extension to the farmer to develop better soil conservation on food crop land
  - Department of Agriculture (Plantation Crop Agency) to supervise and provide information extension to the farmer to develop better soil conservation on private plantation land.

- Land compensation and associated problem of it will be conducted by Land Compensation Committee developed by the Governor of Lampung Province etc.

II. TRAINING

1. PLN PRINCIPAL PROJECT OF GENERATION AND TRANSMISSION OF SOUTH PART OF SUMATRA AND BESAI PROJECT.

Training of personnel of Public Relation and Environmental sub division at PLN PRINCIPAL PROJECT OF GENERATION AND TRANSMISSION OF SOUTH PART OF SUMATRA on environmental management and monitoring will be needed. Comparative study to similar project will also be conducted.

Personnel of Civil sub division at PLN Besai Project will also be trained to handle the project in environmentally manner.

2. PLN REGION IV AND PLN BESAI SECTOR.

Personnel of Environmental subsection who will handle the environmental management and monitoring of Besai Project will be trained on its aspects.
IX. MONITORING

1. PUBLIC HEALTH AND DISEASE VECTOR

Monitoring of public health will be conducted through the PUSKESMAS (Public Health Center) and at Polyclinic at construction camp. The malaria and infection of intestine disease will be the main attention to be monitored. The monitoring will be carried out during construction and during the operation stage. Mosquito as a malaria disease vector will be monitored in the adult stage as well in larvae stage. The reservoir will be monitored whether it will be a good new habitat for the mosquito larvae.

2. EROSION RATE AND SEDIMENT DEPOSITION

Monitoring of erosion rate will be conducted at the upstream river discharge. This will be conducted each month, especially during the rainy season. Sediment deposition monitoring at reservoir will be conducted yearly.

3. WATER DISCHARGE

Monitoring of water discharge will be conducted by continuous automatic monitor equipment at dam site.

4. WATER QUALITY

Water quality will be monitored quarterly at reservoir.

5. AQUATIC WEED

The spreading area of floating and submerged aquatic weed at reservoir will be monitored each month.

6. WILDLIFE

The possibility disturbance of construction activity will be monitored.

7. CONSTRUCTION WORKER

The number of construction worker will be monitored each month, consist of local worker and migration worker.
8. SOCIO-ECONOMIC OF AFFECTED PEOPLE

The socio-economic condition of the affected people will be monitored each year.

9. WATERSHED CONDITION

Monitoring of watershed condition will be conducted by the Land Rehabilitation and Conservation Station each year.

10. FISHERY

Fish production, fish species, number of people dealing with fisheries will be monitored by the Fisheries Agency.
## IMPACT CHECKLIST FOR
### BESAI-BUKIT KEMUNING TRANSMISSION LINE PROJECTS
#### (150 KV, 12.5 KMS)

<table>
<thead>
<tr>
<th>Actions Affecting Environmental Resources</th>
<th>Potential Environmental Impact</th>
<th>Initial Environmental Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No significant Impact</td>
<td>Significant Impact</td>
</tr>
<tr>
<td></td>
<td>Small</td>
<td>Moderate</td>
</tr>
<tr>
<td>A. Project Siting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Ecologically - sensitive areas</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2. Historical/cultural features</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3. Settlements</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>4. Land value/use changes</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>5. Land form/drainage alternation</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>B. Project Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Critical environmental areas</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2. Historical/cultural features</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3. Settlement/without들 settlement</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>4. Land values/uses</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>5. Landform/drainage alterations</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>6. Safety: Explosion/hazardous spill</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7. Noise/Vibration/Pollution</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>8. Worker health &amp; safety</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>9. Access roads</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>C. Construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Construction methods</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2. Hunting/poaching/woodcutting</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3. Construction camps</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>D. Operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Project maintenance</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2. Access control</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3. Land management</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL IMPACT ASSESSMENT-BESAI HPP**
PRELIMINARY IMPACT ASSESSMENT OF
BESAI-BUKIT KEMUNING TRANSMISSION LINE PROJECTS
(150 KV, 12.5 KMS)

A. Project sitting

1. Ecologically - sensitive areas

The transmission will not go through the ecologically sensitive area. It will
go through the bushes, agriculture area (coffee, annual crop etc.).
There is no forest, swamp, parks or other ecologically sensitive area which
will be affected by the project.

2. Historical/cultural features

There is no historical and cultural features will be affected by the
transmission lines. The project will not likely affect the tourism activities.

3. Settlements

There is no houses should be relocated, and no houses will be passing over
by the transmission lines.

4. Land value/use changes

Most of the land use passed over by the transmission lines are bushes and
agricultural land. The crops grow on those land will not be disturbed, except
the crop or vegetation on the tower site. The farmer may allow to grow the
existing crop or similar one on the affected land. So, there will be no
depreciation on the value of the land anticipated.

5. Landform/drainage alterations

There will be no topographic features changes caused by this project. The
transmission lines will not affect the passageways for the communities and
the wildlife pattern nor the drainage pattern as well.

