JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

P.T. PLN (PERSERO)
THE REPUBLIC OF INDONESIA

FEASIBILITY STUDY
ON
THE WARSAMSON HYDROELECTRIC POWER DEVELOPMENT PROJECT
IN
THE REPUBLIC OF INDONESIA

FINAL REPORT

SUPPORTING REPORT

VOLUME-V ENVIRONMENTAL SURVEY

FEBRUARY 1996

PACIFIC CONSULTANTS INTERNATIONAL

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I. INTRODUCTION.

1. Background.

The Government of the Republic of Indonesia, hereinafter the PT. PLN (PERSERO) wishes to develop the Warsamson HEPP by utilizing the water of Warsamson River, approximately 22 km of the western part of Sorong, Irian Jaya.

On the basis of the result of Feasibility Study for Warsamson HEPP that will be developed by "reservoir" type, by utilizing rated head of about 54 m for capacity 46.5 MW and with mean total energy of 247.4 GWh per annum. The construction of this project will, without doubt, gives the impacts toward the environment, negative as well as positive.

By the supply of hydro electric power in this area, Warsamson HEPP will be very usefull. Nevertheless, negative impacts might arise :

- Considerable land use for the reservoir that covers forestrial area, partly villages and up-land area, might affect the flora and fauna as well as social-economic of the area. The change of environment from natural land into water environment will cause wildlife in the area searching for new habitat.

- Utilization of river water for hydro electric power generation will change the flow pattern in the downstream. And if no consideration is taken into account on the proper environmental management activities, it will give negative impacts in the downstream area.

Prior to the implementation of the construction activities, Enviromental Impacts Analysis (EIA) shall be required to minimize the negative impacts and maximize the positive impact of Warsamson HEPP construction activities. This environmental study (EIA) is related to government policy in implementing the sustainable development which is emphasized of national development with the environmental concept.

a. Relevant Laws and Regulations.

Activities of the Warsamson HEPP construction will give effect on the environment. To arrange the management and utilization of natural resources and living environment based on national policy standard integrally and comprehensively, principal laws and regulations are made being the principles for natural resources management and living environment. Principle laws and regulations enacted by the government is closely related to the development of hydroelectric power project, namely :

(1) Law No. 4/ 1982 describing Basic Provisions on Environmental Management.
(2) Laws No. 5/1990, about Natural Resource Conservation and Ecosystem.
(3) Government Regulation No. 20/1990, about Water Pollution Control.
(4) Government Regulation No. 51/ 1993 about Environmental Impact Assessment.
(5) Decree of Head of Bapedal (Environmental Impact Management Agency) No. : Kep. 056/ 1994 on the Guideline on Significant Impact Criteria.

(5) Decree of Head of Bapedal (Environmental Impact Management Agency) No. : Kep. 056/ 1994 on the Guideline on Significant Impacts Criteria.

(6) Decree of the State Minister for Environment No. KEP- 14/MENLH/3/1994 on the Guideline of Environmental Impacts Assessment and Appendices.

(7) Decree of Agreement by Forestry Minister and Mines and Energy Minister, No. 969.K/05/M.PE/1989
No.429/Kpts-I/1989 about the Guideline on the Implementation Arrangement of Mining and Energy Activities in Forestrial Area.

(8) Ministerial Decree of Mines and Energy, No : 0935K/008/MPE/1988, August 31, 1988 on Technical Guideline of Arrangement for Preliminary Environmental Information and Environmental Impact Analysis for activities in Hydro Electric Power Project, accompanied with Appendix I B.

(9) Decree of State Minister of Population and Environment No. KEP-02/MENKLH/I/1988 about Guideline on Stipulation of Quality Standard for Water in Water Source and Air.

(10) Ministerial Decree of Mines and Energy No.103.K/008/MPE/1994 about Supervison on Implementation of Environmental Management and Monitoring Plans for Mines and Energy Sector.

(11) Presidential Decree No.55, 1993 describing Land Acquisition for Development Implementation for Public Interest.

(12) Ministerial Decree of Mines and Energy No.1894.K/09/DPE/1994, about Implementation of Environmental Monitoring for Mines and Energy Sector.

b. Environmental Management Implementation Policy.

Development is a conscious effort to manage and utilize resources to enhance people living quality (Anonymous, 1982). Natural resources is not limited in the amount and quality, meanwhile human needs towards natural sources has been increasing with the ever increasing of population growth and type of demand, and accordingly, contribution of environmental force is disturbed and the quality of living environment has been degrading.

Implementation of development by various activities has increasingly resulted in the decrease of environmental quality, that can interfere ecosystem and social functions, and therefore, wise development shall be based on the environmental concepts as means of sustainability/conservation and, in turns, it can guarantee the present and furture generation.

Development policy with the environmental cocepts, has been contained in Broad Outlines of the Nation's Direction (GBHN) of 1983 through 1993, where harmonized interrelationship

between human being and his God, between man and the other man and between human being and his environment, have clearly been stated.

To help solve problems in relation with development where environment has been considered under the Five Year Development Plan VI, the following issues have been brought about : demography and residential guidance, inventory and evaluation of natural resources and living environment, development of natural resources , critical area rehabilitation, nature and life conservation, protection of development area in an ecosystem, guidance on living environment quality, development of procedure system and development with the environmental concepts.

To conform to the relevant laws and regulations as manifestation of government policy implementation to realize development with the environmental concept, Environmental Impact Analysis (EIA) has been performed for the Warsamson HEPP.

c. Relationship between Project Activities and Significant Impacts.

In utilizing water resource for the development of HEPP, development of the river basin is directly or indirectly concerned, since the continuity of water resource availability will depend on the ecosystem condition of the river basin, in the upstream in particular, and the downstream area of the dam being utilized by people for means of transportation or the other daily needs.

On critical condition of the river basin (upstream area), soil and water conservation as well as protection forest conservation are required, also arrangement of land use in river upstream area, is meant to maintain the existance and function of the dam.

This project will be constructed in Warsamson river is a component in the ecosystem of river basin. As an ecosystem component, the project will affect and will be affected by the environment, considering that Warsamson river is surrounded by forests, where among other grown by "lawang plant", such specific plant has so long been processed into "lawang oil" by the local people, cacao plantation and inhabitant's houses. Apart from that, the area becomes the habitat of endangered birds, among others bird of paradise. Therefore, impacts of the project development shall thoroughly be studied so that negative impacts can considerably be minimized, while positive impacts can be developed to have much greater uses.

It has been visualized that demography and project activities may cause the various impacts toward the project. The direct impact that might occur is the increasing of forestrial destruction, that, in turns, will increase the run off and erosion rate be comes greater while the discharge fluctuates considerably between wet and dry seasons.

2. Objective of the Study.

a. Objective.

The aim and objective of the EIA is as follows :

1) Identify the project activity that cause the significant impacts toward the environment.

2) Identify the environmental components that will be affected by the significant impacts.

3) Predicts and evaluates the project activity that cause the significant impacts toward the environment.

4) Propose the directives to environmental management and monitoring plans (EMaP and EMoP).

b. Necessity of the Study.

Result of Environmental Impact Analysis constitute suggestions on the environmental management and monitoring based on the impact assessment result and inventory of environmental risks caused by the change of environment.

The suggestions on how to countermeasure the negative impacts, minimize the riks and develop the positive impacts may able to be used by the proponent, decision maker or executor of the project. Then the EIA, EMaP and EMoP will rendering inputs for the feasibility study, so that the proposed HEPP is designed with the environmental concepts.

II. METHOD OF STUDY.

Method of the study covers significant impact which be identified, study area, methods of data collection and analysis, impact prediction and evaluation methods.

1. Significant Impact which be Identified.

a. Project activity which be identified.

Activities of Warsamson HEPP which be identified, are activities that might cause the significant impacts, from the pre-construction stage through construction and operation stages.

1). Pre-Construction Stage.

The activities are identified in this stage :

- Survey.
- Land compensation.
- Resettlement.

2). Construction Stage

In this stage the following are identified :

- Mobilisation of labourers , heavy equipment and construction materials.
- Preparatory work and land clearing.
- Construction of access roads and relocation roads.
- Construction of diversion tunnel, power house, dam (main structures), offices, base camps including mining of materials.
- Reservoir impounding.

3). Pre Construction Stage.

Project activities are identified :

- Operation and management of HEPP.
- Operation and management of reservoir.

b. Environmental Components which be Studied.

Environmental components which be studied in this EIA cover parameters being applied to evaluate the impacts of the proposed project activities, as described below.

1) Chemical-Physical Component of the Environment.

Climate and Air Quality.

- Climatic components comprises : climate, temperature (minimum, maximum, mean), humidity, rainfall, wind condition (direction and speed), and solar radiation intensity.

- Disaster periodical data (annually cycle) such as storm, annual flood.

- Air quality in vicinity of the proposed project area.

- Noise sources and noise level.

Physiography and Geology.

Physiographical and geological data includes :

- Topography, geomorphology, geological structure and seismic information as well as mineral sources of Warsamson HEPP area and its surrounding.
- Soil and rock type.
- Location and land area considered unsafe : sliding area, movable area , earthquake, faults, joint, volcanoes, erosion and so forth.
- The uniqueness and extraordinary of land scope.

The above mentioned information is expressed in a map with proper scale.

Hydrology.

The hydrological data to be identified consists of :

- River characteristics.
- Mean discharge, maximum and minimum in wet and dry season , flood discharge and its return period.
- Sediment content (silt) and turbidity in the proposed project.
- Physical condition of the water recharge area.
- Water supply and demand level/water utilization for the community, agriculture and other purposes.
- Physical, chemicals and microbiological quality of the surface water.

Space, Land, and Soil.

Space, land and soil cover :

- Land use and other available resources at present.
- Regional development plan, master plan, future land use, and the other resource use in the proposed location of HEPP and its vicinity.

- Land ownership pattern, land tenures and ownership at the proposed project area.
- Historical remains (biological and geological) and archeology of the study area.
- Aesthetic and landscape values and the recreation resorts available in the study area.

2) Biological Component of the Environment.

Terrestrial and aquatic biological resources are identified through secondary data and field observation, comprising :

- Composition, abundancy and distribution of various flora and fauna species and evaluation from the economical and ecological view point, includes endangered species.
- Habitat of endangered fauna and vegetation might be affected or harmed by negative impacts of HEPP activities.
- Vegetation community available at the study area and its surrounding, in natural and man made environment.

3) Social-Economical and Culture Component of the Environment.

The social-economical and culture of the community to be studied, includes :

- Condition and center of economy, infrastructure, means of living and incomes.
- Population structure, density, distribution, age structure, sex ratio and education.
- Educational facilities and infrastructure.
- Communication with other area/location and people mobility.
- Health condition and facilities.
- Cultural facility .
- Land ownership .
- Condition of community association structure.
- Customs and tradition, manner of interaction internally and externally.
- Social problems and how to countermeasure the problems.
- People perception if the project is constructed.
- People perception toward environment.
- Other important issues.

2. Study Area Boundary.

Study area is bounded on the Warsamson river basin and its vicinity, includes its ecosystem and administration.

a. Project Boundary.

The project boundary in the proposed Warsamson HEPP shall cover the dam site and reservoir area at El. 60 m, the proposed area of power house, quarry site and other facilities required by the project, such as access road, office or base camps and so forth.

b. Ecological Boundary.

Ecological boundary related to the proposed dam construction of Warsamson HEPP covers upstream and downstream area of the dam in Warsamson river basin, where mutual interference is given by the proposed project activities and river basin ecosystem.

c. Social Boundary.

Social boundary as the space around the proposed Warsamson HEPP as the place performing various social interaction that contain certain norms and values which already established (Klayili, Malano, and Batu Lubang villages).

d. Administrative Boundary.

Administrative boundary of the study area covers area in Kecamatan Sorong (Klasaman and Malano villages), Kecamatan Makbon (Batu Lubang and Klayili villages) and Kecamatan Morait (Mega village), Kabupaten Sorong, Irian Jaya Province.

e. Study Area.

The study area is the association of four areas mentioned above and conformed to technological practice namely to countermeasure the environmental destruction that will be limited based on cost, facility and available time to implement this study.

The map of study area boundary is as presented in Figure 2 - 1.

3. Methods of Data Collection and Analysis.

a. Method of Primary Data Collection.

Primary data of biophysical-chemical was collected from site at the locations of sampling and observation, are as follows :

Table 2 - 1 Location of Sampling / Observation.

Parameter	Location					
	Downstream of dam	Dam site	Power house	Reservoir area	Sorong City	Total
- Air quality	-	1	1	-	2	4
- Water quality	3	1	-	4	-	8
- Plankton & benthic	2	1	-	4	-	7
- Flora & fauna	2	1	1	7	-	11
- Social,economical and culture	1	-	-	3	-	4

Among several respondents (household) of population estimated to be affected by the project activities are two villages in Kecamatan Makbon (Batu Lubang and Klayili) and two villages in Kecamatan Sorong (Malano and Klasaman). They were interviewed using questionnaires to obtain data on social-economic and culture. Number of respondents is ± 10% of population affected by the project. The locations of air and water quality samples, biological observation and respondent determined at the pre survey is as shown in Figure 2 - 2.

b. Method of Secondary Data Collection.

Secondary data was collected from varies sources as follows :

- Pre Feasibility Study and Feasibility Study of the Warsamson HEPP.
- State or private institutions relevantly to the project activities and environmental issues such as Directorate General of Forest Protection and Natural Conservation Department of Forestry, Indonesian Wildlife Fund (IWF), Agency of Land Affairs (BPN), Statistical Bureau of Kabupaten Sorong and others.
- Environmental Impact Analysis Report, Resettlement Plan and Environmental Management and Monitoring Plans of HEPP development in other area.
- References having close relation with HEPP development activities.
- Relevant resource persons in both environmental impact analysis and HEPP project.

c. Respective Aspect Analysis Method.

Climate and Air Quality.

Inventory of climatic data was obtained from secondary data, covering the meteorological data such as air temperature, wind velocity and wind direction, humidity, rainfall and rain intensity. Air quality was collected from primary data, which parameter and analyzes methods is presented as below.

Table 2 - 2 Parameter and Analyzes Methods of Air Quality.

No.	Parameter	Analyzes Method/Equipment
1.	Sulfur dioxide (SO2)	Pararosanilin/Spectrophotometer
2.	Oxide nitrogen (Nox)	Saltzman/Spectrophotometer
3.	Dush	High Volume Sampling Method
4.	Hydrogen sulfate (H2S)	Spectrophotometer
5.	Noise level	Sound level meter

Physiography and Geology.

Survey on physiography, geology, sliding and land modification due to excavation, material mining and so forth, was done by the use of available map from feasibility study, while hazardous sliding area and natural resources was inventorized and represented in the map with proper scale.

Water Quality.

This survey is to study water quality in the upstream and downstream of Warsamson river basin related to the proposed Warsamson HEPP project activities, to obtain information or baseline data of the area. Collected data was evaluated to assess water quality status and its uses.

Surface water samples was taken from the river water by a water sampling bottle, and then was analyzed at the BTKL's laboratory, Jalan Percetakan Negara No. 23A, Jakarta.

Microbiological parameter measured is MPN Coliform and MPN Eschericia coli, and this water sample was taken by sterile vessel. Parameter and analyzes methods is presented as below.

Table 2 - 3 Parameter and Analyzes Methods of Water Quality

No.	Parameter	Analyzes Methods/Equipment
1.	Temperature	Thermometer
2.	Dissolved solid	Gravimetric/Analytical balance & paper 0.45 mm
3.	Si O2	Turbidometer
4.	Electric conductivity	Conductivitymeter
5.	pH	pH meter
6.	Dissolved oxygen	DO meter
7.	Carbon dioxide	Spectrophotometer
8.	NO2, NO3 & NH4	Spectrophotometer
9.	N-total & P-total	Titration/Buret
10.	COD & BOD	Titration/Buret
11.	H2S	Organoleptic
12.	SO4	Spectrophotometer
13.	Cl	Titration/Buret
14.	Pesticide	Tin Layer Chromatography
15.	Coliform & E. coli	MPN, MPN table, filter holder and counter funnel.

River flow.

Discharge measurement of Warsamson River was carried out on location nearby Malano bridge, river stream measurement by using a current meter.

Land Use.

Land use interpretation is proposed to be on the reservoir area and the construction area of the Warsamson HEPP, which is based on the land use map from the Directorate of Land Use, Agency of Land Affairs Kabupaten Sorong.

Erosion Rate and Sedimentation.

Erosion rate and sedimentation can be identified by measuring suspended load of Warsamson river and its confluence. Water sampling was done simultaneously with discharge measurement in Meteorological Survey of the Warsamson HEPP.

Plankton and Benthic.

The respective plankton and benthic samples were collected by plankton net # 25 and Eckman grab.

The diversity index of plankton and benthic was computed by the use of the following formula (Shannon & Wiener) :

$$H^1 = \Sigma \frac{ni}{N} \log \frac{ni}{N}$$

H^1 = Diversity index.
ni = Individual number of each species.
N = Total of individual number for entire species.

Flora

Vegetation is observed and identified by calculating Important Value Index (IVI), timber potency and species diversity index.

a. Important Value Index (IVI).

Important value index is cumulative of relative density, relative frequency and relative dominancy, which calculating by a formula as follows (Soerianegara and Indrawan, 1985).

IVI = RDe + RF + RDo
Rde = Relative Density
RF = Relative Frequency
Rdo = Relative Dominancy

$$\text{Relative Density (\%)} = \frac{\text{Density of each species}}{\text{Density of entire species}} \times 100\%$$

$$\text{Density (Stalk/ha)} = \frac{\text{Individual number of each species}}{\text{Area of entire plot}}$$

$$\text{Relative Frequency (\%)} = \frac{\text{Frequency of each species}}{\text{Frequency of entire species}} \times 100\%$$

$$\text{Frequency} = \frac{\text{Number of plot contained each species}}{\text{Number of entire plots}}$$

$$\text{Relative Dominancy (\%)} = \frac{\text{Dominancy of each species}}{\text{Dominancy of entire species}} \times 100\%$$

$$\text{Dominancy } (m^2/ha) = \frac{\text{Basal area of each species}}{\text{Area of entire plots}}$$

IVI is classified into :

- Very low : 0 % - 60 %
- Low : 61 % - 120 %
- Moderate : 121 % - 180 %
- High : 181 % - 240 %
- Very high : 241 % - 350 %

b. Timber Potency.

Assessment of timber potency through the approach by calculating the volume of each trees :

V : $1/4\ \pi D^2 \times T \times F$
π : 3.14
D : Diameter
T : Tree height
F : Correction factor (0.7)

Average volume per ha (m^3/ha) is classified into :

- Low : < 0
- Moderate : 20 - 40
- High : > 40

c. Species Diversity Index (H^1).

H^1 : $-\sum (Pi)\ (ni.Pi)$

Pi : $\frac{ni}{N}$

H^1 : Species diversity index
ni : Individual number of species to i
N : Individual number of entire species

Diversity index of vegetation is classified into :

Scale of diversity index	Vegetation
< 1.00	Very bad
1.00 - 1.66	Good enough
1.67 - 2.33	Good
2.34 - 3.00	Better
> 3.00	Best

Fauna.

Fauna was observed by inventory and interview methods.

a. Inventory Method.

This inventory method is aimed at recording all fauna species available at the proposed Warsamson HEPP and its vicinity, by performing cruising (includes observation tracks for wild animal and catching for fish) to area such as residential area, village, at the proposed dam site, at the proposed reservoir area, rivers and forest surrounding the reservoir area, which are considered potential for the fauna. During the cruising to different habitat, fauna encountered is recorded the species, number and its habitat.

Species abundancy of fauna is classified into :

A	:	Very high	:	Met more than three times in one observation route.
B	:	High	:	Met three times in one observation route.
C	:	Moderate	:	Met twice in one observation route.

D : Low : Met once in one observation route.
E : Very low : Do not met by tracks and/or direct encounter but got information that the species exist in this area.

b. Interview Method.

This interview is aimed at recording the available fauna at the study area that could not be recorded during inventory. Interviewing the various type of community who know much about the fauna, is expected to complete the fauna survey.

Agriculture and Food Ecology.

To identify the general view of the agricultural condition of the proposed inundation area and its vicinity, was studied through field survey, and for more detail items correlated with agriculture in the community, a special study was performed, related to social-economic and cultural aspects as well as food ecology. The study of the latest is done by random sampling and classification.

Demography.

Demography study at the proposed inundation area and vicinity is by secondary data analysis such by applying the latest statistical year book of Sorong, Kecamatan and village monography.

Social-Culture.

Social cultural aspects of the proposed inundation area of Warsamson HEPP and its vicinity was studied by interview method to several selected respondents.

Community Health.

The study of community health is by surveying household , namely by interviewing the household at the study area.

Variables to identify people health is among others :

- Disease type frequently suffered
- Sanitation
- Medical care
- Medical facilities number.

Regional.

Study of regional aspect is by analyzing secondary data and by performing field survey (direct field observation).

4. Impact Identification and Prediction Methods.

Impact identification method is by using the flow chart describing the causal relationship between project activities and environmental components and a matrix.

Prediction the impacts magnitude due to Warsamson HEPP activities in many stages towards environmental components/parameters, primary or subsequent impacts, to be analyzed by using the following method:

Formal Method.

Magnitude of impact towards environmental components/parameters as the result of direct or indirect project activities, will be assessed using varied mathematical formula, to assess the quantitative value of the impacts. This method is especially assessed impacts on the physical chemical components and several biological aspects.

One of formal method is environmental quality standard. Impact assessment on an environmental component can be done by using quality standard which has been standardized based on the effective laws and regulations, nationally, sectorally as well as regionally. The use of quality standard is by means of comparing an environmental parameter/component that has changed or assessed to change upon allowable threshold.

Informal Method.

One of informal method applied is analogical method. This method, where problems arise at certain location as the impacts of HEPP activities will be studied for the basis and consideration for assessing the impacts will appear at other location having the same ecosystem manner.

5. Impacts Evaluation Method.

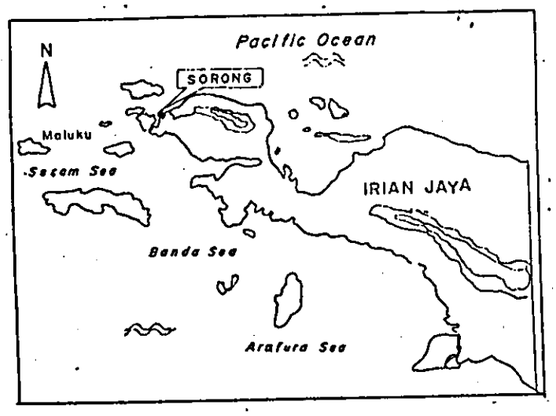
Method used to evaluate impact significancy degree based on Guideline on Significant Impact Criteria (Decree of Head of Environmental Impact Management Agency /BAPEDAL No. KEP-056/ 1994), namely on :

a. Number of people directly or indirectly affected,
b. Area over which the impacts will be experienced,
c. Duration of impact experienced,
d. Intensity of impact,
e. Number of other environmental components that will be affected,
f. Extent of cumulative impacts, and
g. Reversibility.

The above impacts was classified into significant and insignificant impacts.

A	:	Insignificant positive	B	:	Significant positive
a	:	Insignificant negative	b	:	Significant negative

Gambar : 2 - 1
Figure : 2 - 1



KEY MAP

LAUT

Sausapor

S. Warsor

U

Mega

Makbon

KEC. MAKBON

KEC. SAUSAPOR

SORONG

SORONG (JEFMAN)

Malan

KEC. MORAIT

Klayili

KEC. SORONG

KEC. BERAUR

KEC. TAMINABUAN

0 5 10 km
SCALE

Legenda / Legend :

- Bendungan/Dam
- Gedung sentral/Powerhouse
- Sungai / River
- Batas Proyek, Daerah genangan El. 60 m / Proyek Boundary, Inundation Area El. 60 m
- Batas Ekologi / Ecological Boundary
- Batas Administrasi / Administrative Boundary
- Batas Sosial / Social Boundary
- Batas Wilayah Studi / Study Area Boundary

Sumber :

1. Peta Topografi Daerah PLTA Warsamson PT. Aerokarto, Skala 1 : 10.000
2. Alternatives of warsamson HEPP (Preliminary)
   Pasific Consultans International, Progress Report I, December 1993
3. Peta HPH Intimpura · skala 1 : 100.000
4. Peta Daerah Studi, Prastudi Kelayakan PLTA Warsamson, Geo Ace, mei 1993

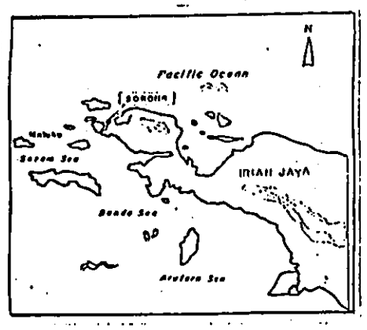
DEPARTEMEN PERTAMBANGAN DAN ENERGI

PT. PLN (PERSERO)

PEKERJAAN STUDI ANDAL PLTA WARSAMSON

PETA BATAS WILAYAH STUDI
MAP OF STUDY AREA BOUNDARY

Gambar : 2-2
Figure : 2-2



KEY MAP

N

LAUT

Makbon

Mega

KEC. MAKBON

KEC. SORONG

KEC. MORAIT

Malan

F11 P7 P.3 A.3 A8 A.7 U.1 U.2 F.1 F.2 S.4 S.3 F.3 A.2 P.2 A.1 P.1 P.5 A.5 P.6 A.6 P.4 A.4 F.6 F.10 F.7 F.4 F.8 F.9 S.1 F.5 S.2

Legend :

U Air quality
A Water quality
P Plankton and Benthic
F Flora and Fauna
S Social Economic and Culture

Reservoir Area El. 60 m
Dam site

0 5 10 Km
SKALA 1 :

DEPARTEMEN PERTAMBANGAN DAN ENERGI
PT. PLN (PERSERO)

PEKERJAAN STUDI ANDAL PLTA WARSAMSON

Sampling / Observation Location for Air and Water Quality, Biology, and Social Economic Culture

III. DEVELOPMENT PLAN OF THE WARSAMSON HEPP

I. Identity of the proponent and Environmental Impact Analysis (EIA) Arranger.

a. Identity of the proponent :

Name	:	PT PLN (PERSERO)
Officer In-charge	:	Head of Environmental Division
Address	:	Jl. Trunojoyo Blok M I/135 Kebayoran Baru, Jakarta Selatan - 12160

b. Identity of EIA Arranger :

Name	:	PT Indra Karya (Persero)
Officer In-charge	:	Ir. Machmud Ali
Address	:	Jl. Biru Laut X Kav. 9, Cawang Jakarta - 13340

2. The Objective of Warsamson HEPP Construction

The aim of Warsamson HEPP project is to utilize the Warsamson river discharge in order to obtain installed capacity of 46.5 MW by utilizing rated head about 54 m, and the purpose is in order to meet the demand of electricity in Kabupaten Sorong area, Irian Jaya Province.

The comsumption of energy has increased more than threefold from 7,682 in 1980 to 29,883 MWh in 1993 or about 11 % per annum on the average. It is assumed that the energy demand will increase to 26.5 MW for the year 2008 and 46.1 MW in 2015.

The Project feature is summarized from the Feasibility Study on the Warsamson Hydroelectric Power Plant Development Project in the Republic of Indonesia, Interim Report , undertaken by JICA in association with Pacific Consultants International, May 1995.

3. Use and Necessity

a. The Proposed Demand and Power Supply

The maximum output of existing power plant of Kabupaten Sorong by November 1994 is about 9,652 kW (of which 9,100 kW is for the Sorong system), being supplied from below electric power sources :

- PLTD I (Klademak) : 2,050 kW
- PLTD II (Klasaman) : 7,050 kW
- PLTD (Katapop) : 0 kW
- PLTD (Doom) : 170 kW
- PLTD (Teminabuan) : 162 kW
- PLTD (Klamono) : 20 kW
- PLTD (Kalobo) : 40 kW
- PLTD (Makbon) : 40 kW
- PLTD (Sausapor) : 40 kW
- PLTD (Seget) : 40 kW
- PLTD (Ayamaru) : 40 kW

The following table represents the power demand projection of the Sorong System, the service area of the proposed project as shown in table below.

Table 3 - 1 The Power Requirement Region of Sorong Area.

Year	Power Requirement (MW)
1994	7.5
1996	9.1
1998	11.1
2000	13.4
2002	16.0
2004	19.0
2006	22.5
2008	26.5
2010	31.2
2012	36.5
2014	42.7
2015	46.1

The existing PLTD diesel power plant (PLTD I, PLTD II and PLTD Katapop) are assumed to have a useful life of 20 years. Based on this assumption basis, the total power supply capacity will reach its peak in 1999 and 2003 by 13.95 MW, thereafter it will gradually decrease to 5,600 kW when the all machines will reach its life time in 2015.

From the said table and the present PLTD condition, as well as on the considerable power demand projection basis through year 2004, and to reduce dependence electric power from diesel, which is in line with the government policy on oil dependence, the Warsamson HEPP in that year is extremely expected.

b. Project Location.

1) Geography

The proposed Warsamson HEPP is located on S 1° Latitude and E 131° 30' Longitude. Figure 3-1 presents the project location map.

2) Administration

This HEPP will utilize the Warsamson river discharge to drive the turbine that will produce electricity energy. The water for generating energy will be stored by means of dam, which dam location is proposed to be about 3 km from the river estuary. The area of river catchment is based on map of scale 1 : 250,000, approximately 1,460.0 km^2. From its upstream to downstream area, the river passes Kecamatan Morait, Kecamatan Makbon and Kecamatan Sorong, Kabupaten Sorong.

The dam site is located on Malano Village, Kecamatan Sorong, Kabupaten Sorong, and its reservoir will cover part of Kecamatan Morait, Kecamatan Makbon and Kecamatan Sorong. Some of houses (26 houses) are residing at the proposed reservoir area on the cocoa plantation belonging to the "Desa Baru"/New Village (Malawor Village), one of Sorong villages in Kecamatan Makbon. The area of the cocoa plantation is about 175 ha and located nearby the Klalin River. The Desa Baru people has moved from Batu Lubang Village, previously reside in the coastal area of the same kecamatan.

2 (two) houses in Malano Village also located in the proposed reservoir area adjacent to Warsamson river. This village is one of several villages in Kecamatan Sorong.

3) Access road to Project Location

The project location is 22 km of the western part of Sorong City, Irian Jaya, can be reached by 2 (two) means of transportations, via sea from Sorong City by speed boat, running the north coast to the north east direction, parallel with the coast line. On location about 1 to 2 km from the Warsamson River estuary, the speed boat lands on the coast, and travel is continued on foot via pathway.

Other alternative is through highway being constructed with pavement, where it is proposed to connect Sorong City and Kecamatan Makbon. Distance between Sorong City to project location is approximately 22 km, as follows :

(a) Sorong City to Malano (Warsamson River bridge)

18 km distance, where road is paved with sand and rock and can be passed by four-wheeled vehicle.

(b) Warsamson River bridge to project (dam site)

Pathway is ± 4 km distant and can only be passed by foot, taking about 2 hours.

c. Development Plan and Warsamson HEPP Project Component

1) Land use for project.

The land will be used for the project is as follows :

a) Reservoir area, 3,000 ha covering :
* 2800 ha of forest area
* 175 ha of cocoa plantation
* 25 ha of husbandry

b) Main construction area, 25 ha of forest area.
c) Access road and relocation road of 40 ha of forest area.
d) Resettlement area, 175 ha of forest area

2) Source of Construction Materials.

Source of main construction materials in the form of mixed rock, comprising lava and limestone will be applied as concrete aggregate , obtainable from quarry site. The other type of rock is green schist and serpentinite which is unsuitable for concrete aggregate since it is potentially crack.. Rock material excavation is principally done by blasting.

Embankment of soil will be obtained by scraping off the surface of nearby hills by heavy equipment. Hills containing weathered tuff will be used as quarry site which is located 500 m to 750 m from the dam site.

Construction material volume required for concrete dam is of 45,600 m^3. Apart from main materials obtainable from area adjacent to the project site, main materials from outside the project area also needed such as cement, steel concrete, pipes, and so forth.

3) Construction Schedule.

The construction schedule tentatively of the work required to complete the Warsamson HEPP Project is 4 (four) years, excluding detailed design, which is as the following :

Activity	Year 1	2	3	4
- Land acquisition				
- Preparatory Work				
- Dam, saddledam Works				
- Approach channel, penstock				
- Power house				
- Metal Work				
- Electro-mechanical Work				
- Transmission and Substation Work				

4) The Warsamson HEPP Project Component

a) Dam

The Warsamson HEPP Dam is a concrete gravity type of dam, 47.5 m height. The dam will form a reservoir of 30 km2 area, with storage capacity 200 million m3. The highest water level of the reservoir is 60.2 m above sea level while the lowest is 50 m above sea level.

b) Power House

This project will use vertical francis type of turbine, taking into account the unit capacity and the effective head.

The power house has installed capacity 46.5 MW by average annual energy production, 247.4 GWh.

c) Saddle Dam

The saddle dam should be constructed on Klalin River in order to avoid the overflow.

The lay-out of Warsamson HEPP, optimum alternative plan (Alt-D) is as shown in Figure 3-2.

The general feature of the proposed Warsamson HEPP, based on the Feasibility Study result is as follows :

- Location : Kabupaten Sorong, Irian Jaya
- Catchment area : Warsamson
- River name : Warsamson
- Development type : Reservoir
- Hydrology :
  River catchment area (km^2) : 1,460
  Annual mean of rainfall (mm) : 1800 - 4400
  Mean of discharge (m^3/s) : 62.2

- Reservoir
  Effective Volume (million m3) : 200
  Full supply level (El., m) : 60.2
  Reservoir area (km2) : 30

- Main Civil Work
  Dam elevation (El., m) : 62.5
  Dam volume (m3) : 45,600
  Dam height (m) : 47.5
  Length of headrace tunnel (m) : 280

- Installed capacity (MW) : 46.5
  Annual energy (GWh) : 247.4
  Rated head (m) : 54
  Maximum design discharge of generation (m3/sec) : 99
- Project life time (year) : 50

d. Construction Stage of Project Development

Subsequently, the following activities will be performed for Warsamson HEPP.

1) Pre-construction Stage.

Activities during pre-construction stage covers :

a) Field survey/investigation

This activity will cover topographical and geographical mapping for several dam locations alternative, power house, water way, access road, appurtenants and so forth. Access road for topography mapping preparation and drilling location, will be performed by felling trees or bushes in relatively small area.

b) Land acquisition

In this stage, land acquisition is for main construction area such as for dam, power house, cofferdam, quarry site water way and other facilities such as base camp, access road etc, and land acquisition for reservoir will be carried out during construction stage. Area to be acquired is in the form of forest, and no settlement area is encountered.

Field activities are in the form of measurement and forest inventory, while other activities will be done at the home base.

c) Resettlement Plan

This activity provides alternative for resettlement, namely by local transmigration, moving to area adjacent to project site. 28 (twenty eight) households have to be moved from the reservoir area.

2) Construction Stage

During the construction stage the following activities will be executed :

a) Mobilization of materials and equipment.

Mobilization of equipment and construction materials will be done through Kabupaten road, kecamatan road and access road provided for Warsamson HEPP. Main equipment such as turbines, generator and transformer will be mobilized during the middle and end of the project

period. Mobilisation of construction materials such as cement, steel, pipes and so forth will be done as required. Rock and earth are transported through access road from excavation site to dam site of relatively short distance (500 to 750 m).

b) Preparatory and land preparation.

The preparatory and land preparation activity on the construction locations such as dam, power house, switch yard, base camp and so on.

c) Land clearing

The land on main structure location (25 ha), access road and relocation road (40 ha), where trees will be cut down/felled prior to the implementation of construction activities.

d) Construction of access and relocation roads.

The development of this HEPP will require access road to construction activity location, the length of access road from Malano to the structure location is 6,2 km through forest area. Road condition from Sorong to Makbon up to Malano bridge will be improved.

The Warsamson HEPP project activities will inundate Malano bridge, Klalin bridge and part of Sorong - Makbon road. Since part of the road Sorong - Makbon is cut off, one bridge and one road link Sorong - Makbon about 11 km will be relocated. This relocation road is required since the construction work.

e) Construction material.

The construction material for dam and main structure is available nearby the activity area. Rock will be taken from the quarry site, about 500 - 750 m from the dam location. Sand (crushed sand and beach sand) will be taken from the quary site and the Makbon beach. The quarry site is located in the forest area and remote from settlement area.

f) Construction of houses, offices and base camps.

The staff houses, offices and base camps will be constructed around the project site. Base camps, staff houses and offices will be 20,000 m2 on the road side of Sorong - Makbon near the existing Malano bridge (5 km from dam site)

g) Manpower acceptance and termination of work

Some manpower (professionals, inspectors, local staff/labour) will gradually be required as needed. The overall construction work will be done by the Contractor, and labour force requirement will depend on work type. Local labour will be available at the project area, and the construction implementation will be supervised by the Consultant.

After the completion of the construction work, termination of work on the part of Contractor and Consultant (based on Contract) will be done.

h) Main structure construction

Main structure construction will include dam, saddle dam, cofferdam, spillway, penstock, powerhouse and transmission lines will be implemented after land acquisition, preparation, land clearing, access road and base camp construction have been completed, and construction materials are available.

Water requirement for construction activity will take from Warsamson river and its tributaries adjacent to construction activity location.

i) Impoundment

The reservoir area will be impounded after the construction of dam, saddle dam and its facilities as well as land acquisition of reservoir area and clearing have been completed. The resevoir area will be filled with water by plugging the diversion tunnel.

3) Post Construction Stage

After the completion of main structure construction, and intake of diversion tunnel has been plugged, the Warsamson river flow will be hindered by dam, and reservoir will be formed. The effective volume will reach 200 million m^3, by maximum water level 60.2 m and reservoir area 3,000 ha. The reservoir will be operated by water elevation 50 m to 60.2 m to produce electric power of 247.4 GWh per annum.

4. Type of Project Development.

Type of Warsamson HEPP development in accordance with the Feasibility Report (Interim Report , 1995) carried out by Pacific Consultants International is reservoir type, and accordingly, the proponent is compulsory to conduct Environmental Impact Assessment (EIAs) with reference to Liability Activities List for EIAs or the so-called "Daftar Kegiatan Wajib Amdal" (Attachment I, State Ministerial Decree of Environment, Head of Environmental Impact Management Agency, No KEP-II/MENLH/3/94). It is contained in the list that HEPP of any type and size, except Mini Hydro Electric Power Plant (PLTM) and run-off-river type, shall carry out EIAs, and this statement also valid to the Warsamson HEPP. Therefore, the project proponent shall arrange the Terms of Reference for Environmental Impact Analysis, Environmental Impact Analysis, Environmental Management and Monitoring Plans (EMaP and EMoP).

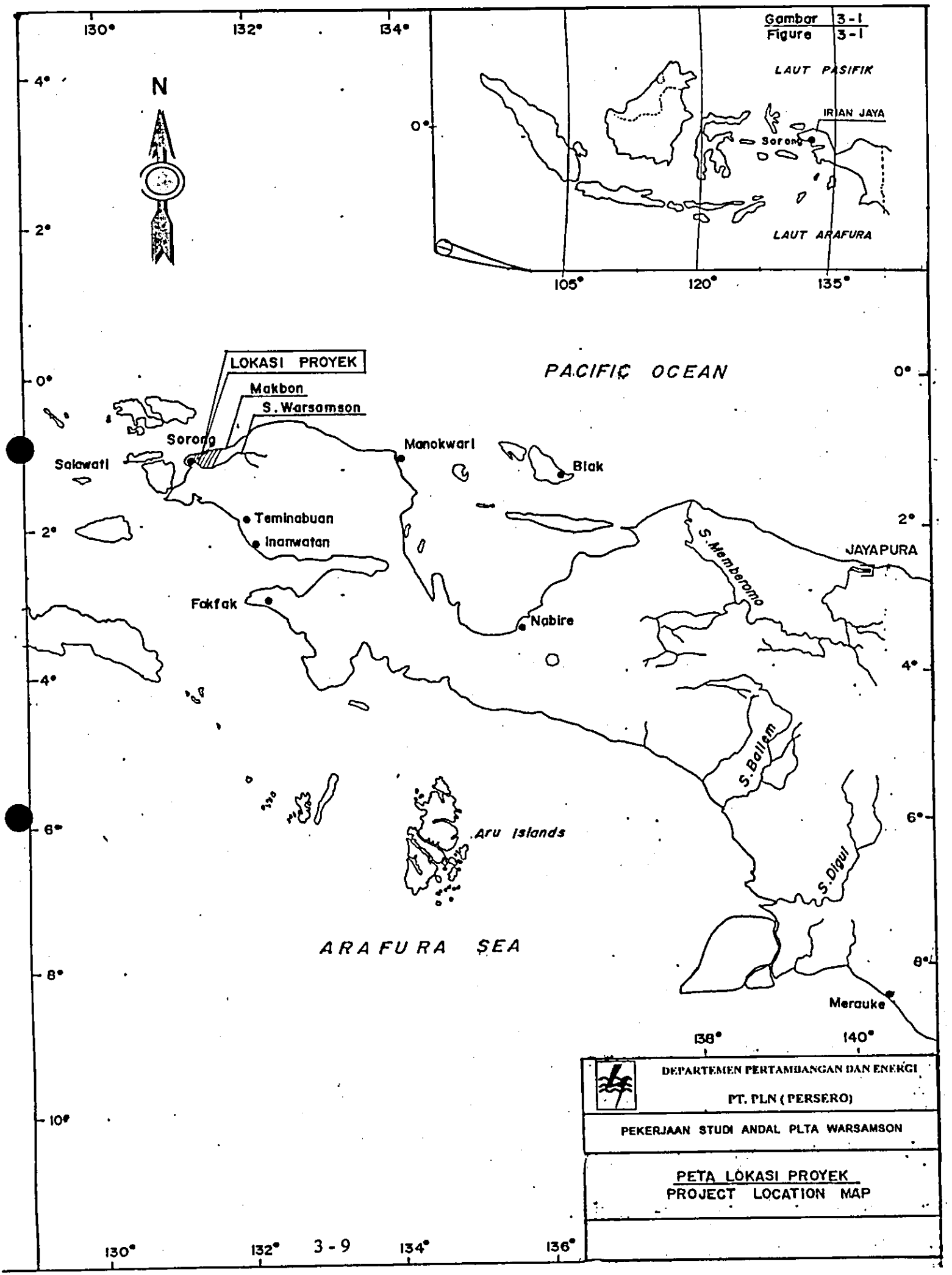
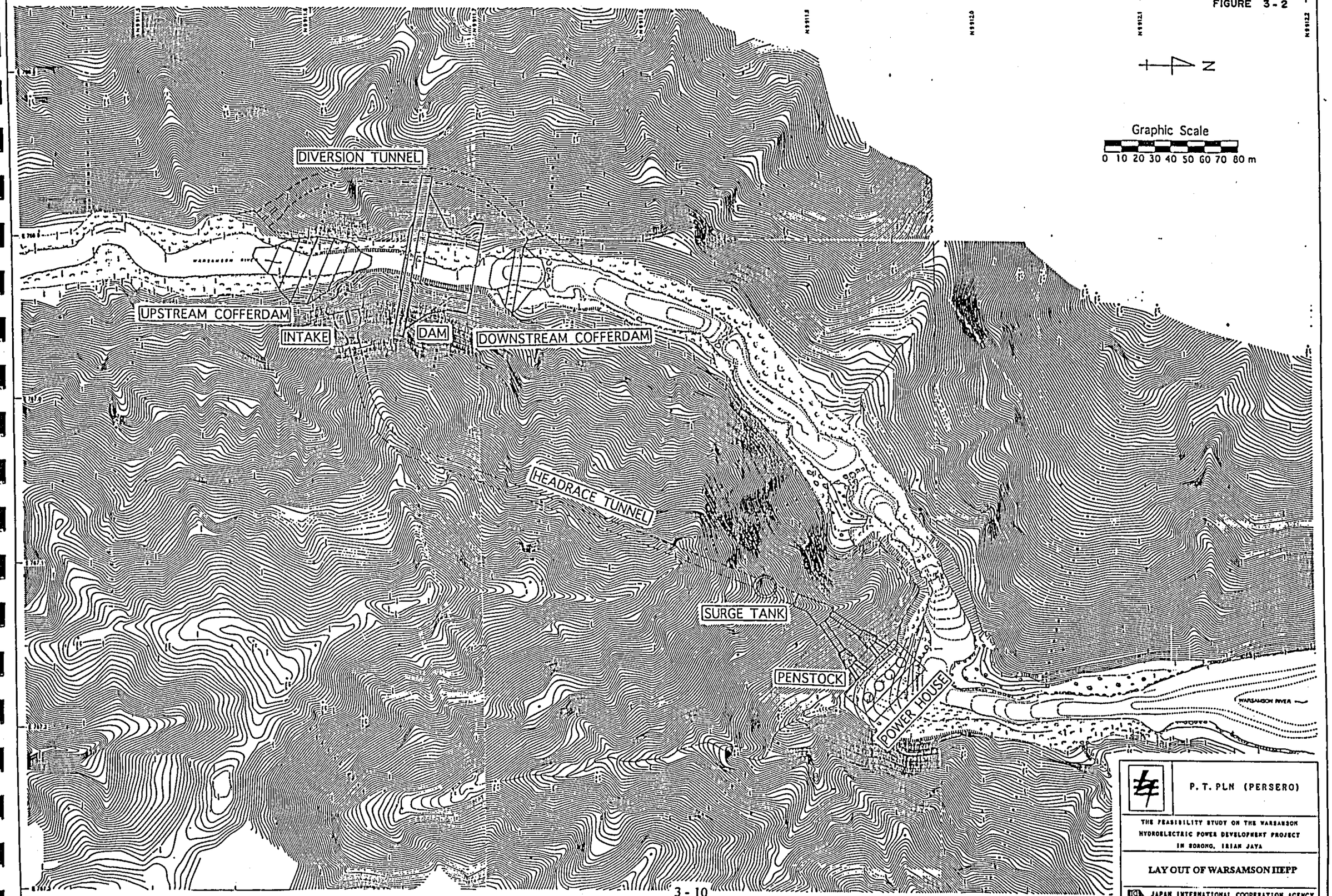

Gambar 3-1
Figure 3-1
LAUT PASIFIK
IRIAN JAYA
Sorong
LAUT ARAFURA
105°
120°
135°
N
130°
132°
134°
136°
4°
2°
0°
6°
8°
10°
LOKASI PROYEK
Makbon
S. Warsamson
Sorong
Salawati
Manokwari
Biak
Teminabuan
Inanwatan
Fakfak
Nabire
PACIFIC OCEAN
S. Memberamo
JAYAPURA
S. Ballem
S. Digul
Aru Islands
ARAFURA SEA
Merauke
138°
140°
DEPARTEMEN PERTAMBANGAN DAN ENERGI
PT. PLN (PERSERO)
PEKERJAAN STUDI ANDAL PLTA WARSAMSON
PETA LOKASI PROYEK
PROJECT LOCATION MAP

FIGURE 3-2



P. T. PLN (PERSERO)

THE FEASIBILITY STUDY ON THE WARSAMSON HYDROELECTRIC POWER DEVELOPMENT PROJECT IN SORONG, IRIAN JAYA

LAY OUT OF WARSAMSON HEPP

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

IV. ENVIRONMENTAL SETTING

1. General.

The envirionmental setting (baselines), initial environmental condition prior to construction of HEPP will experience the alteration by the project activity and this stipulated in explanation of Law No.4/1982, article 16, that principally, all activities cause alteration (impacts) toward the environment. The environmental setting covers chemical physical components (climate, physiography, hidrology and land use), biological components (flora and fauna) and social-economical and culture (demography, social- economic and culture).

Special attention was paid on air condition and river water, protected flora and those having ecological as well as economical value for the local people; flora as the habitat of endangered animals and natural conserved area in the study area and its vicinity. Apart from that, sliding areas adjacent to the residential area, uniqueness of land and rock, social-economic of the community, presence of primitive tribal/people and the historical remainings, also paid attention in this Study. This environmental setting survey was conducted during November 1994 to January 1995 and May 1995.

2. Physical Chemical Component of the Environment

a. Climates

1) Climate and rainfall.

Study area as the other area in Indonesia has tropical season. This area affected by Western and Eastern season which results in two seasons, rainy season and infrequently rainy season. Generally, rainfall occured in March through October and the second season occured in November to February, which ranges from 1793 mm to 4466 mm per anum (1920 through 1993), as shown in Table 4 - 1.

2) Temperature, humidity, wind speed and direction and sunshine radiation.

Climate condition in the study area which be represented by other climate component such as temperature, humidity, wind speed and sunshine radiation, as presented in Table 4 - 2.

Monthly wind direction blew from south direction to the north and the opposite. Mean wind speed varies from 8.7 knots to 13.6 knot. Based on the data on January 1993 through December 1993 (Table 4 - 3) the wind rose can be drawn as in Figure 4 - 1.

3). Air quality and noise.

In area surrounding the Warsamson river basin very slight activities cause air and noise pollution. At Sorong road link to Makbon village, from about Km 19, almost no physical activity cause air pollution. Number of vehicles passing this road from Km 19 to Makbon during day time ranges from 2 - 5 unit/hour.

Air quality and noise survey were conducted at November 12 and 13, 1994 for 6 (six) samples locations, 1. (U-1) in proposed Power House site (10:00 a.m to 01:00 p.m) and 2. (U-2) in proposed dam site (09:00 a.m to 01:00 p.m), 3. (U - 3) in front of PT. PLN (PERSERO) Sorong Branch (09:00 a.m to 01:00 pm), 4. (U - 4) in front of Intercity Hotel (09:00 am to 01:00 pm), 5. (U - 5) in front of Sahid Hotel (09:00 am to 01:00 pm), and 6. (U - 6) in front of Base camp (09:00 am to 01:00 pm). Table 4 - 4 shows the result of air quality analyzes. If compared to standard of air quality (Ministerial Decree of Population and Environment, KEP.02/MENKLH/I/1988), indicates that air quality in this area is still below the treshold of quality standard. It is also for noise level, the measurement result indicates that noise level at the said area is about 60 dBA, a figure far enough from the quality specified of 85 dBA (Noise level of maximum permissible noise exposure for damage risk criteria by Manpower Department is 85 dBA for 8 hours perday). Noise level on heavy trafic highwway is 80 dBA. Noise measured at the area is assummed from the animals voices, and friction of wind to trees.

b. Physiography

1) Topography

The study area is bordered by mountaineous line with Mount Sagami (673 m) in the south, as the peak, and Mount Mayalon (686 m), in the north. Warsamson river flows from the east to west direction of about 158 km long. About 17 km to the east of Sorong, river direction turns to north and ends at Pacific Ocean in Dampir Straits. Topography of Warsamson river basin comprises relatively plain area in the upstream with elevation mean of 50.0 m above sea level, and at the downstream of the hilly area, with elevation of about 20 m to 200 m above the sea level.

2) Regional geology

The proposed project area is divided into three terrains, namely Tamran in the nothern part, Sorong jointed system block, and Kemun block, ocupying southern area (Regional Geological Map of Sorong Area, as shown in Figure 4 - 2.

3) Geology of the study area

a. Morphology

The present morphology of area surrounding Warsamson river is a natural system, namely processes generated from the inner part of earth, uplift folding , fault as well as outer processes such as abrasion, sedimentation, and sliding which takes place million of years.

The morpholigical shape of Warsamson river basin and its surrounding area can be classified having 6 (six) morphological units, namely morphology of valley, weak undulating field, strong undulating field, smooth hill, steep hill and mountains. (See Figure 4 - 3).

(1) Valley morphology unit

This morphology unit occupies the central and upstream of Warsamson river and valley area adjacent to Dore Bay. The morphology is also termed as valley between mountains. The

morphology of the area stretches longitudinally from west to east direction, forming a valley having elevation between 0 - 100 m from the sea level, with gradient about 10m and valley slope is less than 5 %. Warsamson river occupies the Warsamson valley which is side to side with Sorong fault system. This river has several bents, having water span with 100 m. Rocks and soil composed this valley is covered with the lake deposit comprises of silt, sand, gravel and peat spreading on considerable area. Dore Hum valley is covered with swamps and swampy area. This valley is formed by interfingering in the north and south, and meets in the west end. Erosion in this area is to side direction and sediment deposition is of fine size with tough enough process. Water available in this area is mostly of inundated water .

(2) Weak undulating field morphology unit

This unit occupies the downstream area of Warsamson river, longitudinally from the river bent from west to north direction, and to east direction. This morphology is undulating area composed of large area of valleys between low valley, with slope of about 4 - 6 %, and elevation about 50 - 100 m. The gradient is 11 - 50 m. On this morpholigical units river trenches are available reaching Warsamson river. Rocks and soil being the composition of this morphology, is marl, mudstone of grey colour, breccia, aglomerate, sandstone, limestone and calcareous clay. Most of these rock has experienced weathering, into clay and sandymud of brownish red.

(3) Strong undulating field morphology unit

The morphology unit occupies west area of Warsamson river downstream, flowing from south to north, namely waterfall upstream to southern part of Malano Bridge. Elevation of about 50 - 150 m from sea level, by slope ranges between 8- 45%, and gradient 11 - 50 m. The morphology is mainly composed of shale, breccia, limestone, aglomerate, mudstone, conglomerate, marl, sandstone and calcareous mudstone. The weathered soil is of sandy clay of yellowish brown to reddish brown. Erosion occurs in this area is ground movement process on cliff crossed by roads, and erosion that have occured on land uncovered by vegetation.

(4) Smooth hill morphology unit

This unit occupies the hill area adjacent to Forest Concession of PT. Intimpura, with elevation about 50- 125m and slope between 16 - 40%, while the gradient is 25 - 100m. This area is composed of hills separated by rivers. This morphology is composed of mudstone intercalated with sandy limestone and partly with marl. Erosion occurs in this area is in the river upstream by forming "V" valley. Ground movement frequently occurs on excavated cliffs.

(5) Steep hill morphology unit

This unit is distributed longitudinally from north of Klasaman village to the south and turned to the east up to south part of Warsamson river. It was formed by longitudinal valley and separated by deep valley with elevation 100-160 m, slope ranges 40 -60 % and gradient 50- 100 m. This unit is composed of mudstone and slate (dark grey) and intercalated by sandy limestone and partly by mudstone (grey) and intercalated by sandy limstone and sandstone. Erosion occurs in this area in the river upstream by forming "V" valley. Ground movement frequently occurs on excavated cliffs.

(6) Mountains morphology unit

This unit covers north coast and downstream area of Warsamson river, longitudinally stretches from west to east up to Dore Bay. It was formed by mountains stretching from west to east. Slope of ranges 40- 60 %, elevation 100 - 200 m, and gradient more than 300 m. This unit is composed of volcanic rock comprises lava basalt, breccia, tuffa, volcanic sandstone, fault breccia and partly of shale and limestone. Erosion occurs on the upstream and downstream of river trench. Ground movement occurs as sliding and rock drop.

b) Soil and rock unit

The lithology of the proposed Warsamson HEPP reservoir and its vicinity can be grouped into 8 (eight) units as shown in Figure 4-4, and as described below.

(1) Alluvial unit.

The distribution of alluvial unit occupies along the Warsamson river and its flood plane. This unit is composed of sand, gravel, mud, local plant remains and peat. In general the characteristic is loose sand, moderate to coarse in size, poorly - fine sortation, soft mud, high plasticity and gravel of 1-2 cm, being composed of quartz and basal.

(2) Conglomerate unit

The unit distribution is from the Malano bridge to the south direction along the road between Klasaman and Malano bridge. This unit mainly consists of conglemerate, being composed of various conglomerates fragments consisting of gravel and andesite boulder, basalt, metamorphic, quartz sandstone with sand matrics (unconsolidated sand). Also encountered in this unit is mudstone of grey colour, soft and plastic and sandstone of fine-moderate, somewhat compacted. Regionally, this unit is unconformably overlain by silty mudstone and breccia unit.

(3) Breccia unit

The distribution of this unit is on north of Malano bridge and eastward of Warsamson river meandering. This unit is composed of limestone, calcareous clay, aglomerate, tuff, sandstone and volcanic breccia. The rock condition is well cemented and belong to the Sorong fault system.

(4) Mudstone and siltstone unit.

The distribution of this unit covers Klasaman area to the east ward, to settlement area or PT Intimpura Base Camp and its HPH area and the upstream of the proposed Warsamson HEPP reservoir. This unit is composed of mudstone and siltstone. The mudstone is of blackish grey, carboneous in general, somewhat glauconite, gastropode, plastic, the lower part is intercalated with limestone and sometimes sandstone intercalation is encountered. The siltstone is blackish grey in colour and cracked. The measurement result has shown that the strike is N 80°-90°E and dip of 15°-20°.

(5) Calcareous mudstone unit

The distribution of this unit covers western area and the Warsamson river meandering from eastward to northward and to the south part of Warsamson river central. This unit is dominated by calcareous mudstone and marl, grey in colour, plastic and locally intercalated with sandy limestone and sandstone. The result of measurement rock strike and dip has shown N 70°-90°E while dip 9°- 15°. Regionally, this rock is unconformably overlain by tuff and aglomerate, breccia and lava unit.

(6) Tuff and aglomerate unit

The distribution of this unit is on the Warsamson river estuary and road side Sorong - Makbon adjacent to Klalin river. This unit consists of tuff and aglomerate. The tuff condition is from loose to somewhat compacted and aglomerate fragment is in the form of andesite.

(7) Volcanic breccia and lava.

The distribution of this unit is on the downstream of the Warsamson river through the river estuary, in general forming steep hills in the vicinity of the proposed dam location. This unit comprises volcanic breccia and basalt lava. Volcanic breccia consists of andesitic fragment and tuffaceous matric. In general, lava is in terms of basal, blackish grey, massive, compacted and columnar joint is available in this rock. Regionally, this unit is unconformity on the shale and limestone unit.

(8) Siltstone and limestone unit

The distribution of this unit is on the proposed dam location, from west to east direction along the road to Makbon, prior to the valley of Dore Bay. This unit comprises siltstone, limestone and slate. The siltstone is blackish grey, plastic, and the result of rock strike and dip shows N27°-28°E and dip 30° - 75^0. Limestone is hard, compacted, fine to moderate in size, while slate, black, compacted, hard and forms cracks. In this unit alternation between shale and limestone is encountered. Regionally, the base of this unit is not outcropped.

c) River stadia

In general, the Warsamson river and its tributaries form rectangulair pattern which is affected by fault system and the rock condition in this area. The affluents located in the south forms dendritic pattern due to their homogeneous rock such mudstone, siltstone and marl, and in the north form parallel pattern due to fault tail through more resistant matter. The Warsamson river stadia has reached mature stadia, which can be visualized from its many meanderings and valley in "V" shape with width reaches ± 100m. The valley shape in the downstream is relatively narrow since it passes more resistant rock such as breccia, lava, shale and limestone.

d) Fault structure.

Regionally, the Sorong fault direction is east-westwardly and known as active fault, and as tectonic activity centre, being reflected by seismic centre in Seram ocean trough. The Sorong fault system can cause tailed fault.

e) Natural resources.

The natural resources encountered in the vicinity of the proposed reservoir area is natural oil basin and excavation material such as cobbles, gravel and sand.

(1) Oil

Oil reserve is encountered in Kais Limestone Formation. In the vicinity of Klaili village, exploration drilling on 3 (three) wells will be carried out by elevation ± 50 - 100 meter. Presently, the Pertamina (State Oil Company) activity is constructing access road to reach the drilling location points.

(2) Quarry material.

This quarry material is in the form of cobbles, gravel and sandstone. Part of this material already taken for asphalt pavement Klasaman - Makbon road. The excavated material is available in conglomerate unit. Commercial mining on the material has not been done, and only taken for pavement in this area.

f) Seismicity

In general, tectonic groove is available in Irian Jaya which is due to the crash of Australia and Pacific plates. The crash process caused deformation, thrust fault, dextral and sinistral (wrench) fault, which, in some places continues through quarterly, even to date. (See Figure 4-5).

The nearest seismic centre is to the north of Sorong (see Figure 4-6), and classified as medium earthquake (70 - 300 km), located in the central of Kepala Burung. The magnitude of earthquake is 5,0 Richter scale and rarely occurs.

Based on Indonesia Isoeism Map made in accordance with Kawashumi formula and earthquake data being recorded at the Meteorology and Geophysics Bureau (1971) has shown that the Warsamson River and its vicinity shows seismic velocity 0.07 - 0.15 g.

In accordance with Nayoan (1987), seismic coefficient in Warsamsson area can be computed (see Figure 4-7) as follows :

zP = 2.11
bl = 2.76
b2 = 0.71
ac = 160 (100 year period)

By this formula : ad = bl (ac x z) b2
ad = 2.76 (160 x 2.11)0,71
ad = 172.21 gal

The seismic coefficient (k) = ad/g
kP = 0.17 g

Further, the seismic coefficient of Warsamson area is 0.17 g.

g) Soil movement.

The field observation result shows that type of soil movement in Warsamson river area and its vicinity comprises land-sliding and rock fall. The sliding generally occurs on shale, marl, mudstone and weathered soil in terms of sandy clay, yelowish brown - reddish brown. This land-sliding occurs on strong undulating area, plain hills, steep hills and on ranges. The land-sliding is commonly occurs on excavated hills, cut-off hills for road and also occurs on land not covered by vegetation. The rock fall frequently occurs on rock such as lava, tuffaceous lava, volcanic sandstone. This process occurs on the mountaineous morphology, due to the loose off of rock from jointed rock or weathered rock.

Based on the above discussion, there are no uniqueness and characteristic of land forms and rocks encountered in the proposed reservoir and the surrounding areas.

c. Hydrology

1) River physical characteristic.

Rivers at the project area can be distinguished into upstream area of the Warsamson river, as the Warsamson river basin on the upstream of dam and the downstream area of the dam. The upstream of Warsamson river consists of Warsamson River and Klamigik River, flowing from east to west and nearby the Klasaman village it meets the Klasaman river and then turns northward. On the upstream of the dam location, Klalin River, flowing from east to west and meets with the Warsamson river on 1 km distance prior to the dam location. Before reaching the Pacific Ocean at Dampir Strait, the Warsamson River passing the waterfall about 2 km on the upstream of Warsamson river estuary. The river basin is bordered by 2 (two) mountainous line on the south part of Mount Sagami (673m), and on the north Mount Mayalon (686 m). The topographic condition on the upstream of the confluence of Warsamson River and Klasaman River, relatively very plane and swampy, while on the downstream, steep hills are on right and left banks of river bank.

2) River flow.

The catchment area of the Warsamson river at the Malano rain-gauge station is assumed to be 1,412.5 km2. The average monthly discharge is estimated as 81.0 m3/sec. in July 1991, 94.0 m3/sec in July 1992, 67.08 m3/sec in January 1993, 40.08 m3/sec in February 1993 and 42.37 m3/sec in March 1993, as shown in Table 4 - 5.

The flood discharge is one of a significant factors to design HEPP, especially to determine structure dimension of spillway, powerhouse elevation and other civil structures. This is termed as design flood discharge.

In relation that annual flood discharge data in long period (> 20 years) is unavailable, design discharge is forecasted by unit hydrograph approach. Based on the report on Pre-Feasibility Study of Warsamson HEPP, May 1992, by the use of unit hydrograph and maximum daily rainfall in Sorong Jefman, the design flood discharge hydrograph in return period in line with design requirement, is as follows :

Table 4 - 6 Flood Discharge and Return Period.

Return Period (year)	Flood Discharge (m3/sec.)
2	815.38
5	1084.80
20	1496.04
50	1666.20
100	1836.37
200	2006.53

Source : Report on Pre-Feasibility Study of Warsamson HEPP by Geo ACE, May, 1992

3) Sedimentation.

Sedimentation analysis is aimed to forecast sediment deposit entering reservoir. Deposit rate or sedimentation of an area is affected among others by soil condition, rainfall intensity, land use and topography. In normal condition, the volume of sediment deposit is estimated to use flow data and curve representing correlation between sediment deposit volume and flow discharge. In the Pre Feasibility Study, field survey has been conducted by taking water sample to be analyzes at the laboratory. Laboratory analysis result of water sample taken at Malano rain-gauge station is as indicated in Table 4 - 7. On the said analyzes basis, discharge curve and suspended load can be arranged to use the following formula :

$$Qs = 0.1506\ Q^{2.105}$$

where :

Qs = mud/sediment content (ton/month)
QP = monthly flow discharge average (m3/sec)

Total suspended load can be assumed by the use of the above formula and the result of monthly discharge measurement. Total sediment content is the total of suspended load plus bed load. This bed load is hard to forecast and commonly to be 15% of the total suspended load.

Estimation of sedimentation rate at the project site is 24015 ton/year. Comparing to sedimentation rate in other area, in Java island in particular, the said is considered to be slight.