B. Project Design

1. Critical environmental areas

The route design has considered not to pass the settlement areas and other
sensitive environmental areas.

2. Historical/cultural features

There is no historical and cultural features will be affected by the
transmission lines. The project will not likely affect the tourism activities.
3. **Settlement/resettlement**

There is no houses should be relocated, and no houses will be passing over. Compensation payment will be given to the people whose land affected by the tower of the transmission lines and the trees/crops affected by the project activities.

4. **Land values/uses**

Most of the land passed over the transmission lines area bushes and agricultural land. The tall trees which will exceed the safety clearance of the transmission lines will be cut and the trees owner will be given compensation.

5. **Landform/drainage alterations**

The transmission lines will pass over the bushes and agricultural land. Most of the crop and bushes will be let uncleared and it will be very few tall trees been cut. The safety clearance has accommodated this matter, so the impact of the project on the land form and drainage alterations can be neglected.

6. **Risk of Explosion/hazardous spill**

The transmission line has been designed to prevent the accidental failure of power lines caused by storm, strong wind, earthquake, lightening, air pollution etc. The design has accommodated the risk of explosion as well. There is no hazardous spill anticipated since no hazardous liquid will be used such as oil containing PCB in the transformator.

7. **Noise/Vibration/Pollution**

During construction phase, the noise, vibration generated by construction activities will be low. There is insignificant pollution of exhaust gas and dust generated by the construction and supply vehicle. During operation there is no vibration and pollution generated by the transmission lines. Transmission lines will be designed to meet the environmental standard of noise level.

8. **Worker health & safety**

During construction phase, there is a risk of the worker to fall down from the tower. To prevent the accident, the worker will be provided with the safety measures such as safety belts, gloves, shoes, helmet etc. Construction of tower and stringing activities of the line will also consider the safety for the community and the traffic.

9. **Access roads**

The transmission lines will almost in parallel with the existing highway connecting the Bukit kemuning through Besai to Liwa. There are also several village road and pathway across the right of way. The right of way is considered an open area and the access is relatively easy to carry the construction material such as the tower material and the cable of the line. In this regard there will be no special access road necessary.
C. Construction

1. Construction methods

The construction methods will consider the prevention of soil erosion. There will be insignificant noise and dust generated by the construction activities. The total clear and cut of the vegetation will be happened only on the tower sites. Cut and fill of the soil will be kept to minimum to prevent soil erosion.

2. Hunting/poaching/woodcutting

There is no potential wildlife or valuable vegetation exist along the right of way which may be hunt/collected/cut by the worker or the surrounding people.

3. Construction camps

Since the transmission is relatively short (12.5 Km), the worker of construction activities will be small, so the construction camp will also small. The demand of water supply and sanitation will not disturb the balance in the chosen area. The impact of the worker on the public health of the local communities will be small.

D. Operation

1. Project maintenance

The transmission line has been designed to prevent the accidental failure of power lines caused by storm, strong wind, earthquake, lightening, air pollution, fire hazard etc. The design has accommodate the risk of explosion and line failure as well. If the line fail, the safety mechanism in the substation will disconnect the power current less than a second, so the broken lines will harmless to the people/wildlife.

2. Access control

There is no special natural resources along the right of way which may be threatened, so no access control is necessary.

3. Land management

The monitoring of the right of way will be carried out regularly to monitor the possible land slide on the surrounding tower and the trees which may grow taller than the clearance zone which may be dangerous.
PROJECT FEATURES

The Besai Hydroelectric Power Project is located in the upper reach of the Besai river, a tributary of the Tulangbawang river which is one of three major rivers in the Lampung province off Sumatera, draining into the Java Sea as shown Drawing No.1.

The Project is formulated as a run-of-river type development with a daily regulating storage capacity.

Harnessing available 95% dependable firm discharge of 8.3 m³/sec and water head of about 245 m, the project is planned to produce an annual energy of 402 GWh consisting of 144 GWh for primary energy and 258 GWh for secondary energy, with an installed capacity of 90 MW. It aims to supply the electric power to the public in the PLN Region IV system so as to cope with the rapid increasing power demand of the system so as to cope with the policy of the Indonesian government, i.e. preservation of the oil resources by developing hydro power potential with the highest development priority.