4) Water supply and demand rate.

a) Water use for domestic requirement.

People at the study area utilize river water surrounding their dwelling place (the Warsamson river tributary) for their daily needs (drinking, washing and bathing), in wet as well as dry season.

b) Water use for other purposes.

Based on meeting with the concern institutions, except utilized for the Hydro Electric Power Project development,the Warsamson river water also planned for some purposes. Informations obtainable are the following :

a. In relation with the use of Warsamson river water for irrigation, Aimas Irrigation Sub-Project in Sorong, Manokwari Irrigation Project, Ministry of Public Works has not carried out survey on the said plan, although site reconnaissance has already done.

b. Infra Structure Preparation Study of Sorong City and the Surrounding Area by the Directorate General of Human Settlement ("Cipta Karya"), Ministry of Public Works reported that the discharge of Warsamson river is most sufficient to supply the water requirement for Sorong City, Aimas and Arar industrial estates. The Warsamson river as potential water source from the discharge and quality aspect compared with the other river in Sorong Area. The water requirement is approximately 1,600 l/sec.

5). River water quality

This survey is aimed at identifying the Warsamson river water quality and to assess the use of Warsamson River water. 8 (eight) water samples have been collected from the Warsamson river water as follows.

- Upstream of Malano Bridge (A1), sampling date : 10:00 a.m 11/11/1994
- Downstream of Malano Bridge (A2), sampling date: 11:00a.m 11/11/1994
- Upstream of the proposed Dam site (A3), sampling date : 11:00 a.m 12/11/1994
- Around Klayili vilage (A4), sampling date : 02:00 p.m 13/11/1994
- Matoa area (A5), sampling date : 04:00 p.m 13/11/1994
- Upstream area of Klayili (A6), sampling date : 06:30 p.m 13/11/1994
- Estuary of Warsamson River (A7), sampling date 02:00 pm 23/2/1995
- Estuary of Warsamson River (A8), sampling date 10:05 am 23/8/1995

It is assumed that changes of water quality may occur due to nature acts such as erosion, fires, impacts due to wildlife activity to the area. Several parameters of water quality were tested directly in the site (in- site test) by using the Water Checker Horiba Model U-10. Parameters tested in the site were temperature, pH ,DO, turbidity, electric conductivity and salinity, and other parameters were tested in the laboratory.

Visually, equal condition has been encountered on waters along the Warsamson river, concerning colour, odor and taste, even on the confluence of small rivers.

The following description have been made up upon the laboratory test result of 6 (six) water samples taken on November 11 to November 13, 1994 (the result of water quality analyzes is presented in Table 4 - 8).

a) Physical - chemical quality

(1) Turbidity

Turbidity value of the six samples range between 28 mg/l to 37 mg/l. From the said value it is assummed that almost all water body has turbidity within the above range. Turbidity of the river water is assumed from soil erosion, such as clay, silt or rock fractures. Effects of this turbidity causes water in brown colour.

(2) Total Dissolved Solids (TDS) and conductivity.

TDS is a combination of suspended solid and dissolved solid. The content varied from 110 mg/l to 264 mg/l. Considerable TDS components has been assummed to generate from household waste. However, the said case for Warsamson river is considered unavailable. The river TDS has generated from unorganic matters and organic solid such as wood fiber and biological matters (algae, bacteria, etc.). Quality standard for water quality criteria group B is 1,000 mg/l.

Conductivity has close relationship with TDS. From analyzes data it is visualized that conductivity ranges from 120 umhos/cm to 335 umhos/cm.

(3) Free ammonia (NH3)

Nitrogen in water generated from protein, chlorophyl and biological matters. NH3 of the Warsamson river water which is relatively higher than potable water standard is assummed to be generated from the protein of the dead animals and chlorophyl which is conversed into amino acid and further analyzed into NH3. It has been assummed that no NH3 is derived from the contribution of the people. In most rivers, NH3 concentration content varies from 10 to 20 mg/l, and in Warsamson river varies between 0.5 mg/l to 4.6 mg/l.

(4) Sulphate (SO4)

SO4 derives from particular mineral such gypsum or oxide of sulphite mineral. The availability of sulphate in Warsamson river water is assummed to derive from sulphite mineral matters

oxided into sulphate. Sulphate content of most river water ranges from 5 to 200 mg/l, while in Warsamson river varies between 66 to 220 mg/l.

(5) Chloride

The chloride in Warsamson river water is assumed to derive from the rocks in the river basin. Cl content of most river water ranges between 20 to 50 mg/l, while Warsamson river water to be between 10 to 26 mg/l. If content of Cl > 50 mg/l, is assummed that the chloride found in this water is generated from sea water seepage or mixed with sea water. Based on the above, it is assummed that Cl content of Warsamson river water is not seepage and not mixed with sea water.

b) Microbiologycal quality

Coliform and fecal coliform were tested in the water samples. This coliform is thought to derive from animal or human waste. The analyzes result shows that coliform content varies from 70 to 230 MPN/100 ml and fecal coliform content is 30 MPN/100 ml.

Based on the analyzes result of water chemical-physical and microbiological quality, the Warsamson river water use is as follows :

(1) The Warsamson river water cannot be classified as Group A, that can be used as direct potable /drinking water without being processed, since some of its parameters do not meet with water quality standard Group A, that is the content of ammonia, coliform bacteria and fecal coliform exceeding the maximum limit allowed.

(2) The Warsamson river water can be classified into Group B, namely as raw water and shall be processed into drinking water and for domestic needs. Most part of parameters meet with standard water Group B, except the ammonia content on location A1, A2, A3, A4, and A7 exceeding the allowed maximum limit. However, the water can be used for drinking water and other domestic need by processing it beforehand : to be boiled and let it stilled before use.

(3) The river water can also be used for fisheries and animal husbandry (Group C), since some of its parameters meet Group C standard, except its ammonia content.

(4) In general, the Warsamson river water meets water quality of Group D, namely for agriculture/irrigation.

d. Space, land and soil.

1) Soil type

Soil type is closely related to sources rock, and also affected by climate, especially temperature and rainfall. Based on lithology and geomorphology, soil types like Podsolic, Organosal and Alluvial are encountered in the Warsamson catchment area. Podsolic is commonly encountered

in the undulating area with dip varies between 3% to 25%. Soil colour at top layer is yellowish brown to reddish yellow, with plastic texture or ashy. This soil type is suitable for drainage media. Podsolic soil is assumed to be dominant, occupying the upstream of Warsamson river catchment area, and estuary area up to 5 km from the proposed dam to upstream direction. Organosal is a type of soil having very thick humus depth at dip (<3%), dominant at the cetral of Warsamson catchment area. Alluvial soil is encountered along the Warsamson river and its flood plane having unfavourable drainage, of fine to moderate texture. This soil is always renewed by river sediment, and accordingly it has high fertility.

2) Land use.

The land use of the study area is mostly comprises forest, 409,207 ha or approximately 90,60% of the total study area. The land use area in the study area and in Kabupaten Sorong is as presented in the following table, and land use map of the study area is represented in Figure 4 - 8.

Table 4 - 9 Land Use Area in the Study Area.

No.	Land Use	Sorong	Makbon	Morait	Sub Total	Percentage	Total *)
1.	Village	3,976	134	19	4,309	0.95	8,897
2.	Transmigration settlement	18,500	-	-	18,500	4.1	53,800
3.	Dryland	1,275	375	126	1,776	0.4	15,276
4.	Mixed garden	1,750	-	-	1,750	0.39	1,750
5.	Grass	-	-	376	376	0.08	25,559
6.	Bushes	10,900	-	-	10,900	2.4	21,128
7.	Sago	-	1,625	3,374	4,999	1.11	197,495**)
8.	Forest (bush)	-	30,123	22,575	52,698	11.66	98,923
9.	Dense forest	46,432	85,717	224,358	356,507	78.91	2,998,508
	Total	82,833	117,974	251,008	451,815	100.0	3,421,300

Source : Sub Directorate of Land Use, the Directorate Agrarian, Irian Jaya Province, 1988.

Remarks : *) Total in Kabupaten Sorong.
**) Incl. mangrove, swamp bushes and lakes.

Based on Land Use Map and the proposed reservoir area, indicating that the land use in the proposed reservoir area of Warsamson HEPP is forest (production forest).

3). Space lay-out plan

Based on the Final Report of General Plan of Space Lay-out ("Rencana Umum Tata Ruang") Kabupaten Sorong, March 1992, stated that the spatial policy of Kabupaten Sorong was divided into 6 (six) development zones. The two development zones are cover the study area. Sorong Development Sub Zone (DSZ) is inclusive in the Development Zone I, and Makbon and Morait DSZ are inclusive in the Development Zone IV, as described below.

a). Development zone I

Sorong DSZ is characterized by the Sorong city as the economical development center of Maluku and Irian Jaya. This zone is as trading city, and extensive agricultural area i.e. in transmigration area of Aimas and Klasaman.

Regional development policy of Five Year Development Plan (Repelita) V is directed to construction of roads facility, particularly roadway to open the isolation of Kecamatan capital, such as roadway from Sorong to Klamono to Ayamaru and Sorong to Makbon. Besides that, roads betterment, rehabilitation/construction of drainages, drinking water facility and storages are required for Sorong city.

b). Development zone IV

Development policy of Makbon DSZ is directed to placement of transmigration in Warsamson valleys as the agricultural area (paddy field) and increase in "lawang oil" production.

Plantations of nutmeg, rubber, coffee and coconut will be cultivated extensively in Morait DSZ. In Forestry sector, this zone have been carried out the timber business, which facilities such as the first quayes in Makbon and Sausapor, roadway from Sausapor to Kwoor and from Mega to Sausapor are required to be rehabilitated and/or constructed.

In this respect, no interest difference can be visualized between the proposed development of Warsamson HEPP and development policy in the area of Sorong, Makbon, and Morait. Map of Development Zone of Kabupaten Sorong is presented in Figure 4 - 9.

3. Biological Component of the Environment

a. Flora

1). Cultivation crop

Several crops are cultivated in the study area by planting them in their dry land and house garden. The following table presents the crops cultivated by local people.

Table 4 - 10 Cultivation Crops in the Study Area.

Local name	English name	Botanical name
Pisang	Banana	*Musa paradisiaca*
Kangkung	Leafy vegetable	*Ipomoea reptans*
Ubi kayu	Cassava	*Manihot esculanta*
Keladi	Calladium	*Colocasia esculanta*
Coklat	Cacao	*Theobroma cacao*

Source : Primary Data, November 1994.

Among the above crops, cacao, banana and leafy vegetable have economocal value. Banana belongs to fruit class widely consumed by the local people.

2). Natural (Forest) Vegetation

Parameter used in this analysis is vegetation structure, trees/timber potency and species of conserved vegetation/flora and species has economical value.

a) Vegetation Structure

Vegetation parameter analysis is based on the systematic strip sampling toward the condition of seedling (diameter class = 20 - 29 cm), sapling (diameter class = 30 - 39 cm), poles (diameter class 40 - 49 cm) and trees (diameter class 50 cm up).

The vegetation species composing the natural forest ecosystem, species density per hectare and important value index (%) for seedling, sapling, pole and tree level in the observation area are presented in Table 4 - 11. Result of Natural Forest Vegetation Analysis. Important value index varies from 32.5% to 300% (classified into very low to very high).

Diversity index of vegetation is presented in Table 4 - 12 below. Diversity index varies from 0.52 to 1.56 (classified into very bad to good enough).

Table 4 - 12 Diversity Index of Vegetation.

Observation Area	Vegetation Level			
	Seedling	Sapling	Pole	Tree
I.	0.67	0.97	0.95	1.28
II.	10.09	0.69	1.33	
III.	0.67	0.64	1.04	1.56
IV.	0.69		0.64	
V.	0.52		0.69	1.38
VI.		0.56		
VII.	0.64	1.384	1.04	
VIII.	1.04	0.95	1.04	1.33
IX.	1.08	0.68	1.01	1.75
X.	1.04	0.64	1.05	1.04

Source : Analysed from Primary Data, November 1994.

b). Tree potency

Tree (timber) potency analysis on the basis of tree species and average tree volume per hectar, by applying a systematic strip sampling. Vegetation potency in the observation area is mostly distributed equally on each diameter class. *Pometia sp* ("Matoa") and *Agathis sp* ("Damar") have high trees volume i.e. 29.53 m^3/ha and 20.27 m^3/ha, respectively. Potency of diameter class 50 cm up is constitutes commercial trees in the area. Result of trees potency analysis per hectare and its recapitulation are presented in Tables 4 - 13 and 4 - 14. Average trees volume for poles and trees vary from 16.5 m3/ha to 57.6 m3/ha (classified into low, moderate and high).

c). Protected flora

Analysis in the observation area indicates that the following flora are protected *) : *Pericoosis mooniana* ("kayu nani/kuku") and *Diospyros sp.* (ebony). These flora is distributed fairly from river banks up to elevation 100 m and above.

d). Other protected flora

Apart from other protected flora namely orchid was encountered in the study area although not great in population. These orchids species **) are *Cymbidium spp*, *Eria spp*, *Gramatophylum spp*, *Vanda spp*, and *Dendrobium spp*.

e). Flora having economical value

Flora having economical value, namely *Cinnamomun cullilawan* ("kayu lawang") was encountered in the observation area. Average trees volume is 27.0 m3/ha. This species able to be felled by the permission first of local Governor.

3). Condition of land coverage

Condition of land coverage based on the interpretation of land use, scale 1/500.000 (Figure 4 - 10) or the status of the forest zoning is classified into :

- Permanent Production Forest
- Limited Production Forest
- Convertion Forest
- Protection Forest
- Natural Reserve and
- Other Purpose.

*) Protected flora refers to the Agricultural Ministerial Decree No. 54/Kpts/UM/2/1972
**) Protected flora refers to the Agricultural Ministerial Decree No.Kep.37/5/1968.

b. Fauna

1). Terrestria fauna

a). Population

Quality of terrestrial fauna was analysed by individual abundancy. Result of observation indicated that 30 species consist of 15 species of birds, 5 species of mammals, 7 species of reptiles and 3 species of insect were identified. Amongst others are endangered species***), consist of 10 species of birds (4 species are endemic), 2 species of mammals (1 species is endemic), 4 species of reptiles (1 species is endemic) and 3 species of insects (all identified species are endemic). Species wealth of terrestrial fauna in observation area is presented in Table 4 - 15. Individual abundancy in the area is differ for every species of terrestrial fauna, depending on the ecological characteristic of fauna. Fauna abundancy, particularly the endangered species unable to be analysed quantitatively due to limited data and observation time. Therefore, this parameter was analysed qualitatively, by Pearson method (1975). Generally, terrestrial fauna abundancy in this observation is classified into very low to low abundancy, except for insects, the individual abundancy is classified into moderate abundancy. Table 4 - 16 presents species abundancy of terrestrial fauna in observation area.

b). Habitat

Each individual or mammals group generally has its own habitat, an area used by the individual or group of animal to conduct their daily activities such as drinking, eating, sleeping, mating, bathing, and so forth. The habitat of mammals species, birds, reptiles, and insects in the study area are primary and secondary forest, bushes and garden.

2). Aquatic biota

River ecosystem is a group of several communities interacting each other toward biotic and abiotic factors and accordingly river environment becomes habitat for organism having characteristic living in the river. The living organism constitutes producer group namely plankton and consumer group, namely benthic and necton. Observation on aquatic biota (plankton and benthic) was conducted by collecting 7 (seven) samples, then analyzing by Environmental Engineering Laboratory (BTKL) Jakarta. Observation were done to visualize the presence of necton in Warsamson river water, apart of that also interviewing with the local people and information collecting from the Fisheries Agency of Sorong.

***) Endangered refers to the Forestry Ministerial Decree No.301/Kpts-II/1991.
Edemic : the fauna only live in Irian Jaya.

a). Plankton

Plankton is aquatic biota and mostly of microscopic size and they live by flying within water body (passive movement). Plankton is distinguished into phytoplankton and zooplankton. In water (river) ecosystem, plankton position is very essensial, especially as food chain. In this light, plankton occupies first position, where phytoplankton synthesizes simple organic matter to be energy through photosynthesis process, that when plankton occurance is disturbed, the occurance of other living creatures series such as fish/necton will also be disturbed. In other words, plankton is one of community components functioning as pollution indicator. On the basis of survey result, it indicates that there are 43 species of plankton community being encountered, composing of phytoplankton (*Cyanophyceae*, *Diatomae*, *Bacillariophyceae*, *Chlorophyceae* and *Desmicliceae classes*) and zooplankton (*Crustaceae*, *Flagellata* and *Ratifera classes*). Individual number (species abundancy), species number and diversity index of plankton are presented in Table 4 - 17. Highest diversity index is of 1.26, namely sample A.2, located about 4 km distance from the rivermouth and the lowest diversity index is 0.73, namely sample A.7, located about 100 m from the rivermouth. However, no significant distinction is exhibited by diversity index of plankton obtainable from several observation locations. And based on quality scale of water environment, plankton diversity index condition is classified into very bad to good enough.

b). Benthic

Benthic is a aquatic biota whose existance and density in certain water is greatly affected by substrate condition of water bottom and quality. Water with condition somewhat substrated/muddy, becomes favorable habitat and suitable with this biota, beside other factors such as current, temperture and so forth. Due to the benthic characteristic is immobile in water bottom and it has slow movement, benthic is commonly used as quality indicator for water environment. Change of benthic community is the indicator used in environmental monitoring biologically (Mc.Inthre, 1980). Table 4 - 18 presents species number, individual number and diversity index of benthic, which included classes of *Gastropoda* and *Palecypoda*. The table indicates there are three species of benthic. Diversity index value is 0 for all locations, except location A.3 is 0.3. Based on quality scale on water environment, benthic condition in this area is classified into very bad.

c). Necton

Definitely, necton is an aquatic biota that can move actively to entire water environment as its habitat. Despite its ecological value for the water ecosystem, necton has also economical value. Utilization of Warsamson River as source of income (fish and shrimp catching) by local people seem is not prominent. The fisheries potency in this river is assummed to be low comparing to the south part of Sorong. Necton species identified in Warsamson River was 15 species consist of 11 species of fish, 3 species of eel and 1 species of shrimp, as presented in Table 4 - 19. Based on the relevant regulations and laws (the Agricultural Ministerial Decree No.716 Kpts/UM/10/1980 and the Forestry Ministerial Decree No.301/Kpts-II/1991), those species are not included in the endangered species.

4. Social Economical and Culture of the Environment.

a. Demography

1). Population number and density

According to the latest information (Statistical Year Book of Sorong, 1992), population number is 99,618 persons in Kecamatan Sorong, 3,028 persons in Kecamatan Makbon and 2,307 persons in Kecamatan Moraid, respectively. 26 families in Malawor hamlet (Batu Lubang Village) and 2 families in Malano Village is assessed residing in the proposed reservoir of the Warsamson Project. Table 4 - 20 presents the number of people reside in the proposed reservoir area and Figure 4 - 11 representing the location of their residence. Average of each family has 5.2 persons, with the lowest number of person is 2 and highest 8 persons/ family. Highest population density is Kecamatan Sorong : 72 persons/km2, while population density of Kecamatan Makbon is 2 persons/km2 and Kecamatan Morait is 1 persons/km2, respectively.

2). Population structure by age and sex ratio

Percentage of manpower age group (15 years and above) in the study area is 52.6 % in Kecamatan Sorong, 50.6 % in Kecamatan Makbon and 52.0 % in Kecamatan Morait, respectively. Population structure in Malawor (Batu Lubang Village) by age presents in Table 4 - 21. Sex ratio is 114 in Kecamatan Sorong, 111 in Kecamatan Makbon and 102 in Kecamatan Morait, respectively.

3). Population growth rate

Average growth rate of population per year from 1988 to 1992 is 5.9 % in Kecamatan Sorong, 5.5 % in Kecamatan Makbon and 1.1 % in Kecamatan Morait, respectively. The average growth rate per year in Kabupaten Sorong in the same period is 3.7 %.

4). Population structure by religion

Population structure by religion in the study area is tabulated as below.

Table 4 - 22 Population Structure by Religion.

Religion Follower	Percentage (%)		
	Sorong	Makbon	Morait
- Moslem	47.7	2.9	10.8
- Catholic	9.2	0.3	0.7
- Protestant	42.1	96.8	88.5
- Hindu	0.5		
- Buddhah	0.5		
Total	100	100	100

Source : Statistical Year Book of Sorong, 1992

5). Population structure by education

Based on the registration per month (1992), percentage of registered student in the year in Kabupaten Sorong is tabulated below.

Table 4 - 23 Population Structure by Education.

Level	Student (%)
- Elementary school	13.8
- Primary school	14.5
- High school	65.7
- Bachelor degree	2.5
- Scholar	3.5
Total	100

Source : Statistical Year Book of Sorong, 1992

Number of scholl facility (building) in the study area is tabulated below.

Table 4 - 24 School Faciliy in the Study Area.

Building	Sorong	Makbon	Morait
- Elementary school	62	7	5
- Primary school	16	1	1
- Secondary school	16		

Source : Statistical Year Book of Sorong, 1992.

b. Economic

1). Livelihood Occupation

According to Village Monographs, 1993, livelihood occupation in Kecamatan Makbon is as follows.

Table 4 - 25 Livelihood Occupation in Kecamatan Makbon.

Occupation	Number of persons	
	Batu Lubang	Klayili
- Government employee	6	5
- Private employee		1
- Farmer	126	185
T o t a l	132	191

In spite of most of them have occupation as "farmer", as written in the Monographs, one leader of Moi tribes gave his opinion that people living of this village is not clear, for if they are farmers they have agricultural tools such as hoe and knowledge about planting and harvesting time, but they do not have such kind. They have means of catching fish if they are called fishermen, but they do not have fish catching facility/tools such as raft or a net, fishhook etc. Thus, it can be clarified that Moi tribes living is not clear, since they are spoilt by nature. If they need some fish for sale or to be consummed, they just catch the quantity they need. If they want to eat, they just fell sago palm tree, in other words the term agriculture is in the sense of primitive or on the basis of their old tradition.

People in the proposed reservoir area is mostly as plantation farmer at people cacao plantation as their main occupation, and their secondary job is catching fish and collecting forest product such as "rambutan", "langsat" (yellow fruit), "mangoes", and so farth to be sold in Sorong City. Work opportunity at study area mostly as driver of city transportation and labour of several projects.

2). Family income.

Income difference of the people is commonly due to the area of land ownership, crop yield/production and number of household member involved. Most of the people at the proposed Warsamson HEPP work at people cacao plantation, each household obtain 1 ha

plantation area. The management of the plantation is assisted by Plantation Service of Kabupaten Sorong. Table 4 - 26 represents the people income of the proposed reservoir of Warsamson HEPP. People income is calculated based on Sayogya criteria (1978), namely if the annual per capita income is equivalent or less than 260 kg rice, the people is classified as in poverty, while if the income is more than 260 kg rice, they are classified as moderate. Table 4 - 26 shows that 42% of people can be classified as moderate and 58% as in poor level. This calculation adopt price 1 kg of rice is Rp 750.-.

3). Structures and infrastructures.

In Malawor (Batu Lubang village) no economic structures such as market or shop is available. The nearest market is located in Kecamatan Sorong, about 32 km, passing Makbon - Sorong road. The daily need is obtainable from Sorong market. Transportation used is rural transportation (four-wheel and two-wheel vehicles). People of Malawor/Batu Lubang sell the forest product (fruits), also passing the same road, and the Malano people, being in closer distance (10 km) when going to Sorong market.

4). Land ownership, crop, and price.

People residing in Malawor/Batu Lubang have forest land which is cultivated into people plantation. The land is gained via heredity estate being the proprietary right ("hak ulayat") of Moi people's ancestor. Land ownership area varies, depending on their capability to cultivate. Land located at El.65 m or lower, land on the Warsamson River side will be impounded by the proposed reservoir area belonging to proprietary rights of several clans such as Kalaghison-Kabanolo, Malibela - Gintata, Muli - Maladele, Mobilala - Tiliwun, Kalasuat - Tobema, Osok - Klalin and Malagawak. Some clans on the upstream area of Warsamson River consists of Osok-Mamsa, Osok-Abunso, Malibela- Klasaman, Malibela - Mili, Malibela-Magalili, Malibela- Klaibin, Kilala-Kadakolo, Kilala-Kalamoto, Kilala-Willim, Kilala-Magablo, Su-Samolo, Su-Klami, and Su-Safisa. The land ownership of the project (construction) area is 65 ha covering area for dam site, waterway, diversion channel, quarry site, base camp, access road, relocation road belonging to Kalagison, Malibela, Osok and Mili clans.

In accordance with the Decree of the Regent of Kabupaten Sorong, No 60/1993 dated April 6, 1993, maximum land price in the cacao plantation is Rp 2,000.-/m^2 and minimum Rp 1,000.-/m^2 (land has been cultivated for agriculture actively and continuously), maximum land price of proprietary right ("hak ulayat") is Rp.500,-/m^2 and minimum Rp.100,-/m^2. Mostly of the forestry area was managed by the forest concession of PT. Intimpura. They informs that the timber production varies from 34 m^3/ha to 50 m^3/ha and the average of timber price is 65 US$/$m^3$.

5) Utilization of natural resources.

Apart from forest land utilization for cacao plantation, people in the study area also utilize other natural resources such sago for their daily diet and utilization of forest product (especially fruit) either being consumed by them or sold to Sorong City. In some crossing area, river water is used as means of crossing.

c. Culture.

1). Customs and traditions.

In general, customs and traditions of the people (clans) are much influenced by Moi ethnic group. On every new activity start such marriage, building new office or other building done cooperatively, a custom ceremony will be handled resided by the head of clan/ethnis group. Although the customs mostly affected by other ethnic group, such as in marriage between Moi ethnic and other ethnic group, they use no more timor clothes as marriage gift, but to be changed by money. Cooperation between local community and new comers is favourable.

2). Groups and social organisation.

In Kabupaten Sorong, some social organization are encountered such as Non Governmental Organisation (NGO) including NGO concerns in the environment such as "Yayasan Sosial Agustinus" /YSA (Agustinus Social Foundation).

3). People perception towards the project.

Interview with 50 respondents (35 respondents from Batu Lubang Village, consisted of 28 respondents reside in proposed reservoir area and 7 respondents their land might be located in proposed reservoir area, and 12 respondents from Klasaman Village and 3 respondents from Kecamatan Sorong, where their land is located contiguous with the boundary of the reservoir area), has indicated that the people in the study area have heard about the project a year before. Most of them (28 respondents in proposed reservoir area and 12 respondents outside reservoir area) agree with the project development since it is government program, and the remaining (6 respondent) disagree since they "lose" their land or occupation, while 4 respondent gave no response. The result of interview in groups on 6 December, 1994 in Desa Batu Lubang as shown in the following table :

Table 4 - 27 People Opinion about the Proposed Warsamson Project.

No.	Opinion	Outside the reservoir area	In the reservoir area
1.	Agree, since it is government program.	12	28
2.	Agree, since they can work at the project.	-	-
3.	Agree, since it is new infrastructure development.	-	-
4.	Disagree, due to lose of land and occupation.	6	-
5.	Disagree, due to unproper land compensation.	-	-
6.	No response.	4	-
	Total	22	28

Source : Primary Data Analysis, December 1994 and May 1995.

4). Perception on the land compensation.

Most people affected by the project are ready to release their heredity rights if the project owner hold a discussion to reach agreement on the land indemnity. They also wish to talk directly with the project owner, PT PLN (PERSERO), and they wish no other party will involve.

5). Perception on people resettlement.

People residing on the proposed reservoir area, namely in Malawor hamlet, previously resided on Batu Lubang Village, nearby the coast. They moved to that village by considering that the area is close to their main food stuff, that is sago. Than assosiation with the Plantation Service of Sorong, they develop part of forest area as cacao plantation area. The newly married people will cultivate the land. On these basis and their understanding that the project is the government program, seem that no constraint is faced concerning people resettlement.

6). Archaeological remain and unacculturated tribal group.

Based on the interview with village head of Batu Lubang and head of customs/Moi tribes, in the study area there are no unacculturated tribal group nor archaelogical remains having cultural value encountered and need protection before the development of Warsamson HEPP.

5. Public health.

Basically, public health is a combination of some factors : environment, behaviour, medical care and heredity. Environment and behaviour give the most contribution on the status or public health level.

a. Incidence and disease prevalence.

Kabupaten Sorong, which is located in the area of Head of Bird of Irian Jaya Province having people health characteristic similar to other area characteristic in Irian Jaya Province. Presently, people health problem is dominated by local endemic diseases. The 10 big diseases distribution. being the people problem in Kabupaten Sorong in 1993, are as presented in the following table.

Table 4 - 28 10 Big Diseases Distribution in Kabupaten Sorong, 1993.

No.	Disease Type	Proportion
1.	Malaria	30% - 40%
2.	Accute respiratory disease	20% - 30%
3.	Diarrhoeal disease	10% - 25%
4.	Skin disease	5% - 15%
5.	Intestinal helminthes	5% - 10%
6.	Eyeache	5% - 10%
7.	Eartrouble and mastoid	3% - 8%
8.	Rheumatic disease	2% - 5%
9.	Tuberculosis	2% - 4%
10.	Toothache	1% - 3%

Source : Health Agency of Sorong, 1993.

Apart from the said 10 big diseases, epidemic also found in Sorong area, namely dengue haemorrhagic fever and filariasis. Disease pattern in Sorong area is dominated by epidemic closely related to hygiene & sanitation and unhealthy people 's behaviour, especially degree of awareness and knowledge not reflecting clean and healthy life attitude. This, is the only cause of epidemic into endemic. Based on characteristic and nature, endemic in Sorong area can be classified into 2 (two) catagories :

First, endemic which is potential to be epidemic, frequently followed by relatively high death rate. This type of diseases are malaria, diarrhoea, and dengue haemorrhagic fever.

Second, endemic mostly suffered by people, chronic in nature, and rarely cause death. This disease category are : intestinal helminthes, skin disease, tuberculosa and filariasis.

Apart from the said catagories, other endemic is also encountered which reflects the poor social condition, namely venereal disease which tends to increase in line with the increase of economic, transportation and information.

Below is description of some potential endemics that should be taken into account considering the nature, characteristic, tendency and potential to cause suffering and death.

1). Malaria.

Malaria is the main endemic widely suffered by people in Sorong area. The endemic rate of this disease in Sorong in particular and in Irian Jaya area in general, is still high, which is reflected by the high prevalence rate for early age (infant and child under five years). In 1993, as in line with the Public Health Centre (PUSKESMAS) report, the prevalence rate of patient (infant and child under five years) is about 60%, by the highest proportion for tropical malaria, caused by *Plasmodium falsifarum*. The spread of this disease is closely related to the poor sanitation, including the land clearing for various development purposes such as for settlement area, industry, agriculture, fishery, mining and so forth, where sanitation is not taken into account. Malaria disease is a species of disease spread by vector, a species of mosquito of Anopheles species. Vector potential in Sorong area especially and in Irian Jaya area in general, is *Anopheles farauti* and *Anopheles barbirostris*, and parasite mostly causes malaria is *Plasmodium falsifarum*, which can cause tropical malaria. Besides the said vectors, *Plasmodium vivax*, *Plasmodium malariae* and *Plasmodium mixture* are also found in Sorong area. If correlated with work force case, malaria disease is very harmful since the patient's productivity decreases sharply and he needs bed rest.

2). Diarrhoea.

Diarrhoea disease also closely related to poor sanitation : lack of adequate water supply and excreta disposal fasilities and unclean habit such eating without washing hands and using raw water to drinking. Seasonal variation also cause diarrhoea disease, in the sense that this disease frequently increase due to seasonal change, wet season or dry season. The result of field observation through sanitation inspection during 1993 by Health Agency of Sorong indicated that the condition of potable water structure being consumed by people derives from well with high risk (80%) and very high (3%). The following table is a description of diarrhoea patient in 1993 reported by Public Health Centre of Sorong.

Table 4 - 29 Patient Distribution and Death Due to Diarrhoea Disease in 1993.

No.	Month	Patient	Death	CFR(%).
1.	January	404	8	1.9
2.	February	311	0	0.0
3.	March	395	0	0.0
4.	April	356	0	0.0
5.	May	194	0	0.0
6.	June	229	0	0.0
7.	July	257	1	0.4
8.	August	195	0	0.0
9.	September	278	0	0.0
10.	October	278	0	0.0
11.	November	230	0	0.0
12.	December	318	0	0.0
	Total	3,445	9	2.3

Source : Health Agency of Sorong, 1993.

The dangerous diarrhoea disease frequently cause epidemic is cholerae caused by *Vibrio cholerae*. This is an acute disease. If in relative short period patient does not receive rehydration the patient will die.

3). Dengue haemorrhagic fever (DHF).

This disease is spread by a species of mosquito, *Aedes aegypti* and *Aedes albopictus*. Control and preventive program of the disease has reduced death rate. However, it has not succeeded in minimizing the cases in general. DHF has spread widely throughout Indonesia. Adequate medicine or vaccine has not been found, so that prevention is the best alternative to reduce the spread. In Sorong area, DHF shall be considered highly owing that the disease frequently cause epidemic and followed by death. DHF also related to seasonal variation. Seasonal change is often followed by case increase.

4). Venereal disease.

Venereal disease is closely related to the people social culture that has been growing parallel with the economic condition increase and development activity. This disease is directly spread by the virus bearer to the contact person via sexual intercourse. The kind of sexual disease mostly suffered by salor, driver and prostitute are gonorhoea and siphilis, which description in Kabupaten Sorong in 1993, is as shown in the following table.

Table 4 - 30 Venereal Disease Patient Distribution in Sorong, 1994.

No.	Month	Gonorhoea	Siphilis
1.	April	74	37
2.	May	21	15
3.	June	20	12
4.	July	49	10
5.	August	11	10
6.	September	2	14
7.	October	-	12
8.	November	-	13
9.	December	2	12
	Total	179	135

Source : Health Agency of Sorong, 1994.

Presently, a kind of disease where patient lose his/her body resistant, spreadout throughout Indonesia. This disease is called AIDS (Acquired Immune Deficiency Syndrome), caused by virus. This disease has spread in Irian Jaya, and the main cause is sexual intercourse with infected patient or blood transfusion.

b. Potable water supply.

Kecamatan Makbon is an area where potable water has not been provided. People surrounding the proposed project area use river water to meet their water demand, such as for washing, bathing and waste disposal. This habit is highly risky for the spread the disease such as diarr hoea, although physically and chemically the river water still meets the requirememnt. Potable water facilities and waste disposal have not been provided in the project area and its vicinity.

c. Nutrition status.

In respect of people nutrition condition, the monitoring result of Posyandu (Integrated health service) activities carried out by Health Agency of Sorong 1993 indicated that the nutrition condition on infant and child under five years is considered low. This, is supported by Public Health Centre report on disease pattern, where anemia on infant is considered high (third in rank, about 3.4%). On child under five years, it belongs to big 10, although anemia is also caused by endemic like intestinal helminthes and malaria. On the above mentioned basis, indication on having high risk on health issue is considered very high, such as the spread of certain disease like cretine endemic, catarac and so forth.

d. Type and number of health facilities.

Type and number of health facilities in the study area is presented below.

Table 4 - 31 Type and Number of Health Facilities.

Type of Facilitiesh	Number		
	Sorong	Makbon	Morait
- Public Health Centre	3	1	1
- Sub Public Health Centre	20	1	1
- Medical Clinics	22	1	1

Source : Statistical Year Book of Sorong, 1992

Type and number of health facilities and population density in each kecamatan is in parallel.

e. Coverage of physician's and paramedic's service.

Number and quality of doctors and paramedics of an area will describe their service coverage. One Public Health Centre is required to serve 20 thousand to 30 thousand people, generally with 3 (three) general doctor, one dentist, 4 paramedic and 2 sanitarian, 4 paramedic assistants. Since Sorong area is isolated geographically, speed and properness in health service provision is affected. Number of doctor and paramedic in the study area is as shown in the following table.

Table 4 - 32 Number of Physicians and Paramedic.

Work Force	Sorong	Makbon	Morait
- Medical specialist	5	-	-
- Public physician	18	1	1
- Dentist	5	-	-
- Nurse	265	4	6

Source : Statistical Year Book of Sorong, 1992

Distribution of public facilities in the study area is as presented in Figure 4 - 12.

Table 4.1 Monthly Rainfall at Sorong Jefman

(mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year Total	Day Max	
1920	60	60	86	434	125	510	117	174	251	247	135	45	2.244	75	(6)
1921	230	211	367	345	276	273	324	238	450	104	251	305	3.374	109	(9)
1922	145	292	152	310	132	327	351	277	232	197	83	178	2.676	112	(9)
1923	427	210	229	290	158	172	122	10	127	113	53	237	2.148	54	(4)
1924	146	337	230	233	396	253	563	296	380	203	315	216	3.568	154	(9)
1925	196	266	245	186	340	312	260	343	216	17	111	206	2.698	117	(5)
1926	138	79	137	339	488	325	515	279	647	179	264	218	3.608	187	(8)
1927	230	100	267	255	406	447	385	120	572	175	244	114	3.315	144	(6)
1928	111	175	222	242	334	321	252	209	166	57	187	211	2.487	104	(5)
1929	195	61	308	284	527	470	235	140	236	180	166	124	2.926	100	(5)
1930	61	156	406	175	207	610	28	24	15	447	151	152	2.432	198	(6)
1931	242	51	105	288	563	671	443	133	318	159	158	144	3.275	123	(5)
1932	109	157	230	223	330	204	524	392	188	394	177	261	3.189	137	(7)
1933	200	216	145	156	223	294	376	363	543	226	113	188	3.043	139	(2)
1934	305	171	300	250	306	445	469	413	281	496	347	257	4.040	117	(8)
1935	197	70	208	211	448	485	253	410	171	520	247	184	3.404	100	(8)
1936	273	265	393	282	306	299	477	200	308	519	73	175	3.570	115	(3)
1937	243	191	332	250	318	449	376	208	525	355	260	117	3.624	138	(10)
1938	189	90	257	204	351	225	310	720	396	250	161	367	3.520	165	(8)
1939	211	181	89	329	315	423	146	93	126	29	215	12	2.169	89	(4)
1940	211	219	215	212	278	321	47	485	156	49	145	111	2.449	104	(6)
1941	125	46	137	321	623	40	88	181	184	202	181	174	2.302	122	(5)
1958	43	90	196	144	182	191	126	485	156	179	162	206	2.160	x	
1959	206	52	108	322	517	533	429	181	184	264	245	174	3.215	x	
1960	305	160	99	193	316	223	870	112	192	91	211	181	2.953	x	
1961	125	204	218	197	142	266	348	115	143	67	147	167	2.139	x	
1962	416	210	130	383	404	331	150	376	136	272	127	231	3.166	x	
1963	280	239	184	255	549	240	307	134	32	32	83	240	2.575	x	
1964	114	286	128	428	229	309	269	148	113	182	165	310	2.681	x	
1965	278	25	148	301	292	319	21	36	1	133	255	221	2.030	x	
1966	130	143	141	138	303	261	194	419	219	143	245	227	2.563	75	(5)
1967	335	148	80	271	399	297	352	101	53	172	127	115	2.450	109	(7)
1968	131	61	356	102	170	453	348	206	332	249	377	273	3.058	112	(6)
1969	141	50	411	186	578	240	484	311	98	350	259	164	3.272	148	(7)
1970	194	127	243	275	585	214	461	351	241	123	200	259	3.273	225	(7)
1971	211	203	138	192	479	416	294	437	317	341	197	113	3.338	114	(10)
1972	165	268	134	166	167	512	68	150	102	33	154	94	2.013	152	(6)
1973	294	111	232	469	357	331	240	366	240	163	80	48	2.931	80	(3)
1974	53	304	99	375	437	309	258	225	284	210	181	174	2.909	117	(5)
1975	158	111	134	278	355	312	232	285	345	144	127	249	2.730	67	(4)
1976	111	210	105	170	324	123	171	193	121	319	171	38	2.056	106	(8)
1977	121	184	260	279	289	460	140	181	164	220	154	174	2.626	98	(5)
1978	265	51	530	126	145	324	407	307	290	107	205	271	3.028	108	(7)
1979	54	93	250	278	205	521	97	71	508	75	249	182	2.583	123	(9)
1980	151	136	92	233	275	213	108	189	18	162	133	83	1.793	70	(7)
1981	166	96	226	174	409	112	435	37	300	43	151	178	2.327	120	(3)
1982	139	117	270	194	335	260	x	x	291	120	87	188	x	259	(9)
1983	249	33	78	186	491	420	418	528	521	447	145	186	3.702	135	(5)
1984	218	260	332	541	599	480	833	227	574	103	144	155	4.466	130	(4)
1985	141	349	63	149	548	352	250	290	336	253	234	200	3.165	150	(2)
1986	98	154	162	141	162	228	230	55	268	218	113	183	2.012	90	(7)
1987	338	15	213	92	278	93	30	153	58	362	206	92	1.930	80	(10)
1988	x	133	205	123	417	316	550	680	337	277	262	235	x	115	(8)
1989	77	111	x	252	154	232	323	259	260	391	253	99	x	84	(10)
1990	103	13	37	x	120	116	149	265	207	285	53	65	x	112	(9)
1991	251	106	x	x	x	x	x	33	x	x	x	x	x	x	
1992	11	42	109	x	x	x	x	x	234	368	x	x	x	x	
1993	x	x	x	x	x	115	168	3	64	x	x	x	x	x	
Average	184	149	203	249	339	321	299	243	250	215	181	178	2.847		

x : No Data

Source : Feasibility Study on the Warsamson Hydroelectric power Plant Development Interim Report, May 1995 Pacific Consultants International.

Table 4 - 2 Climatic Condition in the Study Area

	Jan	Feb	Mar	Apr	May	Jun	Jul	Agt	Sep	Oct	Nov	Dec	Mean
- Temperature (^{0}C)	28.2	28.3	28.4	28.4	28.6	28.0	27.6	28.0	28.1	28.3	28.4	28.1	28.2
- Humidity (%)	78.3	77.7	80.0	81.0	82.0	82.0	81.7	82.5	80.5	79.5	79.8	80.5	80.5
- Wind Speed (knots)	10.7	12.7	11.9	8.7	9.5	13.6	11.9	12.2	11.8	10.3	8.7	9.2	10.9
- Solar Radiation (%)	72.5	84.0	66.5	62.5	72.0	64.5	57.0	70.2	66.0	60.0	60.3	64.3	66.6

Sources : Data Collection from Meteorological Station, Jefman (1988 through 1993)

Table 4 - 3 Wind Direction and Wind Speed 1993

Month	Wind Direction (Dominant)	Wind Speed (Knots) Max.	Min.
January	North	15	4
February	North	15	5
March	North	17	5
April	North	11	0
May	North-South East	17	5
June	South-South East	18	0
July	South	15	4
August	South-South East	25	3
September	South-South West	16	0
October	North-South	15	5
November	North-South	8	5
December	North-South	15	5

Sources : Jefman Meteorological Station, 1993

Table 4 - 4 Air Quality Analyzes Result

Parameter	Unit	Sampling Location						Quality Standard *
		U - 1	U - 2	U - 3	U - 4	U - 5	U - 6	
- Dust	ug/m3	12	10	160 & 170	60 & 57			260
- Carbon monoxide (CO)	ppm ug/m3	ud	ud	0,80 & 1,25	0.75 & 0.66			20
- Oxide nitrogen (NOx)	ppm ug/m3	0.0031 5.91	0.0026 4.92	0.006 & 0.007 11.3 & 13.7	0.005 & 0.007 10.0 & 13.9			0.05 92.50
- Sulphur dioxide (SO2)	ppm ug/m3	ud ud	ud ud	0.001 & 0.001 0.37 & 0.37	0.00 & 0.00 0.16 & 0.16			0.1 260
- Hydrogen sulfide (H2S)	ppm ug/m3	ud tt	ud ud	ud & ud ud & ud	ud & ud ud & ud			0.30 42
- Lead (Pb)	ug/m3	-	-	0.03 & 0.04	ud & ud			60
- Noise level	dBA	55 - 65	53 - 61	57 - 68	56 - 67	61 - 70	56 - 65	

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Note :

ud : undetected

* : Quality standard refers to Ministerial Decree of Population and Environment for Air Quality (ambient) Kep-02/MENKHL/I/1988.

Source : Primary Data Analysis, November 1994 and May 1995.

Table 4.5 Water Level and Calculated Discharge

Month / Day	1991 Jul		1992 Jul		1993 Jan		1993 Feb		1993 Mar	
	H (m)	Q (m3/sec)	H (m)	Q (m3/sec)	H (m)	Q (m3/sec)	H (m)	Q (m3/sec)	H (m)	Q (m3/sec)
1	1.60	83.53	1.04	39.40	0.76	20.57	1.46	71.70	0.99	35.88
2	1.60	83.53	1.00	36.58	0.76	20.57	1.22	52.65	0.98	35.19
3	1.59	82.67	0.97	34.49	0.64	13.60	1.34	61.98	0.93	31.75
4	1.92	112.61	0.96	33.80	0.48	8.49	1.25	54.95	0.91	30.39
5	2.65	189.46	0.94	32.43	0.43	7.14	1.29	58.04	0.91	30.39
6	1.98	118.38	0.93	31.75	0.40	6.39	1.24	54.18	0.90	29.72
7	1.74	95.91	0.92	31.07	0.37	5.68	1.09	43.00	1.00	36.58
8	1.66	88.77	0.91	30.39	0.36	5.45	0.96	33.80	1.13	45.92
9	1.56	80.10	0.90	29.72	0.37	5.68	0.95	33.12	1.10	43.72
10	1.82	103.22	0.89	29.05	0.32	4.58	1.22	52.65	1.15	47.39
11	1.48	73.35	0.94	32.43	0.27	3.61	1.15	47.39	1.01	37.28
12	1.68	90.54	1.01	37.28	0.24	3.08	1.06	40.83	0.93	31.75
13	1.68	90.54	1.10	43.72	0.23	2.91	0.95	33.12	1.30	58.82
14	2.00	120.32	1.19	50.38	0.35	5.23	1.14	46.65	1.21	51.89
15	3.32	272.85	1.45	70.87	1.29	58.04	0.91	30.39	1.14	46.65
16	2.06	126.22	1.76	97.72	1.42	68.41	0.99	35.88	1.22	52.65
17	1.58	81.81	1.96	116.44	1.70	92.32	1.05	40.12	1.42	68.41
18	1.40	66.79	4.60	466.39	1.64	87.01	1.01	37.28	1.45	70.87
19	1.22	52.65	2.33	153.97	1.69	91.43	1.00	36.58	1.26	55.72
20	1.10	43.72	1.90	110.71	2.04	124.24	1.06	40.83	1.16	48.14
21	1.00	36.58	1.76	97.72	2.34	155.04	1.08	42.27	1.10	43.72
22	0.90	29.72	1.71	93.21	2.43	164.76	0.69	16.19	1.00	36.58
23	0.94	32.43	1.68	90.54	2.52	174.70	0.61	12.55	0.91	30.39
24	0.81	23.77	1.63	86.14	2.58	181.45	0.57	11.22	0.92	31.07
25	0.82	24.42	1.57	80.95	2.61	184.87	0.71	17.43	1.02	37.99
26	1.78	99.54	1.59	82.67	2.02	122.27	1.32	60.39	1.25	54.95
27	1.44	70.05	2.23	143.46	1.59	82.67	0.97	34.49	1.11	44.45
28	1.11	44.45	2.43	164.76	1.52	76.70	0.79	22.48	1.06	40.83
29	0.91	30.39	2.32	152.91	1.85	106.01	-	-	1.04	39.40
30	0.86	27.05	2.73	198.77	1.85	106.01	-	-	0.96	33.80
31	0.99	35.88	2.86	214.27	1.68	90.54	-	-	0.92	31.07
Average		81.01		94.00		67.08		40.08		42.37

Source : Feasibility Study on the Warsamson Hydroelectric power Plant Development Interim Report, May 1995 Pacific Consultants International.

Table 4 - 7 SEDIMENT CONTENT ANALYZES RESULT

No. Lab : PKA 92/10

Location : Sorong, Irian Jaya

Sampling date : ----------

No.	Parameter	Unit	Analysis Result					
			1.	2.	3.	4.	5.	6.
	Suspended residu	mg/ L.	7,0	10	124	142	76	112
			7.	8.	9.	10.	11.	12
	Suspended residu	mg/ L.	300	268	294	56	54	60
			13.	14.	15.	16.	17.	18.
	Suspended residu	mg/ L.	20	11	18	16	8.0	9.0
			19.	20.	21.	22.	23.	24.
	Suspended residu	mg/ L.	10	44	316	19	20.	25
			25.	26.	27.	28.	29.	30.
	Suspended residu	mg/ L.	30	40	34	27	60	66

Source : Pre Feasibility Study of Warsamson HEPP Geo Ace, May 1992

Table 4 - 8 Water Quality Analyzes Result

Parameter	Unit	Sampling Location								Quality Standard *
		A - 1	A - 2	A - 3	A - 4	A - 5	A - 6	A - 7	A - 8	
pH	-	7.2	6.9	6.7	6.7	6.5	6.5	7.8	7.5	5 - 9
Temperature	C°	27/26	27/28	27/28	27/28	27/28	27/28	30.8	30/28	Normal
TDS	mg/l	110.0	110.0	105.0	110.0	120.0	115.0	102.1	264.0	1000
Conductivity	Umhos/cm	120.0	121.0	133.0	135.0	136.0	138.0	186.0	335.0	
DO	mg/l	6.7	6.3	6.6	6.6	6.5	6.4	9.1	6.8	6
BOD	mg/l	4.2	5.04	4.4	4.1	4.5	4.6	7.35	4.3	
COD	mg/l	54.0	36.0	36.0	24.0	18.0	54.0	24.0	36.0	
CO2	mg/l	1.99	2.99	1.99	ud	ud	ud	ud	0.0	
SiO2	mg/l	0.2	0.2	0.2	0.2	0.25	0.3	ud	0.05	
NO2	mg/l	ud	ud	ud	ud	ud	ud	ud	ud	1
N03	mg/l	1.76	1.76	1.76	1.76	3.42	3.42	1.46	1.3	10
NH3	mg/l	3.40	3.42	3.40	3.40	ud	ud	4.6	0.5	0,5
N Total	mg/l	5.16	5.18	5.16	5.16	3.42	3.42	4.12	0.6	
P Total	mg/l	0.12	0.21	0.22	0.18	0.30	0.26	0.09	0.27	
H2S	mg/l	ud	ud	ud	ud	ud	ud	ud	ud	0,1
S04	mg/l	72.0	84.0	72.0	66.0	90.0	108.0	72.0	220.0	400
Cl	mg/l	26.0	24.0	26.0	24.0	20.0	24.0	20.0	10.0	600
Pesticide	mg/l	ud	ud	ud	ud	ud	ud	ud	ud	0,042
Turbidity	mg/l (NTU)	37.0	29.0	31.0	36.0	28.0	29.0	5.0	34.0	
Salinity	mg/l	ud	ud	ud	ud	ud	ud	ud	18.1	
Coliform	MPN/100 ml	70	90	150	90	150	230	230		10,000
Fecal coliform	MPN/100 ml	30	30	30	30	30	30	30		2,000

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Note :

ud : Undetected

* : Quality standard refers to Government Regulation No. 20/1990 for water quality criteria group B.

Source : Primary Data Analysis, November 1994, February, and August 1995.

Table 4 - II Result of Natural Forest Vegetation Analysis

No.	Local Name	Botanical Name	STRATA							
			Seedling		Sapling		Pole		Trees	
			K	I N P	K	I N P	K	I N P	K	I N P
I	Matoa	*Pometia sp*	37,50	110,0	50,00	90,00	37,00	110,0	37,50	136,51
	Bintangur	*Cllophyllum sp*	-	-	37,50	77,50	12,50	45,00	25,00	80,76
	Bilin	*Octomeles sumatrana, Miq*	-	-	-	-	-	-	12,50	43,15
	Damar	*Agathis sp*	-	-	-	-	-	-	12,50	39,57
	Mangga	*Mangifera indica L*	-	-	-	-	12,50	45,00	-	-
	Malam	*Diospyros sp*	-	-	12,50	32,50	-	-	-	-
	Jambu	*Eugenia sp*	25,00	90,00	-	-	-	-	-	-
II	Matoa	*Pometia sp*	-	-	-	-	50,00	100,0	50,00	85,00
	Kamun	*Amoora myrnecophyla, Warb*	-	-	-	-	-	-	25,00	85,00
	Ky.Lawang	*Cinnamomun cullilawan*	-	-	-	-	-	-	25,00	67,50
	Damar	*Agathis sp*	-	-	75,00	200,0	50,00	100,0	25,00	62,50
	Jambu	*Eugenia sp*	25,00	66,66	-	-	-	-	-	-
	Ky. Sepang	*Caesalpinia sappan*	25,00	66,66	-	-	-	-	-	-
	Lege	*Lege*	25,00	66,66	-	-	-	-	-	-
III	Balam	*Litsea ladermanii, Techn*	-	-	-	-	-	-	12,50	96,19
	Mangga	*Mangifera indica L*	-	-	-	-	-	-	25,00	70,50
	Bintangur	*Callophyllum sp*	-	-	-	-	-	-	12,50	50,70
	Matoa	*Pometia sp*	-	-	-	-	25,00	90,00	12,50	41,31
	Telek	*Parastemon sp*	-	-	-	-	-	-	12,50	41,31
	Jambu	*Eugenia sp*	-	-	25,00	133,3	25,00	65,00	-	-
	Maungkawa	*Dillenia papuana*	-	-	-	-	12,50	45,00	-	-
	Pal	*Elmerrillia papuana, Dandy*	-	-	12,50	66,66	-	-	-	-
	Ky.Lawang	*Cinnamomun cullilawan*	25,00	90,00	-	-	-	-	-	-
	Ky. kuning	*Cudrania sp*	27,50	110,0	-	-	-	-	-	-
IV	Damar	*Agathis sp*	25,00	100,0	75,00	200,0	25,00	83,33	100,0	300,0
	Telek	*Parastemon sp*	-	-	-	-	50,00	116,7	-	-
	Mangga	*Mangifera indica L*	25,00	100,0	-	-	-	-	-	-
V	Ky.medeh	*Pometia pinnata, Forst*	-	-	-	-	-	-	25,00	89,53
	Ky.Kuku	*Pericoosis mooniana*	-	-	-	-	-	-	25,00	77,91
	Dooepen	*Litsea glutimosa*	-	-	-	-	-	-	25,00	70,93
	Ky.Tar	*Agathis labilladieri, Warb*	-	-	-	-	-	-	25,00	61,63
	Pal	*Elmerrillia papuana, Dandy*	-	-	-	-	25,00	100,0	-	-
	Maungkawa	*Dillenia papuana*	-	-	-	-	25,00	100,0	-	-
	Ky.Manis	*Cinnamomun burmannii*	-	-	75,00	200,0	-	-	-	-
	Damar	*Agathis sp*	75,00	125,0	-	-	-	-	-	-
	Kiyem	*Rhustaitensis, Guill*	25,00	75,00	-	-	-	-	-	-
VI	Matoa	*Pometia sp*	-	-	-	-	-	-	75,00	300,0
	Ky. Lugun	*Terminalia catappa L*	-	-	-	-	50,00	200,0	-	-
	Goska	*Dillenia papuana, Mart*	-	-	75,00	125,0	-	-	-	-
	Malig	*Lopopethalum*	-	-	25,00	75,00	-	-	-	-
	Ky.Merah	*Palaqium gutta*	75,00	200,0	-	-	-	-	-	-

VII	Matoa	*Pometia sp*	-	-	-	-	-	-	50,00	300,0
	Kibien	*Canarium malacense Lauterb*	-	-	-	-	50,00	83,33	-	-
	Ky.Susu	*Pericoosis amonii, This*	-	-	-	-	25,00	58,33	-	-
	Ky.Malam	*Diospyros sp*	-	-	-	-	25,00	58,33	-	-
	Param	*Beuguiera parvifolia, Wet A*	-	-	25,00	50,00	-	-	-	-
	Kamiem	*Trema orientalis BL*	-	-	25,00	50,00	-	-	-	-
	Tahigua	*Celtis latifolia, Planch*	-	-	25,00	50,00	-	-	-	-
	Wen/won	*Flendersia amboinesis, Poir*	-	-	25,00	50,00	-	-	-	-
	Kirna	*Agathis labillardieri, Warb*	50,00	116,7	-	-	-	-	-	-
	Ballu	*Anthocephalus chinensis, Walp*	25,00	83,33	-	-	-	-	-	-
VIII	Ky. hitam	*Diospyros sp*	-	-	-	-	-	-	50,00	100,48
	Kayar	*Vatica papuana, Dyer*	-	-	-	-	-	-	25,00	74,03
	Matoa	*Pometia sp*	-	-	75,00	93,33	50,00	83,33	25,00	64,35
	Tubuk	*Xylopia papuana*	-	-	-	-	-	-	25,00	61,13
	Ky.Kuku	*Pericoosis mooniana*	-	-	-	-	25,00	58,33	-	-
	Balam	*Litsea ladermanii, Techn*	-	-	-	-	25,00	58,33	-	-
	Mangga	*Mangifera indica L*	-	-	25,00	53,33	-	-	-	-
	Ky.Wele	*Bishoffia javanica BL*	-	-	25,00	53,33	-	-	-	-
	Bilin	*Octomele sumatrana, Miq*	50,00	83,33	-	-	-	-	-	-
	Kas/Kau	*Dillenia papuana, Mast*	25,00	58,33	-	-	-	-	-	-
	Kabu	*Intsia palembanica, Miq*	25,00	58,33	-	-	-	-	-	-
IX	Bintangur	*Callophyllum sp*	-	-	37,50	92,86	-	-	25,00	77,63
	Matoa	*Pometia sp*	-	-	50,00	107,1	-	-	12,50	64,81
	Damar	*Agathis sp*	-	-	-	-	-	-	12,50	40,77
	Ky.Nani	*Pericoosis mooniana*	-	-	-	-	-	-	12,50	39,41
	Ky.Malam	*Diospyros sp*	37,50	70,83	-	-	-	-	12,50	39,41
	Ky.Cina	*Spondias cytherea, Soon*	-	-	-	-	-	-	12,50	37,94
	Ky.Telek	*Parastemon sp*	-	-	-	-	12,50	41,67	-	-
	Jambu	*Eugenia sp*	-	-	-	-	25,00	58,33	-	-
	Bilin	*Octomele sumatrana, Miq*	-	-	-	-	37,50	100,0	-	-
	Ky.Susu	*Pericoosis mooniana*	25,00	58,30	-	-	-	-	-	-
	Ingkris/legis	*Horfieldia sylvetres, Warb*	37,50	70,83	-	-	-	-	-	-
X	Matoa	*Pometia sp*	25,00	58,33	50,00	116,7	-	-	50,00	115,59
	Los	*Dracontomelon dao Merr & Rolf*	-	-	-	-	-	-	25,00	97,04
	Ky. hitam	*Diospyros sp*	-	-	-	-	-	-	25,00	87,36
	Bintangur	*Callophyllum sp*	-	-	-	-	50,00	83,33	-	-
	Jambu	*Eugenia sp*	-	-	-	-	50,00	83,33	-	-
	Ky.Manis	*Cinnamomun burmannii*	-	-	-	-	25,00	58,33	-	-
	Mangga	*Mangifera indica L*	-	-	25,00	53,33	-	-	-	-
	Maroapisa	*Melia excelsa, Jack*	50,00	83,33	-	-	-	-	-	-
	Wen/won	*Flendersia amboinesis, Poir*	25,00	58,33	-	-	-	-	-	-

Notes :

K : Species density / ha

I N P : Important Value Index (%)

Source : Primary Data Analysis, November 1994

Table 4 - 13 Result of Trees Potency Analysis per hectare

No.	Local Name	Botanical Name	Diameter Class (Cm)							
			20 - 29		30 - 39		40 - 49		50 UP	
			N	V	N	V	N	V	N	V
I	Matoa	*Pometia sp*	12,50	3,25	12,50	8,62	-	-	12,50	27,37
	Bintangur	*Callophyllum sp*	12,50	6,50	-	-	12,50	16,50	-	-
	Damar	*Agathis sp*	12,50	2,75	-	-	-	-	-	-
	Bilin	*Octomeles sumatrana, Miq*	12,50	4,25	-	-	-	-	-	-
Total			50,00	16,75	12,5	8,62	12,50	16,50	12,50	27,37
II	Matoa	*Pometia sp*	50,00	18,75	-	-	-	-	-	-
	Damar	*Agathis sp*	-	-	25,00	19,75	-	-	-	-
	Kamun	*Amoora myrnecophila, Warb*	-	-	-	-	25,00	47,75	-	-
	Ky. Lawang	*Cinnamomun cullilawan*	-	-	25,00	27,00	-	-	-	-
Total			50,00	18,75	50,00	46,75	25,00	47,75	-	-
III	Matoa	*Pometia sp*	12,50	3,12	-	-	-	-	-	-
	Balam	*Litsea ladermanii,Techn*	-	-	-	-	-	-	12,50	57,62
	Telek	*Parastemon sp*	12,50	3,12	-	-	-	-	-	-
	Mangga	*Mangifera indica L*	12,50	3,50	12,50	7,37	-	-	-	-
	Bintangur	*Callophyllum sp*	-	-	12,50	11,75	-	-	-	-
Total			37,50	9,74						
IV	Damar	*Agathis sp*	-	-	50,00	42,75	-	-	50,00	137,50
Total			-	-	50,00	42,75	-	-	50,00	137,50
V	Dooepen	*Litsea glutimosa*	-	-	25,00	19,25	-	-	-	-
	Medeh	*Pometia pinnata, Forst*	25,00	8,25	-	-	-	-	-	-
	Ky. Kuku	*Pericoosis mooniana*	-	-	-	-	25,00	35,25	-	-
	Tar	*Agathis labillardieri, Warb*	25,00	13,75	-	-	-	-	-	-
Total			-	-	25,00	19,25	25,00	35,25	-	-
VI	Matoa	*Pometia sp*	50,00	22,25	-	-	-	-	25,00	90,50
Total			50,00	22,25	-	-	-	-	25,00	90,50
VII	Matoa	*Pometia sp*	25,00	17,25	-	-	25,00	37,75	-	-
Total			25,00	17,25	-	-	25,00	37,75	-	-
VIII	Ky. hitam	*Diospyros sp*	25,00	7,50	25,00	18,50	-	-	-	-
	Matoa	*Pometia sp*	25,00	13,00	-	-	-	-	-	-
	Kayar	*Vatica papuana, Dyer*	-	-	25,00	27,00	-	-	-	-
	Tubuk	*Xylopia papuana*	25,00	11,75	-	-	-	-	-	-
Total			75,00	32,25	50,00	45,50	-	-	-	-
IX	Mangga	*Magifera indica L*	-	-	12,5	9,87	-	-	-	-
	Ky.Kuku	*Pericoosis mooniana*	12,5	7,37	-	-	-	-	-	-
	Ky.Cina	*Spondias cytherea, Soon*	12,5	5,87	-	-	-	-	-	-
	Bintangur	*Callophyllum sp*	12,5	3,25	-	-	-	-	12,50	24,00
	Matoa	*Pometia sp*	-	-	-	-	-	-	12,50	31,12
	Ky.Malam	*Diospyros sp*	12,5	7,37	-	-	-	-	-	-
Total			50,00	23,86	12,50	9,87	-	-	25,00	55,12
X	Los	*Dracontomelon dao, Merr & Rolf*	-	-	-	-	25,00	37,75	-	-
	Ky. hitam	*Diospyros sp*	-	-	25,00	27,00	-	-	-	-
	Matoa	*Pometia sp*	50,00	22,25	-	-	-	-	-	-
Total			50,00	22,25	25,00	27,00	25,00	37,75	-	-

Note :
N : Average Trees Number / ha
V : Average Trees Volume / ha (m3/ha)

Source : Primary Data Analysis, November 1994

Table 4 - 14 RECAPITULATION RESULT OF TREES POTENCY ANALYSIS (AVERAGE) PER HECTARE

No.	Local name	Botanical name	Diameter Class (cm)									
			20 - 29		30 - 39		40 - 49		50 Up		> = 20 cm Up	
			N	V	N	V	N	V	N	V	N	V
1	Matoa	*Pometia sp*	22.50	9.99	1.25	0.86	2.5	3.77	5.00	14.89	31.25	29.51
2	Bintangur	*Callophyllum sp*	2.50	0.97	1.25	1.17	1.25	1.65	1.25	2.40	6.25	6.19
3	Damar	*Agathis sp*	1.25	0.27	7.50	6.25	-	-	5.00	13.75	13.75	20.27
4	Bilin	*Octomeles sumatrana, Miq*	1.25	0.42	-	-	-	-	-	-	1.25	0.42
5	Kamun	*Amooramyrnecphyla, Warb*	-	-	-	-	2.50	4.78	-	-	2.50	4.78
6	Balam	*Litsea ladermanii, Techn*	-	-	-	-	-	-	1.25	5.76	1.25	5.76
7	Kayu Lawang	*Cinnamomun cullilawan*	-	-	2.50	2.70	-	-	-	-	2.50	2.70
8	Telek	*Parastemon sp*	1.25	0.31	-	-	-	-	-	-	1.25	0.31
9	Mangga	*Mangifera indica L*	1.25	0.35	2.50	1.72	-	-	-	-	3.75	2.07
10	Dooepen	*Litsea glutimosa*	-	-	2.50	1.92	-	-	-	-	2.50	1.92
11	Medeh	*Pometia pinnata, Forst*	2.50	0.82	-	-	-	-	-	-	2.50	0.82
12	Kayu Kuku	*Pericoosis mooniana*	1.25	0.74	-	-	2.50	3.52	-	-	3.75	4.26
13	Kayu Tar	*Agathis labilladiari, Warb*	2.50	1.37	-	-	-	-	-	-	2.50	1.37
14	Kayu Hitam	*Diospyros sp*	2.50	0.75	5.00	4.55	-	-	-	-	7.50	5.30
15	Kayu Malam	*Diospyros sp*	1.25	0.74	-	-	-	-	-	-	1.25	0.74
16	Kayu Los	*Dracontomelon dao Merr & Roll*	-	-	-	-	2.50	3.78	-	-	2.50	3.78
17	Kayar	*Vatica papuana, Dyer*	-	-	2.50	2.70	-	-	-	-	2.50	2.70
18	Tubuk	*Xylopia papuana*	2.50	1.17	-	-	-	-	-	-	2.50	1.17
Total			42.50	17.90	25.00	21.87	11.25	17.50	12.50	36.80	91.25	94.07

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Note :
N : Average trees number/ha
V : Average trees volume/ha/m3/ha

Source : Primary Data Analysis, November 1994.