The principal features of the project are summarized below:

Operation features of the Project

i) Water levels
   Intake water level:
   FSL EL. 722.0 m
   LOL EL. 720.9 m
   MOL EL. 719.0 m
   RWL EL. 721.6 m

   Tail water level:
   TWL EL. 477.0 m
   (for Q = 45.6 m³/sec, 2 units operation)
   TWL EL. 476.8 m
   (for Q = 22.8 m³/sec, 1 unit operation)

ii) Discharges
   95% dependable firm discharge:
   8.3 m³/sec.
   Plant discharge:
   45.6 m³/sec.
   (for 2 units operation)

ENVIRONMENTAL IMPACT ASSESSMENT-BESAI HPP
iii) Power generation and energy output
Installed capacity : 90 MW
(45.0 MW x 2 = 90 MW)
Power generation, peak : 90 MW
Annual energy, primary : 144 GWh
Annual energy, secondary : 258 GWh

Major structural features of the Project

i) Intake pondage
Catchment area : 415 km²
Annual average runoff : 24.3 m³/sec.
Water level
Extra-ordinary FWL 725.8 m
Design FWL 723.0 m
FSL 722.0 m
LOL 720.9 m
MOL 719.0 m
Pondage surface area : 0.7 km²
Storage capacity, gross, active : 1,200,000 m³, 1,047,000 m³

ii) Intake Dam
Type
Gated concrete weir
Dam crest elevation
EL. 726.3 m
Weir crest elevation
EL. 714.5 m
Sill elevation
EL. 713.0 m
Sluiceway 26.0 m wide
Sluice gate
6.5 m wide x 7.95 m high x nos.
Scouringway
12.0 m wide
Scouring gate
6.0 m wide x 1.5 m high x nos.
Stoplogs
6.5 m wide x 7.8 m total
high x 1 no. for sluiceway
6.0 m wide x 3.9 m total
high x 1 no. for scouringway

iii) Intake
Inlet dimension
13.8 m wide x 10.1 m high
Sill elevation
EL. 716.2 m
Intake gate
3.6 m wide x 6.1 m high x 2 nos
Trashracks
6.0 m wide x 10.1 m high x 2 nos
Trash ranking system
1 set
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>iv) Sand Trap basin</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Width: 17.3 m x 2 nos.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Length: 60.3 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Width of side spillway: 40.1 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crest elevation of Sand flush gate: EL. 722.0 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Side spillway: 1.0 m wide x 1.0 m high x 2 nos.</td>
<td></td>
</tr>
<tr>
<td>v) Inlet of Headrace Tunnel</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inlet dimension: 7.6 m wide x 10.1 m high</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sill elevation: EL. 716.2 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trashracks: 7.6 m wide x 10.1 m high x 1 no.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inlet gate: 7.0 m wide x 6.1 m high x 1 no.</td>
<td></td>
</tr>
<tr>
<td>vi) Headrace Tunnel</td>
<td></td>
<td>Concrete lined circular tunnel</td>
</tr>
<tr>
<td></td>
<td>Type: 4.3 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diameter: 4,893.2 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Length: 4,893.2 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sand drainage facilities: 600 mm φ hollow jet valve x 1 no., 600 mm φ steel conduit, 40 m in length x 1 lane</td>
<td></td>
</tr>
<tr>
<td>vii) Surge Tank</td>
<td></td>
<td>Restricted orifice type, prestressed concrete with reinforced concrete shaft</td>
</tr>
<tr>
<td></td>
<td>Tank: 94.7 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up-surging water level: EL. 733.4 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Down-surging water level: EL. 702.8 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diameter: 13.0 m in Chamber</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.5 m in riser shaft</td>
<td></td>
</tr>
<tr>
<td>viii) Penstock</td>
<td></td>
<td>Inclined/horizontal pressure shaft, steel lined</td>
</tr>
<tr>
<td></td>
<td>Type: 3.8 m to 1.8 m (3.4 m on an average)</td>
<td></td>
</tr>
<tr>
<td>ix) Powerhouse</td>
<td></td>
<td>Surface type</td>
</tr>
<tr>
<td></td>
<td>Type: 28.0 m wide x 44.0 m long x 36.0 m high</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Main building dimension: 10.0 m wide x 32.0 m long x 8.0 m high</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Office and control building dimension: 2.4 m wide x 2.3 m high x 2 nos.</td>
<td></td>
</tr>
<tr>
<td>x) Generating Equipment</td>
<td></td>
<td>Vertical shaft Francis type</td>
</tr>
<tr>
<td></td>
<td>Turbine Type: 2 units</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of units: 46,400 kW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rated output: 231.3 m</td>
<td></td>
</tr>
<tr>
<td><strong>Rated speed</strong></td>
<td>500 rpm</td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>----------</td>
<td></td>
</tr>
</tbody>
</table>

**Generator**
- **Type**: 3-phase, vertical shaft, synchronous type
- **Number of units**: 2 units
- **Rated capacity**: 53,000 kVA
- **Rated voltage**: 11 kV
- **Frequency**: 50 Hz
- **Power factor**: 0.85 lagging

**Main transformer**
- **Type**: 3-phase oil immersed, forced-oil-circulation and forced air cooled, outdoor use type
- **Number of units**: 2 units
- **Voltage**: 11/150 kV
- **Capacity**: 53,000 kVA

**Transmission Line**
- **Transmission line route**: Power station-Existing Transmission line between Baturaja and Kotabumi around Bukit Kemuning
- **Length**: 16 km
- **Number of circuit**: Double circuit
- **Voltage**: 150 kV
- **Conductor**: ACSR 240 mm²
- **Tower**: Double circuit steel towers