Tabel 4 - 15 Species Wealth of Terrestrial Fauna in Observation Area

Local Name	English Name	Scientific Name	Status	EC	Plot Nos. of Observation									
					1	2	3	4	5	6	7	8	9	10
BURUNG														
Kakatua putih	Milky Cockatoo	*Cacatua sp*	UE		i	-	i	-	-	p	-	p	-	-
Kakatua merah	Red Cockatoo	*Cacatua sp*	UE		p	-	p	-	p	-	-	-	-	-
Burung pipit	Sparrow	*Lonchura vana*	UE		p	-	-	p	p	p	-	p	p	-
Burung taun-taun		*Aceros leucocephalus*	UE		-	i	-	i	p	-	-	-	-	-
Gagak hitam	Black Crow	*Corvus macrohincos*	UE		i	i	-	-	p	-	-	-	-	-
Burung nuri hitam	Black Naped Lory	*Lorius domicella*	EN	EC	i	-	i	-	-	-	-	-	-	i
Cenderawasih	Lesser Bird of Paradise	*Paradissidae*	EN	EC	i	i	i	i	-	-	-	-	-	i
Burung mambruk	Grounded Pigeon	*Goura sp*	EN		i	p	i	p	-	-	-	-	-	i
Burung mas	Nicobor Pigeon	*Caloenas nicobarica*	EN		i	-	-	-	-	-	-	-	-	-
Kakatua raja	Palm Cockatoo	*Probasciger artiminus*	EN		p	p	i	-	-	-	-	i	i	-
Kakatua jambul kuning	Sulphur Crested Cockatoo	*Cacatua galerita triton*	EN	EC	i	-	-	i	p	p	p	p	-	-
Kasuari	Single Wattled Cassowary	*Casuarius telanapoli*	EN	EC	p	-	i	-	-	-	-	i	-	-
Burung sesep madu	Soety Honey Eater	*Meliphagidae*	EN		i	p	i	-	-	-	-	p	-	-
Bangau putih	Milky Stork	*Heradias sp*	EN		i	-	-	-	-	-	-	p	-	-
Raja udang	King Fisher	*Aqbedo atis*	EN		p	p	-	i	-	-	-	-	-	-
MAMALIA														
Kanguru pohon	Tree Kangaroo	*Valeriidendro logusursiusi*	EN	EC	i	i	i	i	i	i	p	i	-	-
Kuskus	Gray Phalanger	*Phalanggei*	EN		p	i	p	p	-	-	-	p	-	-
Babi hutan	Wild boar	*Sus scrofa*	UE		i	-	-	-	-	-	i	-	-	-
Rusa	Deer	*Cervus thimorensis*	UE		j	i	i	j	i	-	i	-	-	-
Anjing	Dog	*Cannis-sp*	UE		-	-	-	-	p	-	p	-	-	-
REPTILIA														
Ular rumput	Grass Snake	*Matrix spp*	UE		p	-	-	-	-	-	-	-	-	-
Kadal	Lizard	*Mabuiya multifasciata*	UE		p	p	p	p	-	-	-	p	p	p
Biawak	Monitor Lizard	*Varanus dp*	UE		p	p	p	-	p	-	-	-	-	-
Buaya air tawar	Fresh Water Crocodile	*Coocodeylus novaeguinai*	EN		-	i	i	-	-	-	-	-	-	-
Buaya muara	Marsh Crocodile	*Coocodeylus prosus*	EN		-	i	i	-	-	-				
Ular Kaki Empat	Giant Skink	*Tiligua gigas*	EN	EC	-	-	-	p	p	-	-	-	-	-
Soa Soa	Fintaited Lizard		EN		-	i	-	-	-	p	-	-	-	-
SERANGGA														
Kupu Sayap Burung Surga	Birdwing Butterfly	*Omithoptera paradisca*	EN	EC	p	-	-	-	-	-	-	-	-	-
Kupu burung fiton	Birdwing Butterfly	*Omithoptera tithonus*	EN	EC	-	-	-	p	-	-	p	p	p	p
Kupu burung priomus	Birdwing Butterfly	*Omithoptera priamus*	EN	EC	-	-	-	-	p	-	i	i	-	-

Note : i : Information p : direct encounter j : Tracks

EN : Endangered species UE : Unendangered species EC : Endemic species

Source : Primary Data, November 1994

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Table 4 - 16 Species Abundancy of Terrestrial Fauna in Observation Area

Local Name	English Name	Spesies	Status	Plot Nos. of Observation									
				1	2	3	4	5	6	7	8	9	10
BIRDS													
Kakatua putih	Milky Cockatoo	*Cacatua sp*	UE	E	-	E	-	-	D	-	D	-	-
Kakatua merah	Red Cockatoo	*Cacatua sp*	UE	D	-	D	-	D	-	-	-	-	-
Burung pipit	Sparrow	*Lonchura vana*	UE	E	-	-	D	D	D	-	D	D	-
Burung taun-taun		*Aceros leucocephalus*	UE	-	E	-	E	D	-	-	-	-	-
Gagak hitam	Black Crow	*Corvus macrohincos*	UE	E	E	-	-	D	-	-	-	-	-
Burung nuri hitam	Black Naped Lory	*Lorius domicella*	EN	E	-	E	-	-	-	-	-	-	E
Cenderawasih	Lesser Bird of Paradise	*Paradissidae*	EN	E	E	E	E	-	-	-	-	-	E
Burung mambruk	Grounded Pigeon	*Goura sp*	EN	E	D	E	D	-	-	-	-	-	E
Burung mas	Gold Bird	*Calcaus nicobarica*	EN	E	-	-	-	-	-	-	-	-	-
Kakatua raja	Palm Cockatoo	*Probasciger artiminus*	EN	D	D	E	E	-	-	-	E	E	-
Kakatua jambul kuning	Sulphur Crested Cockatoo	*Cacatua galerita triton*	EN	E	-	E	E	D	D	D	-	-	-
Kasuari	Single Wattled Cassowary	*Casuarius telanapoli*	EN	D	-	-	-	-	-	-	E	-	-
Burung sesep madu	Soety Honey Eater	*Meliphagidae*	EN	E	D	E	-	-	-	-	E	-	-
Bangau putih	Milky Stork	*Heradias sp*	EN	E	-	-	-	-	-	-	D	-	-
Raja udang	King Fisher	*Aqbedo atis*	EN	D	D	-	E	-	-	-	-	-	-
MAMMALS													
Kanguru pohon	Tree Kangaroo	*Valeriidendro logusursiusi*	EN	E	E	E	E	E	E	D	E	-	-
Kuskus	Gray Phalanger	*Phalanggei*	EN	D	E	D	D	-	-	-	D	-	-
Babi hutan	Wild boar	*Sus scrofa*	UE	E	-	-	-	-	-	E	-	-	-
Rusa	Deer	*Cervus thimorensis*	UE	-	E	E	-	E	-	E	-	-	-
Anjing	Dog	*Cannis-sp*	UE	-	-	-	-	D	-	D	-	-	-
REPTILES													
Ular rumput	Grass Snake	*Matrix spp*	UE	D	-	D	-						
Kadal	Lizard	*Mabuiya multifasciata*	UE	D	D	-	D	D	-	-	D	D	D
Biawak	Monitor Lizard	*Varanus dp*	UE	-	E	E	-	-	-	-	-	-	-
Buaya air tawar	Fresh Water Crocodile	*Coocodeylus novaeguinai*	EN	-	E	E	-	-	-	-	-	-	-
Buaya muara	Marsh Crocodile	*Coocodeylus prosus*	EN	E	E	E	-						
Ular Kaki Empat	Giant Skink	*Tiligua gigas*	EN	-	-	D	D	-	-	-	-	-	-
Soa Soa	Fintaited Lizard		EN	-	E	-	-	-	D	-	-	-	-
INSECT													
Kupu Sayap Burung Surga	Birdwing Butterfly	*Omithoptera paradisca*	EN	C	-	-	-	-	-	-	-	-	-
Kupu burung fiton	Birdwing Butterfly	*Omithoptera tithonus*	EN	-	-	-	C	-	-	C	C	C	D
Kupu burung priomus	Birdwing Butterfly	*Omithoptera priamus*	EN	-	-	-	-	C	-	E	E	-	-

Note : C : Moderate abundancy D : Low abundancy E : Very low Abundancy

EN : Endangered species UE : Unendangered species

Source : Primary Data, November 1994

fauna 2a.xls-tab 6

Table 4 - 17 Individual Number, Species Number and Diversity Index of Plankton

No.	Species	Abundancy / ml						
		A1	A2	A3	A4	A5	A6	A7
1	Glocotricha	13	-	-	-	-	4	-
2	Oscillatoria	5	2	10	12	6	10	1
3	Diatoma	4	3	2	-	13	7	-
4	Peridinium	1	-	-	-	-	-	-
5	Anacystis	20	4	5	4	5	2	-
6	Mougeotia	2	-	-	-	-	1	-
7	Cladophora	1	-	-	-	-	-	-
8	Spirogyra	1	-	-	2	-	-	-
9	Calothrix	1	-	-	-	-	-	-
10	Lyngbya	-	3	3	4	-	-	2
11	Lemanea	-	6	5	3	-	-	-
12	Bacillaria paradoxa	-	2	5	2	-	-	-
13	Bacteriastrum varians	-	1	1	-	-	-	-
14	Cyclotella	-	2	1	2	-	3	-
15	Ankistrodesmus	-	2	3	1	3	2	-
16	Fragilaria	-	2	-	-	-	-	-
17	Agmenellum	-	2	-	-	-	-	-
18	Pleurosigma	-	2	4	1	-	-	-
19	Spirulina	-	2	-	-	-	-	-
20	Cymbella	-	1	1	-	-	-	-
21	Synedra	-	3	3	2	3	16	-
22	Nitzschia	-	2	1	4	-	-	1
23	Hydrodictyon	-	2	3	3	-	-	-
24	Coleps	-	2	-	1	-	-	-
25	Closterium porectum	-	2	4	-	-	-	-
26	Gleotrichia	-	1	1	1	-	-	-
27	Anabaena	-	-	1	-	-	-	-
28	Trachelomonas	-	-	1	1	-	-	-
29	Zygnema	-	-	1	-	-	-	-
30	Trigonophyxis arcuata	-	-	1	-	-	-	-
31	Euglena	-	-	1	1	-	-	-
32	Colpoda	-	-	-	1	-	-	-
33	Lepocinclis	-	-	-	1	-	-	-
34	Paramoecium	-	-	-	1	-	-	-
35	Nauplius	-	-	-	1	3	-	-
36	Compsogon	-	-	-	-	-	-	-
37	Melosira	-	-	-	-	1	-	-
38	Dichotomosiphon	-	-	-	-	1	-	-
39	Aphanizomenon	-	-	-	-	1	7	-
40	Rivularia	-	-	-	-	-	4	-
41	Navicula	-	-	-	-	-	-	2
42	Chlorella	-	-	-	-	-	-	3
43	Cocconeis	-	-	-	-	-	-	1
	Individual Number	48	46	57	48	36	56	10
	Species Number	9	20	21	21	9	10	6
	Diversity Index	0.74	1.26	1.21	1.20	0.82	0.89	0.74

Source : Primary Data Analysis, November 1994 and February 1995.

Table 4 - 18 Species Number, individual Number and Diversity Index of Benthic

No.	Species	Class	Abundancy / m2						
			A1	A2	A3	A4	A5	A6	A7
1	Limnaea	Gastropoda	1	2	3	-	-	-	14
2	Pleurobema	Pelecypoda	-	-	3	-	-	-	-
3	Tarebia	Gastropoda	-	-	-	4	4	8	-
	Speciesl Number		1	1	2	1	1	1	1
	Individual Number		1	2	6	4	4	8	14
	Diversity Index		0	0	0.3	0	0	0	0

Source : Primary Data Analysis, November 1994 and February 1995.

Table 4 - 19 Species Wealth of Necton

No.	Local Name	English Name	Scientific Name	Remark
1	Tawes	Java barb	*Puntius gonionotus*	DS
2	Sumpit	Archerfish	*Toxotes jaculator*	DS
3	Kuweh	Scads	*Caranx saxfasciatus*	DS
4	Alu Alu	Barracuda	*Sphyraena spp*	DS
5	Kerapu	Sea - bass	*Ephynephelus merra*	DS
6	Peperak	Ponyfish	*Leiognathus equulus*	DS
7	Julung julung	Half beaks	*Hemir hamphus*	DS, US
8	Sembilang	Eel-tailed catfish	*Plotosus canius*	US
9	Gabus	Snake head	*Ophiocephalus striatus*	US
10	Mujair	Cichlids	*Tilapia mossambica*	US
11	B e l u t	Swamp - eel	*Flura alba*	US
12	Sapu kaca	Mailed catfish	*Chandra buruensis*	US
13	Udang galah	Shrimp	*Macrobrachium rosembergi*	DS, US
14	Moa kembang	Fresh water eel	*Anguilla mauritiana*	US
15	S i d a t	Fresh water eel	*Anguilla bicolor*	US

Source : Fisheries Agency of Sorong, February 1995

Remark :

DS : Encountered in the downstream area of the dam site.
US : Encountered in the upstream of the dam site.

Tbl4-14.xls

Table 4 - 20 Poeple Number in Proposed Reservoir Area of the Warsamson HEPP

No.	Name (H.H)	Family Number		
		Male	Female	Total
1.	Gustap Osok	5	2	7
2.	Wenan Osok	4	3	7
3.	Moses Osok	3	5	8
4.	Bernar Kalasuat	2	3	5
5.	Yokonias Kalasuat	3	2	5
6.	Karel Kalasuat	3	4	7
7.	Yery Tesya	1	2	3
8.	Agus Flance	1	1	2
9.	Yusuf Malagawa	3	3	6
10.	Demianus Kalasuat	2	3	5
11.	Yusuf Osok	2	2	4
12.	Alex Kalasuat	4	3	7
13.	Silas Mili	4	3	7
14.	Yunus Kalasuat	5	2	7
15.	Kornelis Kalasuat	2	4	6
16.	Arius Mili	2	1	3
17.	Henok Malibeli	2	1	3
18.	Sakarius Mili	4	4	8
19.	Benyamin Kalasuat	4	2	6
20.	Yosafat Kalasuat	2	3	5
21.	Matias Magablo	1	3	4
22.	Sepener Kwatolo	2	1	3
23.	Pilipus Mili	1	1	2
24.	Sem Mili	4	3	7
25.	Daniel Bisi	4	1	5
26.	Sadrak Kwatolo	4	2	6
27.	Entong	3	1	4
28.	Hermanius Malibella	5	0	5
	Total	82	65	147

Notes :

- HH : Household
- Nos 1 to 26 reside in Batu Lubang Village
- Nos 27 to 28 reside in Malano Village

Source : Primary Data Analysis, March 1995.

Table 4 - 21 Population Structure by Age in Batu Lubang, 1995

Age (Year)	Number (Person)	%
00 - 04	18	12.2
05 - 09	22	15.0
10 - 14	27	18.4
15 - 19	12	8.2
20 - 26	13	8.8
27 - 40	40	27.2
41 - 59	12	8.2
59 - above	3	2.0
T o t a l	147	100.0

Source : Primary Data Analysis, March 1995.

Table 4 - 26 Family Income of People in the Proposed Reservoir Area of Warsamson HEPP

No.	No. of Persons 1)	Sources of Income Agriculture (Rp.) 2)	Income per capita per year equal to kg rice. 3)	G r o u p
1	7	1.436000	273	Moderate
2	7	875.000	166	Poor
3	8	1.919.000	320	Moderate
4	5	1.040.000	277	Moderate
5	5	1.645.000	390	Moderate
6	7	860.000	164	Poor
7	6	1.156.000	256	Poor
8	5	880.000	235	Poor
9	4	636.000	212	Poor
10	7	2.180.000	415	Moderate
11	7	985.000	188	Poor
12	7	980.000	186	Poor
13	6	860.000	187	Poor
14	3	1.310.000	582	Moderate
15	3	980.000	435	Moderate
16	8	840.000	140	Poor
17	6	1.560.000	346	Moderate
18	5	900.000	240	Poor
19	4	660.000	220	Poor
20	3	600.000	266	Moderate
21	2	880.000	586	Moderate
22	7	980.000	187	Poor
23	5	800.000	213	Poor
24	6	1.020.000	226	Poor
25	4	1.100.000	366	Moderate
26	5	918.000	245	Poor

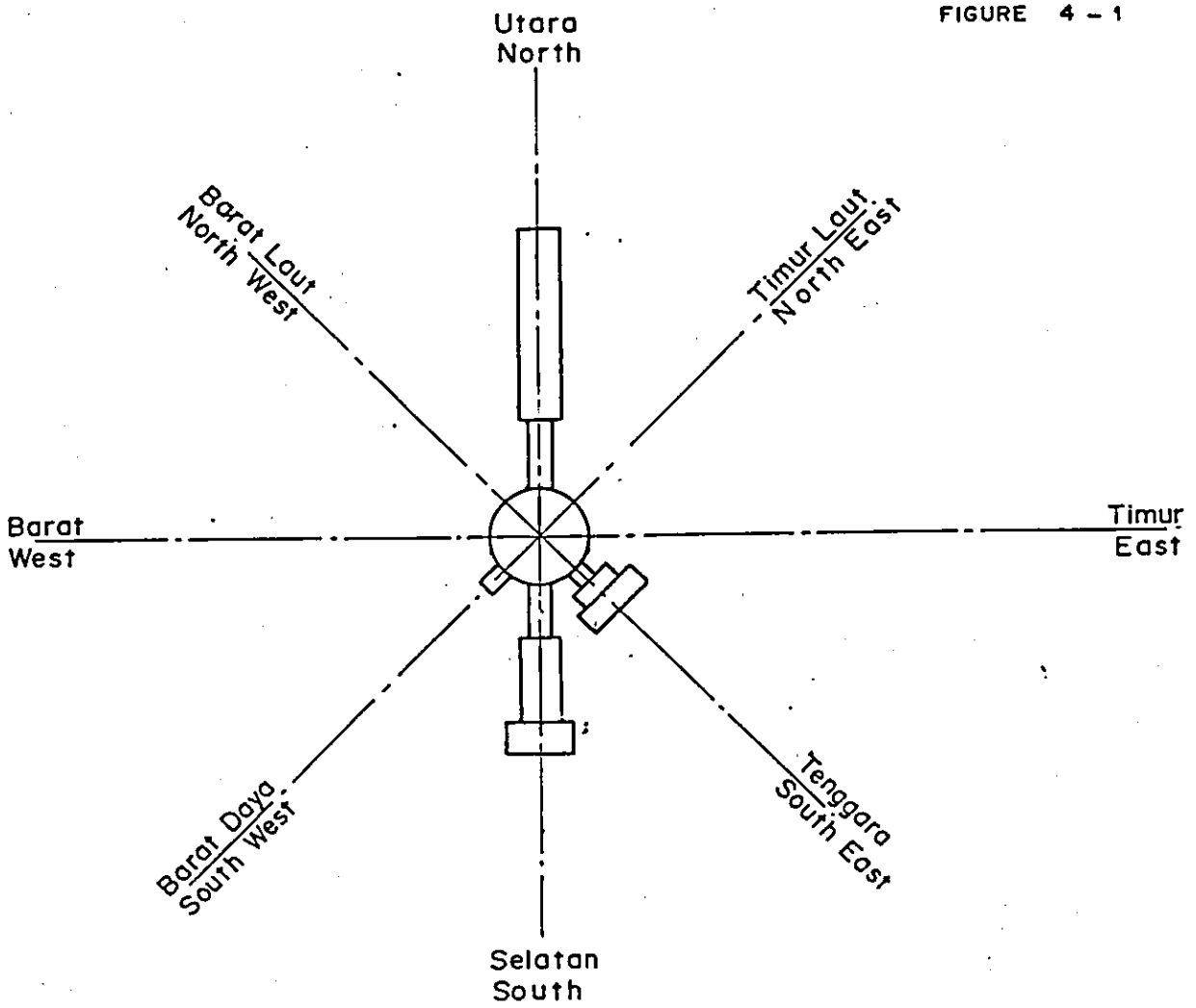
Source : Primary Data Analysis, February 1995.

Note :

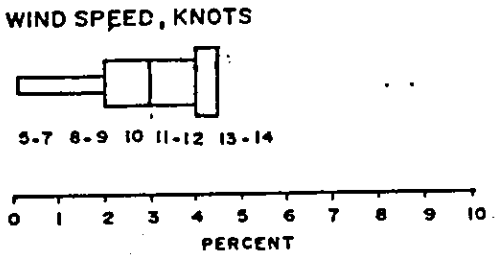
- Total of Mederate Group : 11 families or 42 %
- Total of Poor Group : 15 families or 58 %

$$3) = \frac{2)}{1) \times 750}$$

GAMBAR 4 – 1
FIGURE 4 – 1



Legenda / Legend :



	DEPARTEMEN PERTAMBANGAN DAN ENERGI PT. PLN (PERSERO)
PEKERJAAN STUDI ANDAL PLTA WARSAMSON	
LINGKARAN ANGIN WIND ROSE JAN.1993 - DEC.1993	

Gambar : 4-2
Figure : 4-2

Sheet Location

N

PACIFIC OCEAN

Tg. Dore
Meralt
Makbon
Matamkarta
FAMILANA
TELUK DORE HUM
MANDINKU
Tg. Sorong
P. Ram
SORONG
Kawaruk
Remu
PULAU TSIOF
P. Doom
P. Nanan
Reniu
Fenfamin
SELE STRAIT
PT402-290
Kumesa
Klasaman
P. Ombree
N. Sele 1
P. Sisi
PT136-238
PT137-363
PT59-133
Klagerik 1
Klamesin 1
MARIAT
P. Kobra
Klamagun
PT290-240

5 0 5 Km
Scale 1:250,000

LEGEND

Quarternary	Holocene	River and Litoral deposit
		Lake deposit
	Plistocene	Sele conglomerate
Tertiary	Pliocene	Klasaman Formation
	Miocene	Jetman Breccia
		Sorong Fault (mega Breccia)
		Klasafer Formation
	Eocene	Faumai Limestone
		Dore home valcanic
Paleozoic Mesozoic	Yurassic	Waijar Formation (Ophiolite)
	Triassic	Sorong Granite
	Silurian	Kemum Formation

GEOLOGICAL BOUNDARY
ANTICLINE
SYUCLINE
FAULT
DIP
OIL WELL
GAS WELL

Source : Geology map of Sorong
by P. Sunyoto P.E. Pieter Et al 1990

DEPARTEMEN PERTAMBANGAN DAN ENERGI

PEKERJAAN STUDI ANDAL PLTA WARSAMSON

PETA GEOLOGI REGIONAL DAERAH S. WARSAMSON
REGIONAL GEOLOGICAL MAP OF WARSAMSON RIVER

Gambar : 4 - 3
Figure : 4 - 3

N

SEA

Tg.Kwapir . Tg.Batu tinggi

Tg. Makon

MAKBON

Tg.Mafula

Tg Walik

S.Ogan

S.Wes

S.Wilik

ML.UGANSA

KOMAGI

S.Warsamson

WABELUM

100

KETERANGAN / LEGEND :

- LEMBAH / VALLEY
- MEDAN BERGELOMBANG RENDAH/SEDANG / WEAK UNDULATION FIELD
- MEDAN BERGELOMBANG KUAT / STRONG UNDULATION FIELD
- PERBUKITAN LANDAI / SMOOTH HILL
- PERBUKITAN CURAM / STEEP HILL
- PEGUNUNGAN / MOUNTAINS
- BATAS SATUAN / UNIT BOUNDARY
- SUNGAI / RIVER
- JALAN / ROAD
- BENDUNGAN / DAM

0 1 2 3 4 5 km

Skala / Scale 1 : 100.000

DEPARTEMEN PERTAMBANGAN DAN ENERGI

PT. PLN (PERSERO)

PEKERJAAN STUDI ANDAL PLTA WARSAMSON

PETA SATUAN MORFOLOGI DAERAH SUNGAI WARSAMSON

MORPHOLOGY UNIT MAP OF WARSAMSON RIVER AREA

Gambar : 4-4
Figure : 4-4

KETERANGAN
LEGEND

ENDAPAN ALUVIAL
ALUVIAL DEPOSIT

ENDAPAN KUARTER
QUARTERY DEPOSIT

KONGLOMERAT
CONGLOMERATE

FORMASI KONGLOMERT
SELE CONGLOMERATE

BREKSI
BRECCIA

MEGA BREKSI SESAR
FAULT BRECCIA MEGA

BATU LUMPUR DAN SERPIH
MUDSTONE AND SHALE

FORMASI KLASAMAN / KLASAMAN FORMATION

BATU LUMPUR GAMPINGAN
CALCAREOUS MUDSTONE

FORMASI KLASAFET / KLASAFET FORMATION

TUFA DAN AGLOMERAT
TUFF AND AGGLOMERATE

BATU GUNUNG API DORE HOME / DORE HOME VOLCA

BREKSI VOLKANIC DAN LAVA
VOLCANIC BRECCIA AND LAVA

BATU GUNUNG API DORE HOME / DORE HOME VOLCA

SERPIH DAN BATU GAMPING
SHALE AND LIMESTONE

FORMASI KEMUN
KEMUN FORMATION

BATAS LITOLOGI
LITHOLOGY BOUNDARY

BENDUNGAN / DAM

ELEVASI 100 m
ELEVATION 100 m

SUNGAI
RIVER

SUMBER :-PETA TOPOGRAFI DAERAH PLTA WARSAMSON
PT. AEROKARTO SKALA 1 : 10.000
-PETA GEOLOGI LEMBAR SORONG

0 1 2 3 4 km

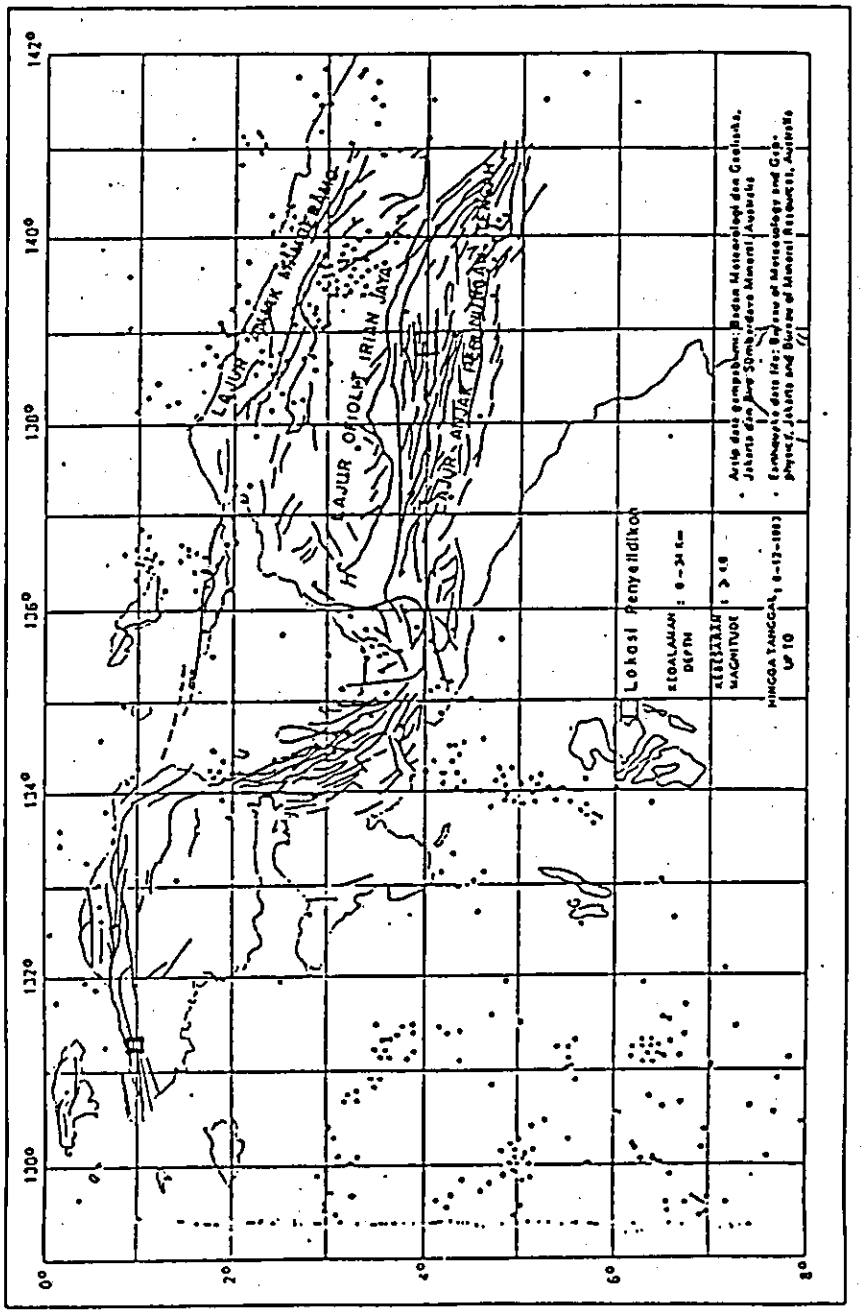
DEPARTEMEN PERTAMBANGAN DAN ENERGI
PT. PLN (PERSERO)

PEKERJAAN STUDI ANDAL PLTA WARSAMSON

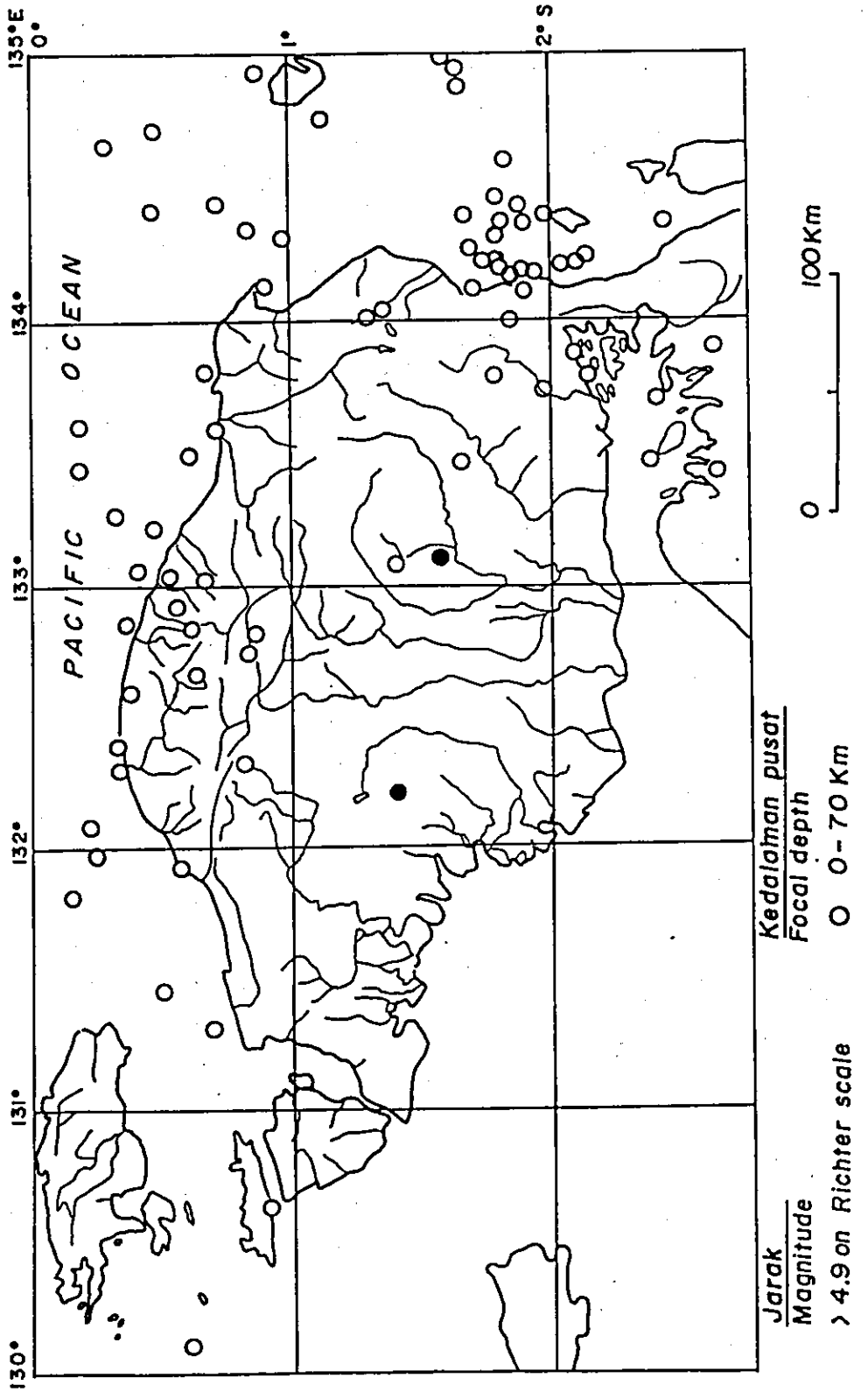
PETA GEOLOGI DAERAH GENANGAN S.WARSAMSON
GEOLOGICAL MAP OF RESERVOIR WARSAMSON RIV.

Gambar : 4 - 5
Figure : 4 - 5

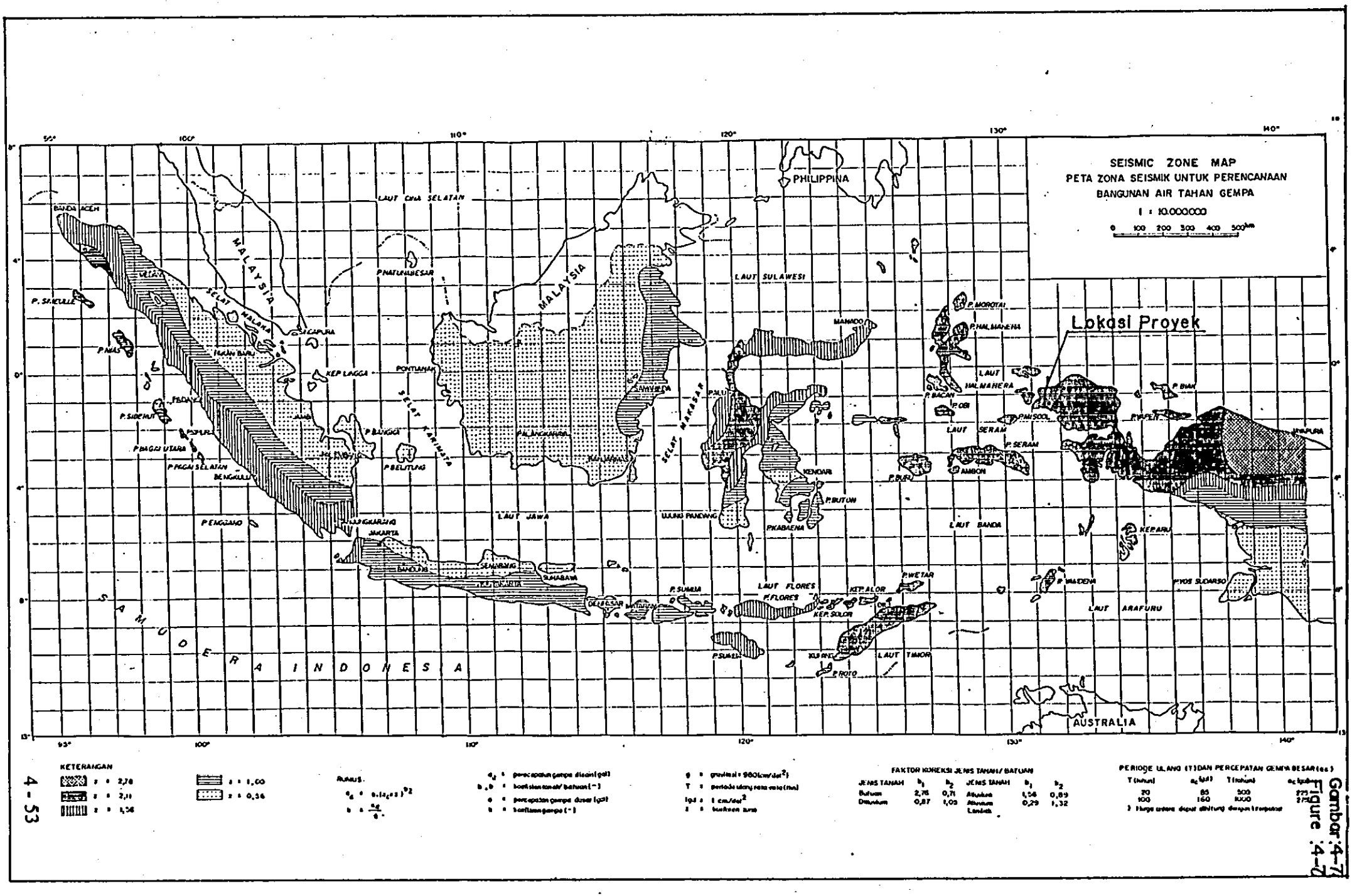
PUSAT GEMPA BUMI
EARTHQUAKE EPICENTRES



Gambar : 4 - 6
Figure : 4 - 6

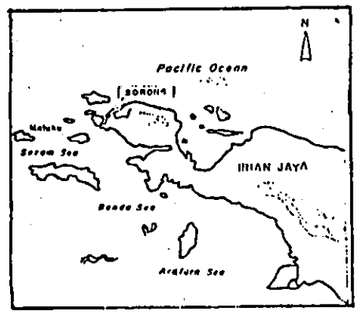


Kegempaan 1900 — 1986
Seismicity, 1900 — 1986



Gambar :4-7
Figure :4-7

Gambar : 4 - 8
Figure : 4 - 8



KEY MAP

N

P.RAM
SORONG
P.TSIOF
DOOM
P.WASIR
SELAT SELE
Saoka
Malanu
Saibek
MAKBON
TELUK DOREHUM
S.Warsamson
KEC.MAKBON
KEC.SORONG
Makambar
S.Klasogun
S.Klasaso
TELUK SEGUN
SEGET
S.Bumai
WANURIAN
S.Klioduk
MEGA
S.MEGA
KEC.SAUSAPOR
KEC.MORAIT
S.Sedin
AYAMARU
TEMINABUAN
HR
Sm
S
Sg

0 25 km
1 : 500000

LEGENDA/LEGEND

- Kampung / Village
- Pemukiman Transmigrasi / Housing Of Transmigratio
- Kebun Campuran / Mix Garden
- Semak Belukar / Bush
- Hutan / Forest
- Daerah Genangan / Inundation Area
- Batas Kecamatan / Kecamatan Boundary

Sumber : Sub Direktorat Tata Guna Tanah Direktorat Agraria Propinsi Irian Jaya, 1988
Source : Subdirectorate Of Land Use Agrarian Directorate Irian Jaya 1988

Note :

Other small villages cannot be shown with the following reasons :
1. Too small to describe in the map.
2. Prepared by year of 1988, the other new villages did not plotted yet to date.

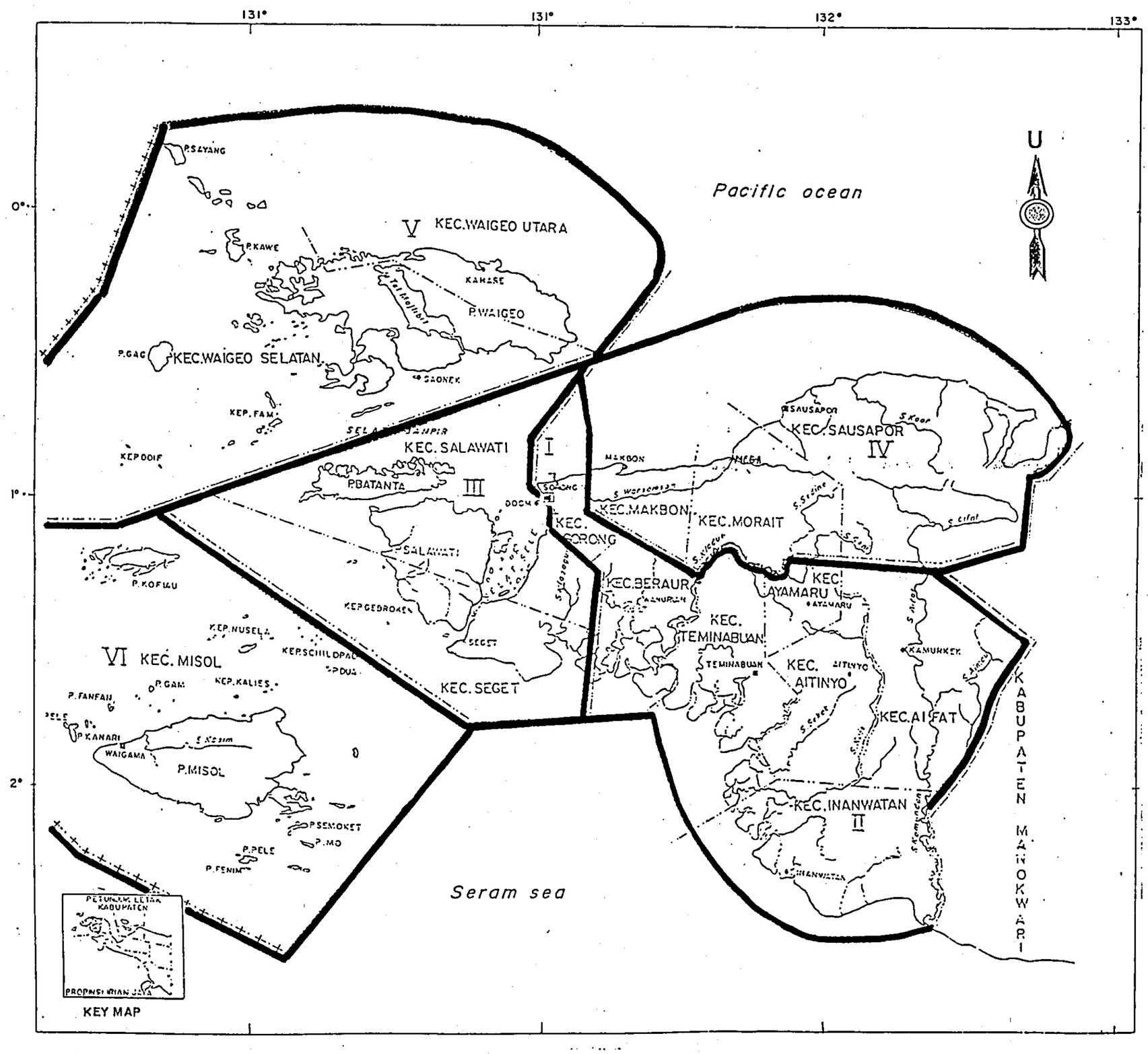
Source : Forestry Agency of Sorong, 1988.

DEPARTEMEN PERTAMBANGAN DAN ENERGI
PT. PLN (PERSERO)

PEKERJAAN STUDI ANDAL PLTA WARSAMSON

PETA PENGGUNAAN TANAH
LAND USE MAP

Gambar : 4 - 9
Figure : 4 - 9



Legenda :
Legend :

- Sungai / River
- Batas Propinsi / Province Boundary
- Batas Kabupaten / Regency Boundary
- Batas Kecamatan / District Boundary
- Batas Wilayah Pembangunan / Development Zone Boundary
- IV Nomor Wilayah Pembangunan / Development Zone Number
- Ibukota Kabupaten / Regency Capital
- Ibukota Kecamatan / District Capital
- Pusat Pengembangan / Development Center

SUMBER :

RENCANA UMUM TATA RUANG KABUPATEN SORONG
LAPORAN AKHIR MARET 1992 PEMERINTAH
DAERAH KABUPATEN SORONG

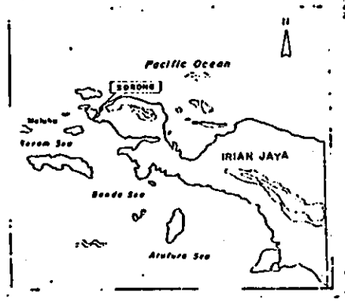
0 16 48 km
Skala / Scale

DEPARTEMEN PERTAMBANGAN DAN ENERGI
PT. PLN (PERSERO)

PEKERJAAN STUDI ANDAL PLTA WARSAMSON

PERWILAYAHAN PEMBANGUNAN KABUPATEN SORONG
DEVELOPMENT ZONE OF KABUPATEN SORONG

Gambar : 4 - 10
Figure : 4 - 10



MAKBON
TELUK DOREHUM
MEGA
S. MEGA
RAM
P. TSIOF
SORONG
DOOM
KEC. MAKBON
KEC. MORAIT
S. Kladuk
S. Sedin
P. WA SIR
SELAT SELE
S. Klawilis
S. Klasagun
S. Kladuk
WANURIAN
AYAMARU
KEC. SORONG
SEGET
S. Klosop
S. Bumai
TELUK SEGUN
TEMINABUAN

0 25 km
1 : 500.000

LEGENDA / LEGEND

TATA GUNA HUTAN / FOREST ZONING

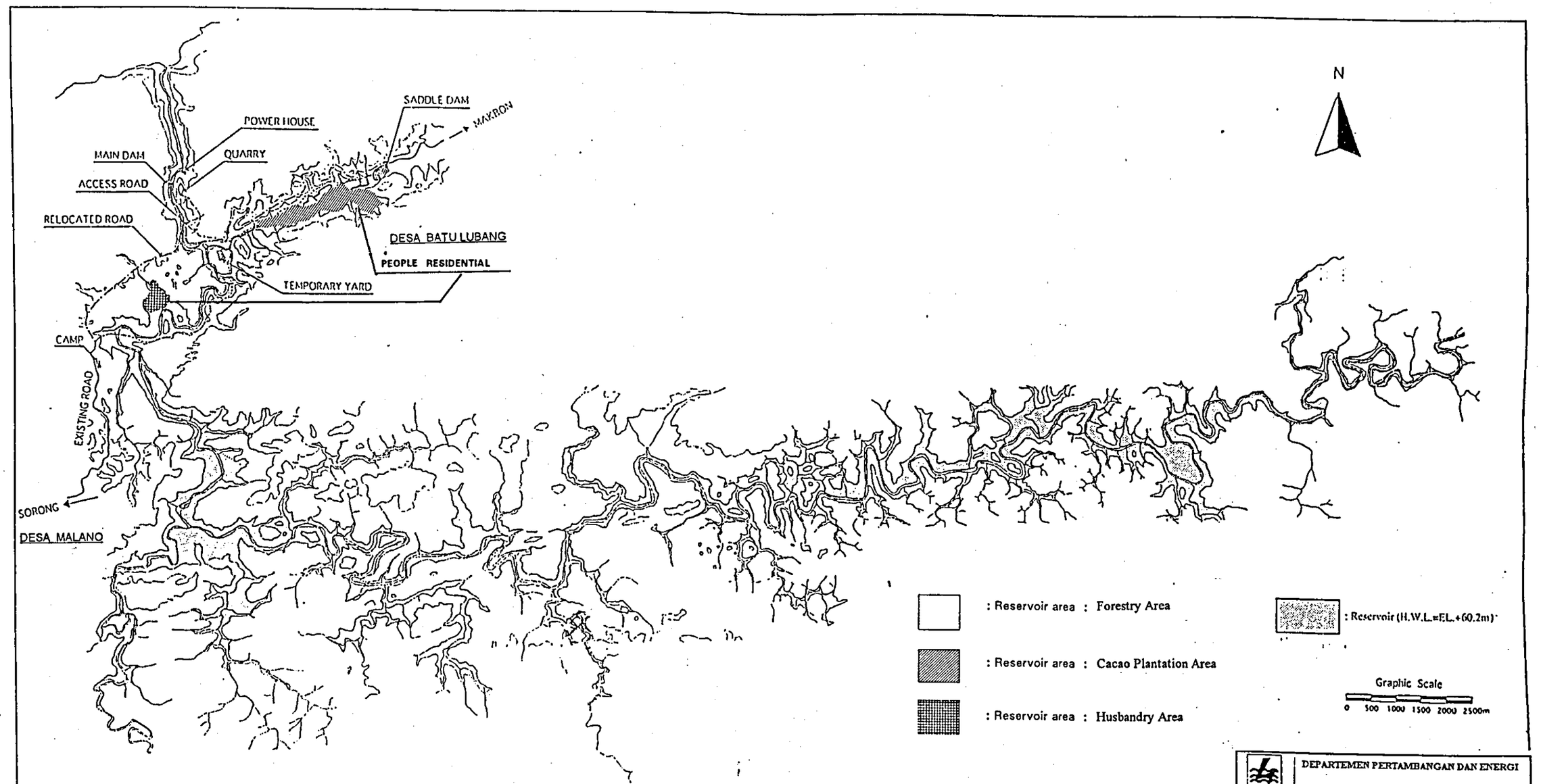
- HUTAN SUAKA ALAM / NATURAL RESERVE
- HUTAN LINDUNG / PROTECTION FOREST
- HUTAN PRODUKSI TERBATAS / LIMITED PRODUCTION FOREST
- HUTAN PRODUKSI / PRODUCTION FOREST
- HUTAN PRODUKSI YG DAPAT DIKONVERSI / CONVERSION FOREST
- DAERAH GENANGAN / INUNDATION AREA
- BATAS KECAMATAN / KECAMATAN BOUNDARY

SUMBER : DINAS KEHUTANAN DATI II SORONG, 1988
SOURCE : FORESTRY AGENCY SORONG, 1988

DEPARTEMEN PERTAMBANGAN DAN ENERGI
PT. PLN (PERSERO)

PEKERJAAN STUDI ANDAL PLTA WARSAMSON

PETA PENAFSIRAN VEGETASI
VEGETATION MAP



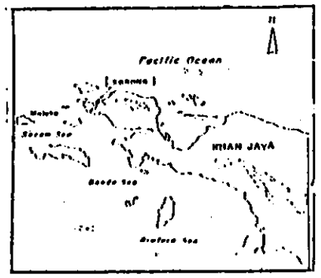
DEPARTEMEN PERTAMBANGAN DAN ENERGI

PT. PLN (PERSERO)

PEKERJAAN STUDI ANDAL PLTA WARSAMSON

MAP OF PROJECT AREA

Figure 4 - 12



U

MAKBON
TELUK DOREHUM
MEGA
S. MEGA
KEC. SAUSAPOR
KEC. MORAIT
KEC. MAKBON
P.RAM
P.TSIOF
SORONG
DOOM
P.WAGIR
S.Warsamson
S.Sedin
S.Kladuk
S.Klawilis
S.Kloduk
SELAT SELE
KEC. SORONG
S.Klasogun
S.Klasop
S.Bumoi
WANURIAN
AYAMARU
SEGET
TELUK SEGUN
TEMINABUAN
AITINYO

LEGENDA / LEGEND :

- Gereja / Church
- Masjid / Mosque
- Kantor Urusan Agama / Office of Religion Affairs
- Rumah Sakit / Hospital
- Puskesmas Pembantu / Sub Public Health Centre
- Puskesmas / Public Health Centre
- Puskesmas Tanpa Dokter / Public Health Ctr. (W/O Phycisian)
- Sekolah Pendidikan Kesehatan / Medical Education School
- Sekolah Taman Kanak-Kanak / Kindergarten School
- Sekolah Dasar / Elementary School
- Sekolah Lanjutan Pertama / Primary School
- Sekolah Lanjutan Atas / Secondary School
- Batas Kecamatan / Boundary of Kecamatan
- Ibukota Kecamatan / Subdistrict Capital
- Daerah Genangan / Inundation Area

0 25 km
1 : 500 000

Sumber : Source
Dinas Kesehatan Kabupaten Sorong, 1987 / Health Agency of Sorong, 1987
Kantor Departemen Agama Sorong, 1988 / Religion Department Office of Sorong, 1988
Kantor Departemen P dan K Sorong, 1988 / Education and Culture Department Office of Sorong, 1988

DEPARTEMEN PERTAMBANGAN DAN ENERGI
PT. PLN (PERSERO)
PEKERJAAN STUDI ANDAL PLTA WARSAMSON

LOKASI FASILITAS UMUM
LOCATION OF EXISTING PUBLIC FACILITIES

V. PREDICTION OF SIGNIFICANT IMPACT

1. General

Prediction of significant impact is a prediction the difference of impact occur in the environment without the project and with the project. Purpose of the prediction of significant impact is to analysis how far the impact of Warsamson HEPP activity toward the environment and environmental impact toward the Warsamson project. In this study the impact prediction is divided into three parts as follows.

a. Impact prediction during preconstruction stage
b. Impact prediction during construction stage
c. Impact prediction during postconstruction stage

The prediction through two steps, namely, first, identification of impact by using a flow chart, and second, prediction of significant impact by using a matrix. The size of signification impact is then evaluated in step of significant impact evaluation.

2. Identification and Impact Prediction

A flow chart of impact identification for Warsamson HEPP during pre construction stage, construction stage, and post construction stage are presented in Figures 5 - 1, 5 - 2, and 5 - 3 and Table 5 - 1 representing an interaction matrix of impact prediction and can be described as below.

a. Preconstruction stage

Activity in this stage consist of survey, land compensation, and resettlement. The impact are described as follows.

1) Survey

- Employment, Flora & Fauna

Area of land affected by the survey activity such as forest land is relatively small. Disturbance to forest flora and fauna caused by establishing a base camp, cutting trees and operating equipment is also very small, as well as number of people involved, get the job as the local labour and/or a guide. From the side of people number relish the benefit in this activity, the impact is classified into insignificant (positive). Physical damage is not happen during the survey, so this activity is not induce the significant (negative) impact.

2) Land compensation

- People Number and Public Order Disturbance

People number who will loss the land of cacao plantation as the main livelihood is 26 families and will loss forest land about 100 families, two families out of them are as the field extension worker (PPL) of Plantation Agency. Land compensation will alter their income.

Payment of indemnity to the people will stimulate the consumerism habit and cause the social discrepancy. This will ignites the disturbance on security and public order (such as stealing of money). Disturbance on security and public order, although in small area, due to involve the people quiet, so pay attention is required. If no pay attention, the impact may become significant negative. If compared with the people number who relish the benefit of project, the number of affected people is much smaller. This impact is classified into insignificant negative.

- Land area

The total area required for the project approximately 3240 ha. . Most of land acquisition for construction area and relocation road (65 ha), for reservoir area (2,800 ha) and for resettlement area (175 ha) are forest area (production forest) and the remaining is husbandry area (25 ha) and people cacao plantation area (175 ha). Project development will alter the function and land ownership from belongings to the proprietary right to be state own/ PT. PLN (PERSERO). This area is very small compared with catchment area 1,460 km2 (2,2 %). Therefore, the impact is classified into insignificant negative.

From the side of impact intensity, this land compensation may able cause the conflict between affected people and project executive cost, in the case of any disagreement on indemnity cost, or the impact is classified into significant negative.

3) Resettlement

- People number and income

28 families, who live in the reservoir area at present, will be resettled entirety to the new location of about 175 ha in area. Resettlement able to cause the anxieties which disturb the habit of resettled people, if compared with the people who will relish the project benefit directly, this number is much smaller, therefore the impact is classified into insignificant negative. The resettlement may able to cause the social sensitivity (if raise the conflict between resettled people and project executive), in case the location of resettlement is not suitable with resettled people's hope and wish, the impact may become significant negative, such as no available of cacao plantation land and increase morbidity rate in new resettlement area.

Life pattern or culture values may not change in the new location, because this area closeby the former area, also no any conflicts will occur, due to still one clan ethnic group i.e., Moi ethnic group. Their incomes may decrease during the transition period, due to decline of cacao plantation production. In this case, the impact is classified into insignificant negative.

- Employment

Some people (about 50 to 75 persons) will be employed as local labourers (carpenters, bricklayer, etc), during the construction of houses (28 houses) and public facility, and preparation of plantation land in the resettlement area. The impact is classified into insignificant positive.

b. Construction stage

Activities during this stage cover mobilisation of heavy equipment and materials, preparatory work and land clearing, construction of access roads and relocation roads, construction of office, repair shop and base camp, construction of main structures including excavation of quarry, man power mobilisation and severance of work relations and impoundment. The impacts are described as below.

1) Mobilisation of heavy equipment and materials

- Air quality and noise

This activity directly will cause the alteration toward the air quality and noise level come from about 110 heavy equipment such as bulldozer, backhoe, dumptruck, tractor and so forth. This activity will pollute the housing, building, and vegetation along the road passed by the heavy equipment by deterioration of air quality and noise, particularly in Sorong City on route of construction material transportation such as cement from Sorong Port to project site. Area over which the impact will be experienced is relatively small, only along the transportation route in city area, this impact is classified into insignificant negative.

In the area the dust content, carbon monoxide and oxide nitrogen contents are 12 ug/m3, undetected and 0.0031 ppm, respectively, during this activity the contents may increase to be tenfold from the present condition (size or power of heavy equipment approximately ten x jeep), so the contents of dust, carbon monoxide and oxide nitrogen to be 120 ug/m3, 10 ppm and 0.031 ppm. This increase is still below the quality standard, therefore impact classification is insignificant negative.

Noise level will increase up to 80 dBA (equivalent to noise level on heavy traffic highway) from 55 dBA to 65 dBA at present condition. This figure is exceed the noise level of maximum permissible noise exposure stipulated by Health Ministerial Regulation is 55 dBA to 65 dBA for residential zone. This impact occur particularly in Sorong city in night time, however in the project site is not disturb due to no dense residential area. The impact of mobilisation of heavy equipment and material is classified into insignificant negative, if the duration of mobilisation less than 2 hours in day time and not more than 10 minutes continuously during night time.

- Road condition and traffic

The heavy equipment particularly dump trucks transporting construction material from Sorong Port to project site will pass the kabupaten road Sorong - Makbon, then continued by pass the access road. This activity will damage the pavement of the road, because the existing road is not used for heavy equipment (more than 10 tons). This activity also cause the traffic jam and accident, particularly in Sorong city along transportation route from Sorong port to project site. The number of affected people and area over which the impact will be experienced is relatively small and the impact only experienced during the construction stage, in this case the impact is classified into insignificant negative. However, if the impacts without any pay attention or mitigation (regulation of the vehicle speed, prevention of the traffic jam/ accident), it will cause the contradiction between local people and the project executive, therefore the impact become significant negative.

- Wildlife

The project site is located in forestry area, where as migration track for the several wildlifes. Noise level raised by the mobilisation of heavy equipment and construction material transportation may not disturb the migration activity of such wildlifes, due to the forestry area as their habitat where protected from the noise disturbance and have similar diversity is still large area. In this case, the impact is classified into insignificant negative.

- Employment

Some people will be employed as local labourers and/or drivers. This impact is classified into insignificant positive.

2) Preparatory work and land clearing

- Erosion

Preparatory work and land clearing or deforestation will increase detachment of soil particles and overland flow (run off) during rainy seasons, consequently will increase the erosion rate. This occur during construction stage on relatively small area (< 2%) compared with catchment area, in this case, the impact is classified into insignificant negative. The erosion rate may cause the turbidity (dissolved solid) of river water increase to 500 mg/l from 120 mg/l at present condition (erosion rate of area with ground cover vegetaion, bush, grass approximately fourfold of erosion of area with ground cover vegetation, forest). This figure is still below the quality standard for fisheries water is 1,000 mg/l. Therefore, the impact is classified into insignificant (negative).

- Loss of forest production

Loss of forest production about 2,440 ha, if compared with catchment area about 146,000 ha is relatively small (1.67 %) or decline of forest (timber) production : 2,440 ha x 40 m3/ha x 65 US$/m3 x Rp.2.150 x 0.4 = Rp. 5.455.840.000,-. From the side of area over which the impact will be experienced, area affected by the impact is relatively small due to the remaining forestry land is still vastly (98.3 %). Therefore, the impact is classified into insignificant negative.

- Flora and Fauna

The land clearing will reduce the vegetation diversity in the project area. Area over which the impact will be experienced is relatively small (< 2%) from the catchment area and same species vegetation with the loss species is still distributed in large area in the surrounding area, in this case, the impact is classified into insignificant negative. This activity will not induce the destruction or disturbance toward the protection area, therefore, it is classified into insignificant negative. The reduce of habitat also relatively small and similar habitat still lay extensively in surrounding of the project area. This impact is classified into insignificant negative. Endangered species or endemic, and or protected will not threatened with extinction, or their natural habitat will not experienced the destruction by this activity.

- Employment

Many local people will be recruited for this activity. The people will be employed as labourers for this activity is about 300 - 400 persons. Therefore this impact is classified into significant positive.

3) Construction of access road and relocation roads

- Topography

Topography form will experience the alteration follow the road body requirement. The area over which the impact will be experienced only along the access road and relocation roads are relatively small area (40 ha) compared with project area (< 2%) and this construction is not alter or modify the landscape or panorama beauty area. Therefore, the impact is classified into insignificant negative.

- Wildlife

The access road and relocation road (increase accessibility to the project area) will reduce the population of wildlife, by the increase of the hunt of wildlife by the worker, local people and the new comer. The hunt may not cause the extinction of endangered species, by considering that the accessibility of access road and relocation road are not too high (no access to entire forest area), only relocate the inundated road and access to construction site. In this case, this impact is classified into insignificant negative. The prevention act/prohibiting and control the traffic of wildlife and animal trade is required by extension and coordination with concern institutions such as : Forest Protection and Natural Reserve (PHPA) and local government.

- Employment

Many labours also will be recruited for this activity. People number involve and relish the benefit from this activity as local labour is about 100 persons. This impact is classified into insignificant positive.

4) Construction of office, repair shop and base camp

- Water quality

The operation of base camp, repair shop and office may decrease the river water quality (Warsamson river and tributaries) by human waste, solid and liquid waste such as oil, lubricant and so forth disposed to the river. These facilities will be operated until the end of the construction period (about 4 years). The coliform content may increase up to 2300 MPN/100 ml from 230 MPN/100 ml at present condition (approximately tenfold of present condition, equal to small hamlet). It is still below the quality standard of raw water for drinking water (10,000 MPN/100 ml).
The impact intensity is classified into significant negative, due to able to increase or spread the water borne diseases and high risk in malaria and DHF diseases. However, if the project take mitigation measures properly, this impact will change into insignificant impact (negative).

- Employment

Some people will be employed as local labourers in the construction work of office, repair shop and base camp is about 50 persons. The impact is classified into insignificant positive.

5) Construction of main structures and mining of material

- Noise, habitat, and fauna

Mining or excavating of material (soil) by using backhoe, shovels, bulldozers, etc., will be obtained by scraping off the surface of nearby hills by heavy equipment. Rock material excavation is principally done by blasting. The total amount of excavation is estimated approximately 26,000 m^3. During construction of the dam, cofferdam will be constructed up stream and down stream of the dam by using the muck from the diversion tunnel.

The noise level raised by the blasting is approximately 110 dBA (equivalent to shooting voice of machine weapon) and the dust content increase up to 200 ug/m^3 (the quality standard is 260 ug/m^3). This disturbance is not affect toward the people due to the nearest residential area located at 3 km from quarry site and bounded by dense forest. This impact may affect toward the starled of wildlifes which stay around the activity and physiologically the wildlifes will suffer shock and induce the delay of heat period, and lay eggs (for birds) if the noise level experienced long time and continues more than 4 hours per day. The area of quarry site and construction of main structures (25 ha) is relatively small/narrow (approximately 1%) from the entire project area (2640 ha). This activity will not induce the endangered species and/or endemic, and/or protected are threatened with extinction or their natural habitat experience the destruction. Therefore, these impacts are classified into insignificant negative.

- Erosion and water quality

The mining of material will increase the river water turbidity caused by water erosion toward the land in quarry site (3 ha). The area over which the impact will be experienced is relatively narrow (< 2%) compared with the entire project area, this activity occur during the construction stage. Therefore, this impact is classified into insignificant negative.

It is considered that a large amount of turbid water will not flow into the river since the dam site is to be closed by cofferdams and the river water will flow through a diversion tunnel.

Lots of cements will be required during construction of concrete gravity dam. The cement component include Na (alkaline), this compound substance may pollute the river water in the downstream area where as the habitat for the aquatic fauna such as crocodile. This water may not affect the aquatic biota by considering that the remaining cement from the baching plant will be deposited in the ditch bed before reach the river or if any part of cement flows into the river, it will coagulate when reaching the river (downstream) and difficult to be digested by the crocodile and in the water (pH neutral), the cement-Na bound will not dispersed. The impact is classified into insignificant negative, or seems no impact.

- Topography

The area of quarry site will change the topography and decrease the soil fertility, however the area is not cultivated by the local people as main means of living. This activity also occur in other construction area such as dam site, cofferdam, penstock, power house and so forth.

The area over which the impact will be experienced is relatively small (< 2%) and will not alter or modify the landscape or panorama beauty area. Therefore, the impact is classified into insignificant negative.

- Employment

The construction of main structures will recruit about 550 persons of manpower (labour, skill labour and professional), in addition, some informal sector (shops for daily needs) will grow around the project site. This impact is classified into significant positive.

6) Man power mobilisation and severance of work relations

- Man power

It is estimated that the number of local people who will be employed for the construction activities is about 330 persons. The impact is classified into significant positive.

After the completion of the construction work, termination of work (severance of work relations) on the part of contractor and consultant (based on contract) will be done. This activity will cause the negative impact such as anxiety. The impact is classified into insignificant negative. Number of people is not higher than 60% of the labour work at main construction.

- Public health

In case of labourers who have communicable diseases are imported or mobilised from outside of Sorong area, they may spread the diseases to the local people, by contact infection such as sexual transmitted diseases and by disease vectors. Nevertheless for the labourers who have vulnerable health risk will be infected by the communicable diseases easily, because malaria and diarrhoeal are the main endemic diseases in Sorong area. However, in general, the extermination technology of those diseases have already exist and the people easy to get the remedial measures, and able to take preventive action correctly before they are mobilised to the project site. Therefore, the impact is classified into insignificant negative.

- Social jealousy

Labourers from outside Sorong, generally have social status much higher than local people around the project site. Social jalousy may occur. This is avoidable by priority of local people to work in the project construction, participate in the tradition activity, etc. This impact is classified into insignificant negative.

7) Impoundment

The reservoir area will be impounded after the construction of dam, saddle dam and its facilities as well as land acquisition of reservoir area and land clearing have been completed. This activity will raise the impacts toward environment.

- Flora and Fauna

The impounding of reservoir will induce the loss of habitat for terrestrial fauna approximately 2,500 ha. The fauna may not sink and have the enough time to migrate to the higher places by considering the increase of river water level gradually and slowly. The area over which the impact will be experienced is relatively small (< 2%) compared with the catchment area (146,000 ha). Intensity of impact, the impounding activity will not cause the endangered species or endemic, and/or protected species are threatened with extinction, or their natural habitat experience the destruction. This impact is classified into insignificant negative.

- Archaeological remains and other structures.

Based on the information from local people, in the reservoir area and adjacent area, there are no archaeological remains having culture value encountered and need protection before the impounding. Other structures such as exploration drilling wells of Pertamina (state oil company), sacred trees and facilities of forest concession (HPH) Intimpura (base camps) were encountered in the study area. Based on the field observation and interview with the local people, informations obtainable are the following :

° Exploration drilling wells.
The location of three exploration drilling wells are in elevation more than El. ± 77 m and two out of them is unused (no source of oil).

° Sacred trees.
The trees (approximately 100 ha) consist of productive trees such as sago, matoa, and yellow fruit. The area affected by impounding water approximately 10 % from the total area (10 ha) where located around the river. These trees able to be compensated.

° Base camps of Intimpura.
The base camps located above elevation 80 m.

The impact is classified into insignificant negative.

- Downstream water

The impounding will reduce the water flow into the downstream of the dam, however the daily need of water for the inhabitant around the project is not use the water of Warsamson river in the downstream. They use the Warsamson river tributaries in the upstream of the dam (such as Klalin River). No impact is expected.

- Road condition

Section of Sorong - Makbon road approximately 10 km from the Malano bridge up to saddle dam site will be impounded by the reservoir water. This activity will completely blocking the passage and communication between Sorong and Makbon people about 606 families and 1993 families respectively. The relocation road and existing road are required since construction work. In the case of the existing road condition is worse after completion of construction work, this may cause the conflict with the local people and concern institutions. Therefore, this impact is classified into siginificant negative.

c. Post Construction Stage

This stage covers operation and management of the project (power plant) and the reservoir. The impact caused by the project activities are described as below.

1) Operation and management of the project (power plant)

- Rural electrification

Rural electrification is yearning and wish of local people which the realisation is very useful for the remote villages such as new village (Malawor) and Batu Lubang including resettlement area. Rural electrification will increase the social status of local people and promote the productive activities which use the electric power. This impact is classified into significant positive.

- People safety

The water discharge release in large amount suddenly at the peak load will dangerous for the safety of water user and navigation in the downstream of the dam (tailrace). No residential area along the river in the downstream of the dam and the river in this area also not be utilised by the inhabitant for daily needs. No impact caused by this activity. Based on the design of reservoir operation, the flood warning system is not required, due to the maximum discharge released from the tailrace is about 100 m^3/sec. and the design flood discharge is 2,000 m^3/sec or equal to the natural flood discharge.

- Employment

Some local labours will be recruited in this activity ($\pm$ 25 persons). This impact is classified into insignificant positive.

2) Operation and management of the reservoir

- Topography

Alteration land morphology to be water area will change the landscape of the reservoir area. Area change to be water is approximately 2,400 ha. This area is relatively small (< 2%) of the catchment area (1,460 km2) and this activity will not extremely alter or modify the landscape or panorama beauty area. Therefore, the impact is classified into insignificant negative.

- Land slides

Several land slides in the potential area to sliding in the surrounding of reservoir area may occur during reservoir operation. In steep valleys which are to be flooded, care is required to assess the potential for landslipes into the new reservoir, generally caused by changed groundwater condition or rapid reservoir drawdown. The entire potential area to sliding is approximately 10 ha and the location is scatered and remote from the residential area. However, if the land slides occur on the land area belongings to the local people whose the land not compensated yet, conflict between the land owner and the project executive would be induced. In this case, the impact become significant negative.

- Water quality

Incomplete clearance of new reservoir area will stimulate the water fertility level by rises of nitrogen (N), phosphorus (P), and ammonia (NH3) contents which the present contents of the substances are quite high compared with the other river. This condition will stimulate growth of the aquatic weeds, although they are not encountered in the river during the field observation, possibly will enter into the lake if the spores and plant carried out by the water flow from the other places. Then depletion of dissolved oxygen content up to less than 3.0 mg/l. Nitrogen and phosphorus contents in Warsamson River, river and lake in Japan are the following.

mg/l

Location	N	P
Warsamson River	3.4 ~ 5.2	0.1 ~ 0.3
Rivers in Japan	0.05 ~ 1.1	0.002 ~ 0.23
Eutrophic lakes in Japan	0.5 ~ 1.3	0.01 ~ 0.09

Source : - Primary Data, November 1994 and February, 1995.
- Feasibility Study on The Warsamson Hydroelectric Power Plant Development Project in The Republic of Indonesia, Draft Final Report 1995, Pacific Consultants International.

Eutrophication can develop particularly in new reservoir. An excess of nutrient produces a bloom of plankton, algae, and weed growth. These growths die and, when rotting on the bottom, use up all available oxygen at depth. Sulphuretted hydrogen is formed and the water is unfit for domestic use. In the river stretch immediately downstream, fish biota may be threatened. The condition known as "*eutrophication*" involves the water and bottom sediments becoming enriched with nutrients to a point where the water quality deteriorates: the nutrient content of the lake rises to a dangerous level, sometimes known as the "trophic" level. More widespread use of fertiliser and detergent and growing quantities of waste water have speeded it up. Phosphorus and nitrogen are the main factors.

The consequences of this situation are that the water cannot readily be used for domestic or industrial supply because of its disagreeable taste and odour, propensity for blocking filters and corrosiveness caused by free ions, it cannot be used for bathing (irritation of the skin) or sport fishing, and it is useless for industrial fishing. The impact is classified into significant negative, if the lake will be particularly utilised for aquaculture.

- Sedimentation.

Sediment and bed load is normally deposited in a reservoir instead of continuing downstream. Silt previously deposited on arable land may have to be replaced by fertilizer and this could have some advantages if applied with care. Under certain hydrological conditions, many of these effect can be partially overcome by passing silt laden water through a low level spillway or sluice at the start of a flood and closing the gates to impound the cleaner flow later in the flood. Estimation of sedimentation rate at the project site is 24,015 ton/year. Comparing to sedimentation rate in other area, in Java island in particular, the said is considered to be slight. The problem of sediment accumulation in a reservoir is often alleviated by erosion control measures in the upstream catchment, such as reafforestation and soil conservation. This is as part of maintenance work periodically of the Warsamson project. Therefore, this impact is classified into insignificant negative.

- Aquatic biota

The river water between just downstream of the dam until the cascade will be reduced, due to the creation of reservoir, the river flow will be regulated and the discharge will be more than the lowest natural river flow in the dry season (approximately 5 m^3/sec). However, the salinity content of river water downstream the cascade may increase due to sea water intrusion and lack of river (fresh) water. Salinity content depends on the discharge, will increase in dry season and decrease in rainy season. The consequence of this situation is that the water is not preferable for habitat of aquatic biota such as crocodile. This impact is classified into insignificant negative, because the aquatic biota (crocodile) is not threatened with extinction (the number of crocodiles in the river is about not more than 10 tails), by considering that the number of same species crocodile is found abundantly in the rivers of Sorong area and in crocodile conservation ground. Crocodile in Sorong conservation ground in this time comprises approximately 600 tail of marsh crocodile and 200 tail of fresh water crocodile which has been collected from Membramo, Waropen, and Klamono.

- Water discharge

Coordination among concern institutions are required, Public Works Department (PDAM, Water Supply Enterprises), Local Government of Kabupaten Sorong and PT. PLN (PERSERO), if the water supply for Sorong city and Arar industrial estate approximately 1,600 l/sec will be implemented during the reservoir filling. The water supply from the long-term planning is not infuence to the energy generating, water discharge required for the energy generating is approximately 41,000 l/sec. (Source : Pacific Consultants International). Therefore, no impact is expected.

- Public health

In the stagnant water such as reservoir will stimulate growth of fish, plankton, microbes, particularly coliform group, if the bathing, washing, and defecating culture is continued in along Warsamson River and its tributaries, and pathogen bacteria also develop due to the water is media for their growth. Besides that, the stagnant water also as the breeding site for malaria mosquitoes. Based on the available health data from Kabupaten Sorong, 1993, the figures of disease pattern and health disturbance which may occur in relation with the plan of Warsamson HEPP Development, it is predicted will increase, so that raise the significant impact (negative).

- Transportation accident.

The reservoir area may stimulate the local people to utilise the reservoir water as navigation. Although this prediction is not support by forms of reservoir (not so extensive) and reservoir is not blocking the relation of people surrounding the reservoir. However, if the people opinion, the reservoir is useful for navigation (crossing facility) to connect the other people in other part by crossing the river/lake, so sink accident may happen, because the people is not familiar with navigation. This impact is classified into insignificant negative, however the project executive necessary to give the training for local people to use the water as reservoir navigation, because if not, this will increase the sink accident.

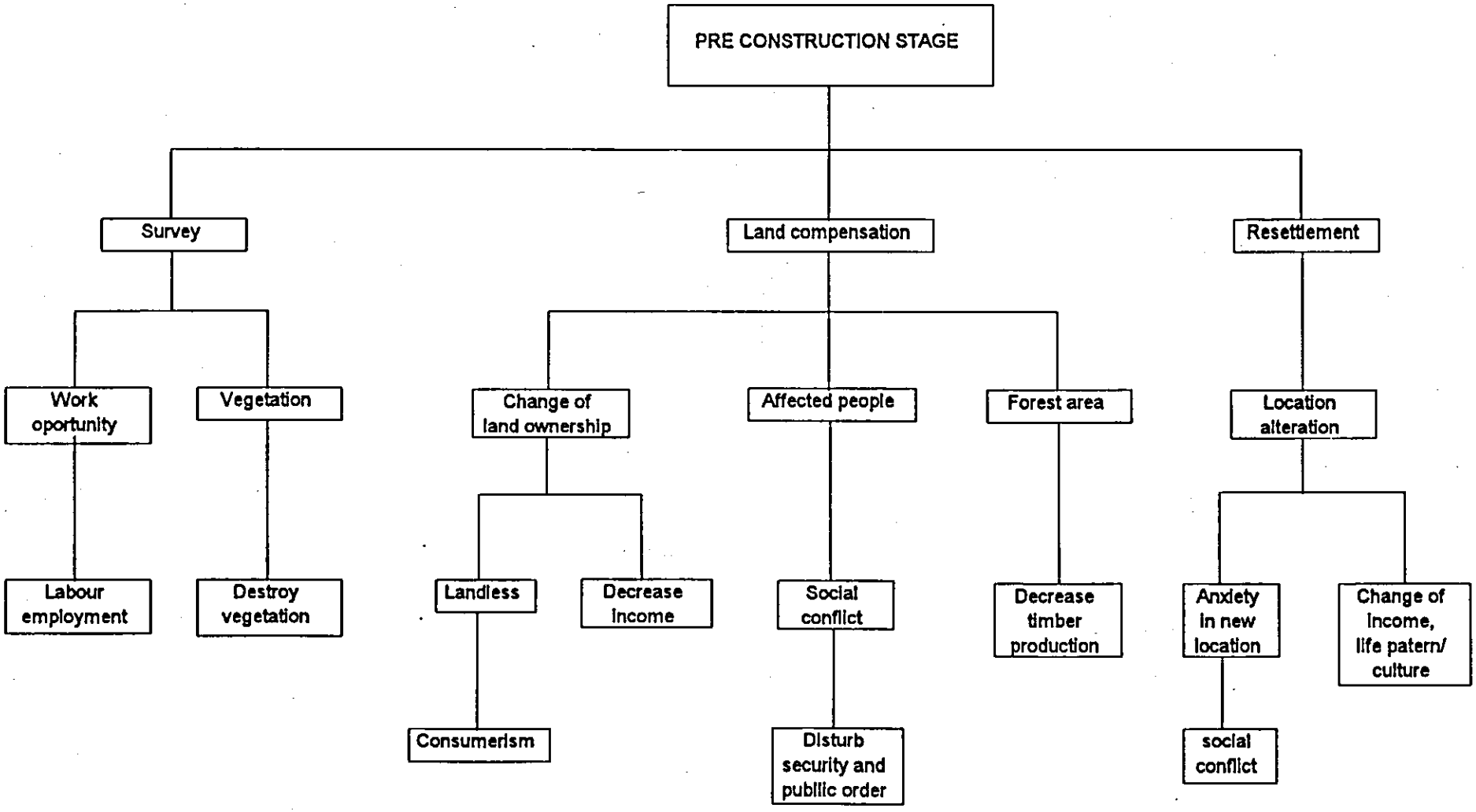


Figure 5 - 1 Flow Chart of Impact on Warsamson HEPP Development During Preconstruction Stage.

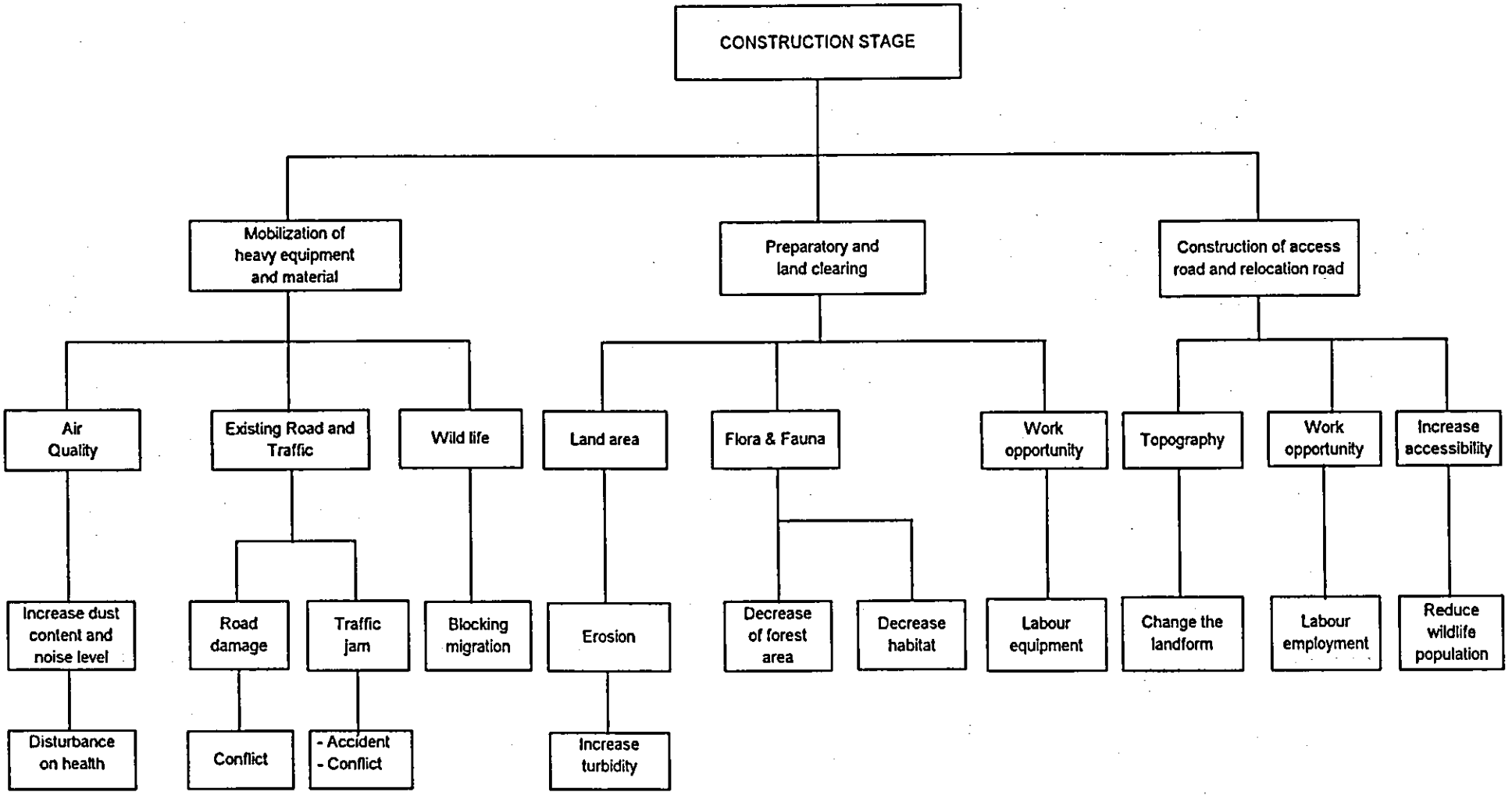


Figure 5 - 2 Flow Chart of Impact on Warsamson HEPP Development During Construction Stage (1/2).

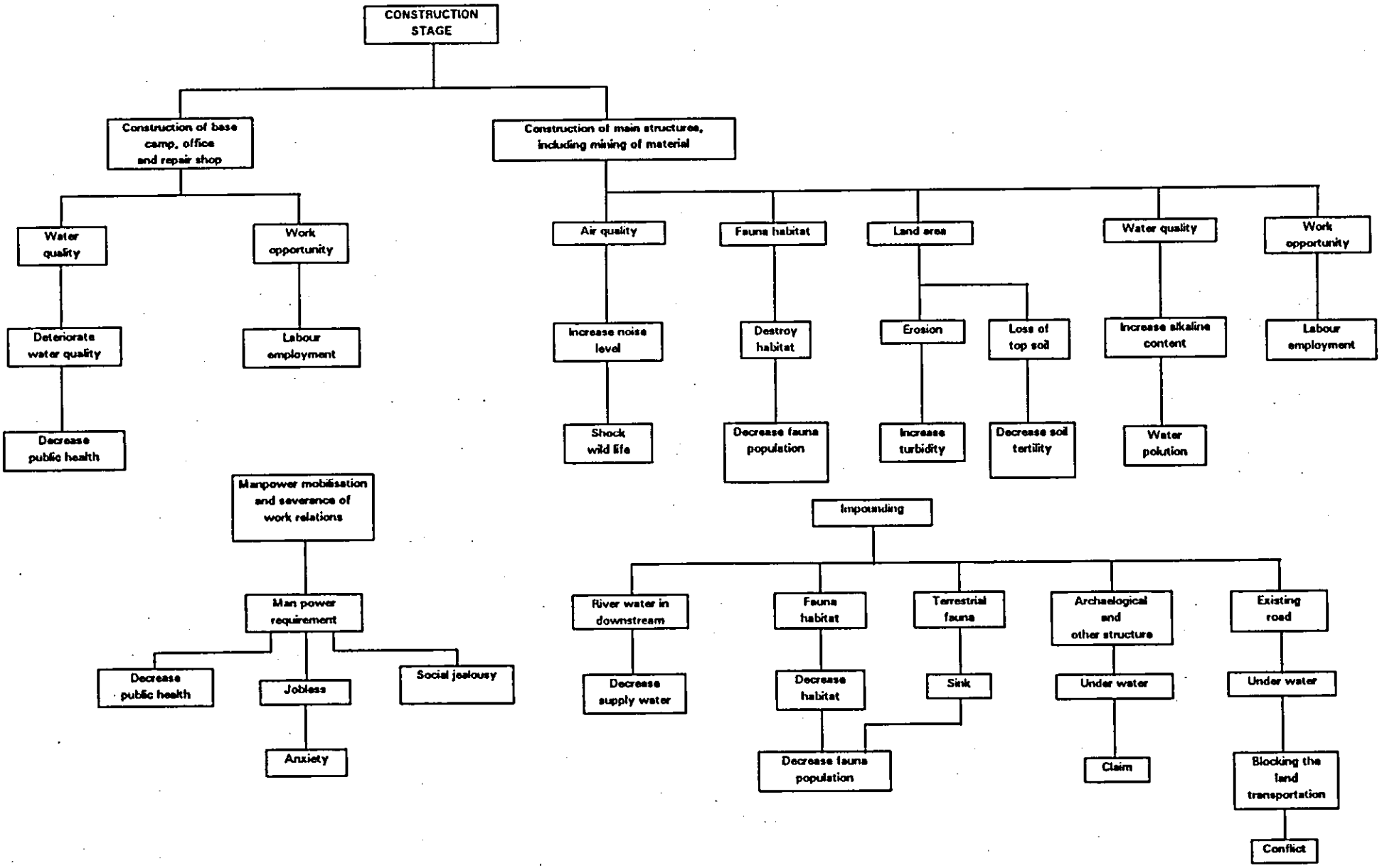


Figure 5 - 2 Flow Chart of Impact on Warsamson HEPP Development During Construction Stage (2/2)

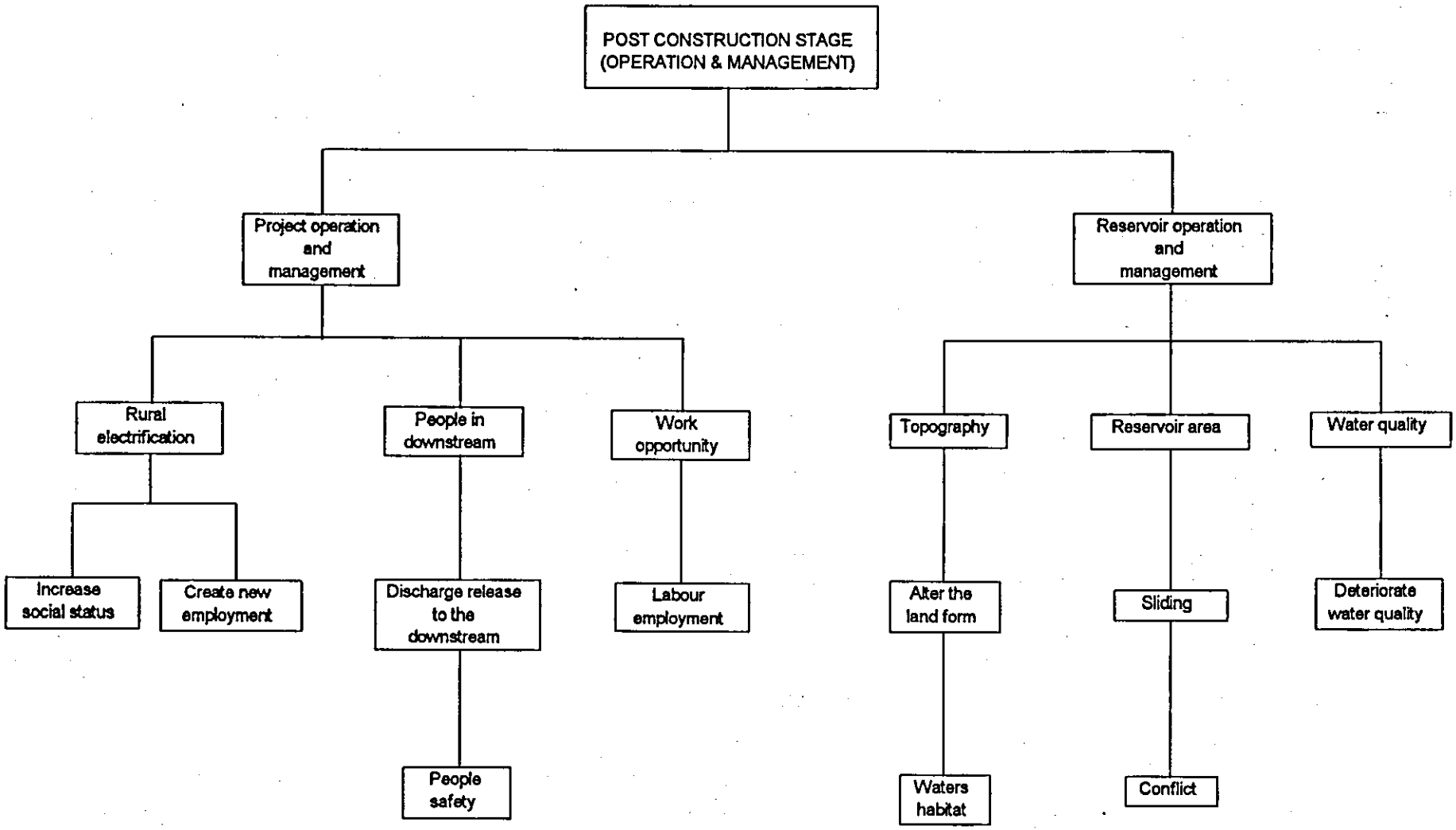


Figure 5 - 3 Flow Chart of Impact on Warsamson HEPP Development During Post Construction Stage.

Table 5 - 1 Matrix of Environmental Impact Prediction of Warsamson HEPP

Project Activity / Environmental Component	Pre-Construction			Construction							Post-Construction		Remark
	P1	P2	P3	C1	C2	C3	C4	C5	C6	C7	PC1	PC2	
1. Physical / Chemical :													o = Possible impact
- Air quality and noise				o				o					• = Possible significant impact
- Water quality / erosion					o		o	o				•	
- Soil fertility								o					P1 = Survey
- Land form						o		o				o	P2 = Land compensation
- Landslides												•	P3 = Resettlement
- Sedimentation												o	
2. Biological :													C1 = Mobilisation of eq.&material
- Vegetation / habitat					o			o		o			C2 = Preparatory work & land clearing
- Rare or endangered plants/					o			o	o	o			C3 = Construction of access
sacred trees							o			o		o	road & relocation roads
- Endangered animals/wildlife				o	o	o		o	o			o	C4 = Construction of base camp,
													office and repair shop
3. Social Economical and													C5 = Construction main structures
Culture :													and quarry sites
- Income			o		o								C6 = Man power mob. & severance of
- Employment	o		o	o	•	o	o	•	•		o		work relations
- Public health							o		o			•	
- Sink/traffic jam/accident				•								o	C7 = Impoundment
- Social status and jealousy									o		o		
- Security and Public order		o											PC1 = Operation & management
- Road network				•						•			of power plant
- Land ownership		o											PC2 = Operation & management
- Anxiety			•				•			•			of the reservoir
- Conflict		•	•	•								•	

VI. EVALUATION OF SIGNIFICANT IMPACT

1. General

Determination or evaluation of significant impact as the follow up of the impact identification and prediction as a result of Warsamson project activity toward environmental components. Significant impacts raised by the project activity were evaluated based on the guideline concerning the size of significant impact, Decree of Head of Environmental Impact Management Agency/Bapedal No. KEP. 056, 1994 (Guideline on significant criteria is shown in Appendix - A).

2. Evaluation of Significant Impact.

Evaluation of significant impact of Warsamson Project activities during preconstruction, construction, and post construction stages is summarized in Tables 6 - 1 and 6 - 2 and described as below.

a. Preconstruction stage.

Project activities which raise the significant impact during this stage are land compensation and resettlement.

1) Land compensation.

Land compensation activity may raise the significant impact toward the environment :

- Non - correspondence/disagreement of indemnity cost.

Evaluation of the significant impact size is the following.

- Number of people affected by the impact (SP1).

  If compared with the number of people affected by the impact of land compensation, so the number of people affected by the impact in the study area, but not relish the benefit of the project (128 families), this number is much less than the people number who relish directly the benefit of the project in the study area (13,894 families, total number of connection, electricity consumers in the Sorong system in 1993, Draft Final Report, Feasibility Study on Warsamson Hydroelectric Power Plant Project, 1995). The impact is classified into insignificant negative (a).

  Disturbance on security and public order, although in small number of people, due to involve the people quiet, so measures such as extension and prevention to secure the people quiet are required. The impact is classified into insignificant negative (a). If by these measures, disturbance on security and public order is not increase.

° Duration of impact experienced (SP3).

Payment of indemnity in land compensation performed during preconstruction stage, however if no agreement about the indemnity cost between the project and land owner, which from the side of impact intensity is classified into significant impact due to raise the conflict, the land compensation process able to continue or not accomplished yet until construction stage even post construction stage. Therefore, this impact is classified into significant negative (b).

° Intensity of impact (SP4).

Land compensation/acquisition activity is regulated in Presidential Decree No.55, 1993. However land compensation may able induce the social sensitivity such as conflict between the affected people and project executive. This will happen, if land compensation is not follow the procedure mentioned in Presidential Decree No.55, 1993 describing land acquisition of development for public interest and the lack of correspondence between indemnity cost and negotiated cost which have been agreed between project executive/land compensation committee and the land owner. In this case, the impact is classified into significant negative (b).

2) Resettlement.

Resettlement activity may raise the significant impact toward the environment.

- Decline of cacao plantation production.
- Increase of morbidity and mortality rates.

Evaluation of the significant impact size is the following.

° Number of people affected by the impact (SP1).

If compared with the number of people affected by the impact of the resettlement, the number of people affected by the impact in the study area, but not relish the benefit of the project (28 families), this number is much less than the people number who relish directly the benefit of the project in the study area (13,894 families, electricity consumers in the Sorong system). This impact is then classified into insignificant negative (a).

° Area over which the impact will be experienced (SP2).

Land acreage for resettlement area (175 ha) is much smaller (6,6 %) than the entire project area (2640 ha). Area over which the impact will be experienced, such as loss of wildlife habitat is small and this activity is not cause the principlal alteration on impact area from the side of impact intensity or cumulative impact. Therefore, the impact is classified into insignificant negative (a).

° Duration of impact experienced (SP3).

Resettlement also performed during preconstruction stage. In the case of the resettlement being performed with no consideration of the resettled people opinion's, which from the side of impact intensity is classified into significant negative impact (b) due to raise the conflict, the resettlement problem or unsatisfaction feeling, anxiety will continue until the next stages.

° Intensity of impact (SP4).

As described above, the resettlement activity may raise the conflict between resettled people and project executive (Regional Settlement and Housing Development Management Agency). This will happen, in the case of location and resettlement implementation are not compatible with the resettled people's hope and wish, decline of cacao plantation production and occur the change/increase of morbidity and mortality rates in new resettlement area. Therefore the impact become significant negative (b).

b. Construction Stage.

Activities during this stage that raise the significant impact cover mobilisation of heavy equipment and materials, construction of office, repair shop and base camp, and impoundment.

1) Mobilisation of heavy equipment and materials.

The expected traffic volume from Sorong to project site (one way) during construction stage consist of:

- maximum 20 microbuses/day for manpower.
- maximum 15 trucks (trailers)/day for temporary facilities.
- maximum 40 trucks (trailers)/day for construction material (cement, concrete reinforcing bars, steel wire, etc.).
- maximum 10 trailers/day for heavy equipment.
- maximum 10 trucks (tank lorries)/day for fuel, food, etc.

This activity may raises the significant negative impact toward the environment :

° Road pavement damage, traffic jam, and traffic accident.
° Health/tranquility disturbance due to noise of heavy equipment.

Evaluation of the significant impact size is the following.

° Number of people affected by the impact (SP1).

If compared with the number of people affected by the impact of heavy equipment mobilisation, so the number of people affected by the impact in the study area, but not relish the benefit of the project approximately 3,986 families, (assumed 20% of Sorong people will affected by traffic jam and some out of them will affected by traffic

accident), this number is much less than the people number who relish the benefit of the project in the study area is 13,894 families (approximately 29 %). In this case, the impact is classified into insignificant negative (a).

° Area over which the impact will be experienced (SP2).

From the side of area over which the impact will be experience is along the route of material transportation road in Sorong city and not cause the principal alteration on impact area (relatively narrow). Therefore, this impact is classified into insignificant negative (a).

° Duration of impact experienced (SP3).

Duration of impact experienced is during construction stage, however if traffic accident happen and no any mitigation measures such as medical service properly (sympathetic care), from the side of impact intensity, this impact become significant negative (b) due to raise the conflict or contradiction between the victim or his family and project executive and then this impact will happen more than one project stage (construction stage to post construction stage).

° Intensity of impact (SP4)

The unsatisfaction of affected people toward the project executive which able to induce the contradiction later on or cause the significant negative impact (b) is :

* No improvement/road betterment toward road pavement damage caused by the project activity.
* No traffic regulation during traffic jam caused by the project activity.
* No proper compensation toward the victim of traffic accident caused by the project activity.
* Duration of heavy equipment mobilisation in Sorong city roads more than 2 hours in day time and 10 minutes in night time continuously.

2. Construction of office, repair shop, and base camp.

Construction and operation of office, repair shop and base camp may raise the negative significant impact :

° Deterioration of river water quality (BOD, coliform, and fecal coli).

° Breeding places for mosquito vector.

Deteriorate of river water quality in the downstream area due to river water pollution by domestic waste from the office and base camp operation, such as content of pathogenical microorganism for diarrhoeal disease in the river water (vibrio cholerae, shigella, and salmonella) through washing apparatuses for eat (spoon,plate, and so forth). Besides that, repairshop and base camp also as breeding places for mosquito vector (excreta disposal place, poor sanitation), which that place will increase the population at risk in malaria and dengue haemorragic fever (DHF) diseases.

People may affected by the spread of communicable diseases :

1) In the downstream area of base camp (user the river water)

- Local labour of husbandry activity (area 100 ha), by considering that this activity has already established at the time of construction work activity .

- People around the project site, due to increase the economic activity (informal sector) such as shops etc. during construction stage.

2) In the base camp and surrounding area

- People around the project site, due to increase the economic activity (sector informal), such as shops etc. during construction stage.

- Project employee (half of labourers about 275 persons will live in the base camp).

Evaluation of the significant impact size is the following.

° Number of people affected by the impact (SP1).

If compared with the number of people affected by the impact of base camp operation, so the number of people affected by the impact in the study area, but not relish the benefit of the project approximately 350 families (assumed 50 families work in husbandry activity, 25 families work in informal sectors and 275 families of project employee live in the base camp), this number is much less than the people who relish the benefit of project in the study area. Therefore the impact is classified into insignificant negative (a).

° Area over which the impact will be experienced (SP2).

Area for the construction of base camp, repair shop and office are very small (2 ha) compared with entire project area, 2640 ha (< 1 %).
From the side of area over which the impact will be experienced, the impact is classified into insignificant negative (a).

° Duration of impact experienced (SP3).

Duration of this impact experienced is during construction stage, however if deterioration of river water quality and base camp operation able to induce the spreading of communicable disease and this without any mitigation measures, it will ignites the contradiction between infected people and project executive, in this case the impact is classified into significant negative (b), due to the impact will continue for long time and classified into insignificant impact negative, in the case of the project take mitigation measurer properly .

° Intensity of impact (SP4).

Increase of coliform content from 230 MPN/100 ml to 2,300 MPN/ 100 ml is still below the water quality standard for drinking water (Group B) i.e., 10,000 MPN/100 ml. The impact is classified into insignificant impact (a). However if no mitigation measures properly taken by the project such as preparing toiled and other waste treatment, in this case will cause the significant impact negative (b). Infectious disease is cumulative, its mean the patient will spread the disease to the other people easily, so that cause the anxiety of local people around the project and perhaps stimulate conflict between infected people and project executive.

It is considered that the possibility of the spread of communicable diseases is very high caused by the base camp and repairshop operation, which not facilitated by water treatment, toilet, and poor sanitation. This impact is classified into significant negative impact (b), because able to induce the conflict between local people and project executive.

3) Impoundment.

This activity may raise the significant impact toward the social economic of the environment :

- Damage of the existing road condition (pavement, sliding).

The existing road has social economic function for the local people. Principally, construction activity is restricted to disturb and decrease the social economic function of the existing road. One mitigation of the submerging of Sorong - Makbon road (partly) is by constructing a relocation road to replace existing road as planned by PT. PLN (Persero). Relocation road is scheduled will be completed before the impoundment date, since the road is required for the construction of the main structures.

Evaluation of significant impact size is the following.

° Number of people affected by the impact (SP1).

If compared with the number of people affected by the impact of impoundment, the number of people affected by the impact in the study area, but not relish the benefit of the project (2,599 families), this number is less than the number of people who relish the benefit of the project in the study area (13,894 families). This impact is classified into insignificant negative (a).

° Area over which the impact will be experienced (SP2).

Area over which the impact will be experienced is along the relocation road section from Malano bridge until saddle dam site and along existing road Sorong - Makkon used for construction work. This is no impact occur, if betterment of relocation road and existing road are completed before impounding date. However, if the betterment is completed after impounding date, this will cause the principal alteration on impact area from the side of impact intensity, the impact is classified into significant negative (b), due to induce the conflict between local government (Public Works) and project executive.

° Duration of impact experienced (SP3).

The impact will occur during just post construction stage, however if existing road is not improved just before impounding, from side of impact intensity will cause the conflict between people, local government (Public Works) and project executive, so the impact is classified into significant negative (b) and the impact will continue until post construction stage.

° Intensity of impact (SP4).

Several possibilities of the relocation road construction and using the existing road for construction road are the following :

a). Completion of relocation road construction is on schedule, i.e. 2 (two) years before impoundment date. This period will be utilised for social conditioning process for the local people to move from the existing road to the relocation road.

b). High accessibility of existing road is possible to utilise the existing road for construction road. In this case, the completion of relocation road construction may behind schedule and the condition of existing road become worse (low accessibility) after the completion of construction works.

If the condition as described in no. a) above, project will give the positive significant impact (B), however if the condition as described in no. b), from side of the impact intensity, project will raise the negative significant impact (b), because able to induce the conflict between project executive, local goverment and local people.

c. Post Construction Stage.

Post construction stage or operation and maintenance stage which raise the significant impact is operation and management of the reservoir.

- Operation and management of the reservoir.

This activity will raise the significant impacts toward the environment :

- Land slides.
- Deterioration of reservoir water quality.
- Decrease of public health.

- Land slides.

Evaluation of significant impact size is the following.

° Number of people affected by the impact (SP1).

Number of people affected by the impact of landslides in the study area, the people who own the landslide area is assumed relatively small, the number is less than the number of people who relish the benefit of the project in the study area. This impact is classified into insignificant negative (a).

° Area over which the impact will be experienced (SP2).

The potential area to sliding in the surrounding of reservoir area is approximately 10 ha, if compared with the entire area of reservoir area (3,000 ha) is relatively small (< 1%). Location of the potential area to sliding is scattered and remote from the residential area. This impact is classified into insignificant negative (a).

° Duration of impact experienced (SP3).

The landslides will occur during post construction stage. If any claim by the local people (the owner of landslides) due to the lack of correspondence between indemnity cost and negotiated cost, from side of impact intensity is classified into significant negative (b), then from the side of the duration of impact experienced, the impact is also classified into significant negative (b), due to the impact will continue for the long time.

° Intensity of impact (SP4).

If the ladslides occur in potential area to sliding, this will not alter or modify the landscape area. This impact is classified into insignificant negative (a). However, if the landslides occur in the land area belongings to the local people whose the land is not compensated yet, this will cause the conflict about the indemnity cost between the land owner and project executive (due to disagreement about the landslide acreage and cost). In the case, this impact is classified into significant negative (b).

- Deterioration of reservoir water quality.

Evaluation of significant impact size is the following

° Number of people affected by the impact (SP1)

Number of people affected by the impact of deterioration of reservoir water quality in the study area, the people who use the reservoir water for daily need (in resetlement area) and who have aquaculture such as floating net in the reservoir about 150 families, this number is much smaller than the number of people who relish the benefit of the project in the study area, in the case, the impact is calssified into insignificant negative (a).

° Area over which the impact will be experienced (SP2).

Distribution of aquatic weed able grow to reach the entire lake surface in short period of time. If lake water is utilised as the aqua culture, the dissolved oxygen will deplete up to zero point or exceed the quality standard of water quality for fisheries activity (fish need more than 3 mg/l to sustain life and reproduce). In the case, the project causes principle alteration on impact area from the side of impact intensity, the impact is classified into significant negative (b).

° Duration of impact experienced (SP3).

This impact will occur during post construction stage, from the side of impact intensity, particularly for the lake water used as the aqua culture, the dissolved oxygen will exceed the quality standard of water quality for fisheries activity (less than 3 mg/l), and if no proper mitigation measures taken by the project, this impact would be experienced over a long period of time. In this case, the impact is classified into significant negative (b).

° Intensity of impact (SP4).

Intensity of impact is as described in discussion above in area over which the impact will be experienced and duration of impact experienced, and this impact is classified into significant negative (b).

• Decrease of public health.

Every environmental alteration always causes the impact toward the public health status, due to interaction environment and human life as a dominant factor to manifest the public health degree. Indicator of alteration in public health status is commonly measured by epidemiological method, which indicates the size of "time-place and person" of morbidity and mortality occurrence by certain cause. The size is expressed in morbidity rate and mortality rate. By considering that the local people still use the river water as the source of raw water for daily needs and defecating culture is continued along Warsamson River and its tributaries, this condition is alarmed will be as the source and spreading of diarrhoeal disease for the local people and new comer. This diarrhoeal disease as local endemic disease in Sorong area. The decrease of environmental health quality able to be "cause" of increasing the case (a victim) of communicable disease which closely related to environmental health problem such as malaria, dengue haemorrhagic fever (DHF) and diarrhoeal disease.

It is assessed that disease prevalence of venereal disease able to increase parallel with the economic condition increase and development activity. Several sexual diseases necessary to pay attention are syphilis, gonorhoea and AIDS.

Evaluation of significant impact size is the following.

° Number of people affected by the impact (SP1).

Number of people affected by the impact, the people who suffered the disease of malaria and other water borne disease during the project activity in the study area, is relatively not too much, it is assumed 12% of population is vulnerable health risk (child under 5 years old) approximately 7,762 persons and 40% of population of productive age approximately 25,872 persons, the number (33,634 persons) is less than the number of people who relish the benefit of the project in the study area (13,894 families or 69,470 persons). This impact is classified into insignificant negative (a).

° Area over which the impact will be experienced (SP2).

Development of proposed Warsamson HEPP will causes the principal alteration on impact area from the side of impact intensity due to induce the conflict with the local community if the project as the source of communicable disease and also from the side of cumulative impact as described in discussion below, so this impact is classified into significant negative (b).

° Duration of impact experienced (SP3).

Duration of impact experienced is only during post construction, however if from side of impact intensity, the activity cause the significant impact such as raise the conflict or contradiction, due to the project cause the local people suffered the such diseases after the project construction, in this case, the impact become significant negative (b).

° Intensity of impact (SP4).

Factors related to this impact are area of disease spreading and people number suffered by the diseases or have risk (population at risk). Commonly, if the diseases related to environmental health have occur in area, so this occurrence will repeated according to characteristic of disease agent. Therefore, occur and spreading of this disease have cumulative characteristic with the intensity increased, if no any mitigation measures properly. From the impact cumulative characteristic, increasing of disease spread as a result of project activity able to cause the conflict between infected people or their families and project executive and/or local government, because the decrease of environmental quality such as water inundation (reservoir), lagoon, clean water pollution, garbage and rubbish dumping as sources of communicable diseases. This case will cause the anxiety of people if disease suffering is follow by the death. Therefore, this impact is classified into significant negative (b).

No description about SP-5 ~ SP - 7, because no impact to be evaluated by factors SP - 5 ~ SP - 7. The criteria is as a shopping list for the impact evaluation. As far as the environmental alteration caused by the project activity is not induce the significant impacts clearly, it is not necessary to analysis in detail.

3. Directive of Environmental Management and Monitoring Plans

Directive of impact mitigation measures (environmental management and monitoring plans) on preconstruction, construction , and post construction stages can be summarized as follows :

1. Pre Construction Stage

- Source of impact : Land compensation and resettlement activity.
- Environment affected by the impact :
  - ° People reside in proposed reservoir area
  - ° Land owner in proposed reservoir area and construction area

- Significant impact :
  - ° Uncorrespondence of indemnity value
  - ° Decline on cacao plant production
  - ° Increase of morbidity and mortality rates

- Management measure :
  - ° Pay compensation with proper price
  - ° Resettle of people in proper place
  - ° Extension about project benefit

2. Construction Stage

- Source of impact :
  1) Mobilisation of equipment and construction material
  2) Construction of base camp, office and repairshop
  3) Impoundment

- Environment affected by the impact :
  1) Sorong - Makbon road network
  2) River water quality in downstream of the base camp
  3) Stretch of Sorong - Makbon road

- Significant impact :
  1) Damage on road pavement, traffic jam, and traffic accident
  2) Deteriorate of river water quality
  3) Damage of existing road

- Management measure :
  1) Improve the damage of road pavement
     Regulate the traffic
  2) Prepare waste water treatment
     Drain the water inundation
  3) Improve the road damage

- Monitoring measure :
  1) Pavement condition of relocation road
     Frequency of traffic jam and traffic accident
  2) BOD, E - coli and coliform contents
     Morbidity rate
  4) Flow traffic smoothness

3. Post Construction Stage

- Source of impact : Operation and management of reservoir

- Environment affected by the impact :
  - Shoreline of reservoir area
  - Reservoir water quality
  - Public health

- Significant impact :
  - Sliding of land belongings the people
  - Deteriorate of reservoir water quality, particularly increase of BOD, N, P, NH3, Fe, Mn, and E - coli contents and deplete of disolved oxygen content
  - Decrease of public health (increase of morbidity rate)

- Management measure :
  - Construct the slope protection
  - Cleaning the reservoir periodically from garbage/rubbish and aquatic weeds
  - Raising and lowering reservoir level weekly during egg - laying season

- Monitoring measure :
  - Acreage and place of sliding in shoreline of reservoir area
  - BOD, DO, N, P, NH3, Fe, Mn, and E - coli contents
  - Morbidity rate of people who reside surrounding the reservoir area

Table 6 - 3 shows the directives on environmental management and monitoring plans or environmental impact mitigation measures for Warsamson HEPP.

Table 6 - 1 Matrix of Environmental Impact Prediction and Evaluation of Warsamson HEPP

Project Activity / Environmental Component	Pre-Construction			Construction							Post-Construction		Remark
	P1	P2	P3	C1	C2	C3	C4	C5	C6	C7	PC1	PC2	
1. Physical / Chemical :													A = Insignificant positive
- Air quality and noise				a				a					a = Insignificant negative
- Water quality / erosion					a		a	a				b	B = Significant positive
- Soil fertility								a					b = Significant negative
- Land form						a		a				a	
- Landslides												b	P1 = Survey
- Sedimentation												a	P2 = Land compensation
													P3 = Resettlement
2. Biological :													
- Vegetation/habitat					a			a		a			C1 = Mobilisation of eq.&material
- Rare or endangered plants					a			a	a	a			C2 = Preparation work and land clearing
- Endangered animals/wildlife				a	a	a		a	a			a	C3 = Construction of access road & relocation roads
													C4 = Construction of base camp, office and repair shop
3. Social Economical and Culture :													C5 = Construction of main structure and quarry sites.
- Income			a		a					-			C6 = Man power mobilisation and severance of work relation.
- Employment	A		A	A	B	A	A	B	B		A		C7 = Impoundment
- Public health							b		a			b	PC1 = Operation & management of the power plant
- Sink / traffic jam/accident				b								a	PC2 = Operation & management of the reservoir
- Social status and jealousy									a		B		
- Security/and Public order		a											
- Road network				b						b			
- Land ownership		a											
- Anxiety			b				b		a				
- Conflict		b	b	b			b			b		b	

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Table 6 - 2 Summary of Environmental Impact Evaluation

Stage/project activity	Significant impact	Factors to evaluate impact	Score	Conclusion	Able to be mitigated
Pre Construction :					
1) Land compensation	- Non-correspondence/disagreement of indemnity cost	SP1	a	b	yes
		SP3	b		
		SP4	b		
2) Resettlement	- Decline of cacao plantation production	SP1	a	b	yes
		SP2	a		
	- Increase of morbidity and mortality rates	SP3	b		
		SP4	b		
Construction :					
1) Mobilisation of heavy equipment and material	- Road pavement damage, traffic jam and traffic accident	SP1	a	b	yes
		SP2	a		
	- Tranquility disturbance	SP3	b		
		SP4	b		
2) Construction of office, repair shop and base camp	- Deterioration of river water quality	SP1	a	b	yes
		SP2	a		
		SP3	b		
	- Breeding places for mosquito	SP4	b		
3) Impoundment	- Damage of the existing road condition	SP1	a	b	yes
		SP2	b		
		SP3	b		
		SP4	b		
Post Construction :					
- Operation and management of the reservoir	- Landslides	SP1	a	b	yes
		SP2	a		
		SP3	b		
		SP4	b		
	- Deterioration of reservoir water quality	SP1	a	b	yes
		SP2	b		
		SP3	b		
		SP4	b		
	- Decrease of public health	SP1	a	b	yes
		SP2	b		
		SP3	b		
		SP4	b		

Table 6 - 3 Matrix of Environmental Impact Mitigation Measures for Warsamson HEPP

Source of impact	Environment affected by the impact	Significant impact	Mitigation measures	
			Management	Monitoring
1. Preconstruction				
- Land compensation	- People reside in proposed reservoir area - Owner of land located in proposed reservoir area and construction area	- Non-correspondence/disagreement indemnity cost	- Pay indemnity with proper price - Extension	- Attitude and people perception toward the project
- Resettlement	- People reside in proposed reservoir area	- Decline of cacao plantation production - Increase of morbidity and mortality rates	- Resettled to appro - priate location - Prepare cacao plantation land - Extension	- Smooth running of project development - Production of cacao plantation - Morbidity rate
2. Construction				
- Mobilisation of heavy equipment and materials	- Sorong - Makbon existing road network	- Road pavement damage, traffic jam and traffic accident frequency - Tranquility disturbance by noise	- Improve pavement of existing road - Regulate traffic	- Pavement condition - Traffic jam and accident frequency - Mobilisation duration
- Construction of office, repair shop and base camp	- River water quality down - stream the base camp - Area in the base camp & the surrounding	- Deterioration of river water quality - Breeding places for mosquito vector	- Construct waste water treatment plant - Drain/remove lagoon, ruins	- BOD,fecal coli,coliform - Morbidity rate
- Impoundment	- Sorong - Makbon existing road section	- Completely blocking the land communication	- Relocation road - Improve of existing road	- Smooth traffic flow
3. Post Construction				
- Operation and mana - gement of the reservoir	- Shoreline of reservoir area - Reservoir water quality - Public health	- Landslides owned by local people - Deterioration of reservoir water quality - Decrease of public health	- Slope protection - Cleaning reservoir water - Regulate reservoir water level	- Acreage and place landslide - BOD,DO,N,P,NH3,Fe, Mn, fecal coli - Morbidity rate

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GUIDELINE ON SIGNIFICANT IMPACT CRITERIA

1. Understanding

Significant impact of an activity according to explanation of Clause 16 Law No. 4/1982. Clause 2, and Clause 3 Government Regulation No.51/1993 is determined by factors as follows :

a. Number of people directly or indirectly affected by the impact (SP - 1)
b. Area over which the impact will be experienced (SP - 2)
c. Duration of impact experienced (SP - 3)
d. Intensity of impact (SP - 4)
e. Number of other environmental component that will be affected (SP - 5)
f. Extent of cumulative impact (SP - 6)
g. Reversibility (SP - 7)

2. Guideline on significant impact criteria (size of significant impact).

a. Number of people directly or indirectly affected.

Impact of an activity, which the determination to be based on the alteration of components of community life and number of affected people to be significant if :

Number of people in the study area affected by the impact, but not relish the benefit of Warsamson HEPP development, the number equal or more than the number of people whose relish the benefit of Warsamson HEPP development in the study area.

b. Area over which the impact will be experienced.

Area over which the impact will be experienced is one of factor which able to determine the significant of impact toward the environment. Therefore, environmental impact of an activity to be significant if :

Development of proposed Warsamson HEPP causes the principal alteration on impact area from the side of impact intensity, or impact irreversibility, or cumulative impacts.

c. Duration of impact experienced.

The environmental impact of an activity able experience on a certain or several stages from the performance of an activity. In other word, the impact of an activity may performs in relatively short time (design, construction, operation, and post operation), however other

activity performs in relatively longtime, since construction stage up to post operation. Based on this understanding, the environmental impact able to be significant if :

Development of proposed Warsamson HEPP causes the principal alteration from the side of impact intensity or impact irreversibility, or cumulative impact, which will be experienced on one or more project stages.

d. Intensity of impact.

Intensity of impact means the alteration of environment is great, or drastic and experienced in relatively extensive area, in period of time relatively short. Therefore, the environmental impact is classified into significant if :

1) Development of proposed Warsamson HEPP will cause the alteration on physical characteristic and or biological environmental that exceeded the quality standard.

2) Development of proposed Warsamson HEPP will cause the principal alteration on environmental component that exceeded the scientific consideration criteria.

3) Development of proposed Warsamson HEPP will cause the endangered species or endemic, and or protected species by relevant laws and regulations is threatened with extinction, or their natural habitat experience the destruction.

4) Development of proposed Warsamson HEPP will cause the destruction or disturbance toward the protection area (protection forest, natural reserve, national parks, wildlife reserve, and so forth) which have been stipulated by relevant laws and regulation.

5) Development of proposed Warsamson HEPP will destroy or extinct the assets and archaeological remains.

6) Development of proposed Warsamson HEPP will cause the conflict or contradiction with the community, local government, or government.

7) Development of proposed Warsamson HEPP will alter or modify the landscape or panorama beauty area.

e. Number of other environmental component that will be affected.

By considering that the component of environment is not independent or in other word one and other is mutually related and affected, the impact of environmental component generally has an advanced impact on the other component. Based on this understanding, the impact is classified into significant if :

An activity raise the secondary impact and other advanced impact which the number of component more than or equal with environmental of component affected by the primary impact.

f. Extent of cumulative impact.

Cumulative means increase, in heaps, or accumulate. Impact of an activity called cumulative if in the initially the impact is not appear or assessed is insignificant, but due to the activity work repeatedly or continuously, after a long time the impact to be cumulative. Therefore the impact is classified into significant if :

1) Environmental impact occur repeatedly and continuously, so that on certain time unable to be assimilated by the natural environment or social.

2) Several environmental impacts to accumulate in the certain space, so that unable to be assimilated by natural environment or social.

3) Environmental impact from several sources of activity cause synergetic effect.

g. Reversibility.

An Impact of an activity toward environment some times reversible, however other impact is irreversible although by the human intervention. In this matter the impact is classified into significant if :

Alteration will be experienced by the environmental component is irreversible although by the human intervention.

Source : Appendix I : Decree of Head of Environmental Impact Management Agency/Bapedal No. KEP-056/1994. Date : March 18, 1994.

2. Environmental Management Plan (RKL)

ABBREVIATIONS

AMDAL	Environmental Impact Assessment (EIAs)
ANDAL	Environmental Impact Analysis (EIA)
BAPPEDA	Regional Development Planning Agency
BAPEDAL	Environmental Impact Management Agency
BP4D	Regional Settlement and Housing Development Management Agency
Ditjen. LPE - DPE	Directorate General of Electric and Energy Development Department of Mines and Energy.
DLLAJR	Highway Transportation Traffic Agency
HPH	Forest Concession
PT.PLN (PERSERO)	State Electricity Corporation
PPT	Land Compensation Committee
PUK	Public Works of Kabupaten (Sorong)
RKL	Environmental Management Plan (EMaP)
RPL	Environmental Monitoring Plan (EmoP)
TKP2LH	Coordination Team for Environmental Pollution Control

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I. INTRODUCTION

1. Background.

Development of Hydroelectric Power Project (HEPP) of Warsamson for capacity 46.5 MW in Kabupaten Sorong Irian Jaya Province, as the government effort to fulfill the electric power demand in Irian Jaya, especially for Sorong Regency. The development of this project will, without doubt, gives the impacts toward the environment, negative as well as positive, as concluded by the Environmental Impact Analysis (EIA/ANDAL) of Warsamson HEPP. To give the basics directive, principles, or rules to prevent, control and overcome the significant impact (negative) and develop the positive impact, arrangement of Environmental Management Plan (EMaP/RKL) for Warsamson HEPP is required. According to the government policy about development implementation with the environmental concept, as mentioned in Government Regulation No.51, 1993, about Liability Activity List for Environmental Impact Assessment (EIAs/AMDAL), it is contained in the list that HEPP of any type and size, except Minihydro Electric Power Plant and run-off-river type, should carry out EIAs, and this statement also valid to the Warsamson HEPP, and accordingly, the proponent is compulsory to conduct Environmental Impact Assessment, arrangement of RKL is to fulfill the government regulation.

2. Relevant laws and regulations.

Activities of the Warsamson HEPP construction will give effect on the environment. To arrange the management and utilization of natural resources and living environment based on national policy standard integrally and comprehensively, principal laws and regulations are made being the principles for natural resources management and living environment. Principle laws and regulations enacted by the government is closely related to the development of hydroelectric power project and used as the guideline in preparing RKL, namely :

a. Law No. 4,1982 describing Basic Provinsions on Environmental Management, Jakarta 1993.

b. Government Regulation of the Republic of Indonesia No.51, 1993 describing Environmental Impact Assessment, Jakarta 1994.

c. State Ministerial Decree of Environmental (Appendix III) No. KEP 14/MENLH/3/94 describing Guideline of Environmental Management Plan (RKL) Arrangement, Jakarta 1994.

d. Government Regulation No. 20, 1990 describing Water Pollution Control, Jakarta 1990.

e. Presidential Decree No.55, 1993 describing Land Acquisition for Development Implementation of Public Interest.

f. Decree of State Minister of Population and Environmental No. KEP-02/MENKLH/I/1988 about Guideline on Stipulation of Quality Standard for Water in Water Source and Air.

g. Health Ministerial Regulation No.718/Menkes/Per/XI/87 describing noise level in relationship with health, Jakarta 1987.

h. Ministerial Decree of Mines and Energy No.103 K/008/MPE/1994, about Supervision on Implementation of Environmental Management and Monitoring Plans for Mines and Energy Sector.

i. Presidential Decree No.37, 1994 describing National Settlement and Housing Development Policy and Management Agency.

3. Objective of environmental management.

Objective of environmental management is to describe the basics directive, principles, or rules to prevention/overcoming/control of impacts. Environmental management is to prevent or avoid the negative impact, overcome, minimize, or control negative impact which raise during HEPP operation, and up to the project management. Environmental management also to develop the positive impact, so that able to give additional benefit.

4. Necessity.

Necessity of environmental management implementation for the proponent and other concern institutions is as follows :

- Necessity for the proponent.
  - ° Give directives in preventing/overcoming/controlling of negative impact (manage the significant impact).
  - ° The basics directive, principles or rules which contained in RKL will be integrated or as the basis of consideration in preparing the detail design.
- Necessity for concern institutions.
  - ° Assist the concern institutions in environmental management to understand their tasks and responsibilities, so that any coordination and cooperation between concern institutions (as the reference for implementation of environmental management activity).
- Necessity for the people.
  - ° Informs about the environmental management of Warsamson HEPP development, so that the people know the Warsamson HEPP development is managed with the environmental concept and hoping that the people surrounding the project able to participate actively in environmental management activity.

II. ENVIRONMENTAL MANAGEMENT PLAN

This Environmental Management Plan (RKL) of Warsamson HEPP covers brief and clear description about sort of each impact caused by the project activities (the project stage during Environmental Management Plan arrangement is Feasibility Study), source of significant impact, measuring standard, objectives, measures, location, period, financing, and institutional for environmental management are described as below.

1. Preconstruction stage.

- Land compensation and resettlement.

a. Significant impact.

Environment affected by the significant impact :

- People reside in proposed reservoir area.
- Owner of land located in proposed reservoir area and construction area.

Significant impact of land compensation :

- Correspondence/agreement of indemnity cost.

Derivative impacts :

- Income, unsatisfaction, perception and attitude of affected people, conflict, and smooth running of project construction and operation.

Significant impacts of resettlement :

- Decline of cacao plantation production and increase of morbidity and mortality rates

Derivative impacts :

- Income, anxiety, unsatisfaction, disappointed, and decrease of public health, perception and attitude of resettled people toward the project, conflict, and smooth running of project construction and operation.

b. Source of impact :

- Land compensation activity.
- Resettlement activity.

c. Measuring standard :

- Anxiety and unsatisfaction level.
- Smooth running of land compensation implementation.
- Trend of morbidity rate in resettlement area.
- Trend of cacao production in new plantation area.
- Perception and attitude of affected/resettled people (positive/negative) toward the project.

d. Objective :

- Arrange the social interaction harmoniously with the affected/resettled people to prevent the raise of disappointed/unsatisfaction, anxiety, and conflict.

e. Environmental management measures :

- Pay compensation with the proper price and the procedure suitable with Presidential Decree No.55, 1995 and base cost refers to the Regential Decree of Sorong No.6, 1993.

- Resettle the people to the appropriate location, follow the procedure stipulated by BP4D and correspond with people's hope and wish, and prepare such facilities in new resettlement area inclusive cacao plantation land, production facility, and facility related to public health and sanitation

- Extension about the project benefit.

- Priority for local labour to work in project construction.

f. Location :

- Location of environmental management is in residential area and resettlement area as shown in Figure 2 - 1.

g. Periods :

- Land compensation.
  Environmental management (extension about benefit of the project) is implemented during one year before and after the land indemnity payment, with period once in every month.

- Resettlement.
  Environmental management (extension about benefit of the project) is implemented during one year before and five years after resettlement implementation, with the period once in four months.

h. Financing :

- Financing to implement RKL (covers personnel and operation cost) as the task and responsibility of the proponent, PT. PLN (PERSERO).

i. Institutional.

Institutional of environmental management consist :

- Executor of environmental management :
  - ° PT. PLN (PERSERO).
  - ° PPT.
  - ° BP4D.
  - ° Plantation Agency

- Supervisor of environmental management :
  (institution who act as the supervisor the RKL implementation).
  - ° Ditjen. LPE - DPE.

- Reporting of environmental management result :
  - ° PT. PLN (PERSERO)
  - ° Local government (Kabupaten Sorong)
  - ° Concern institutions :
    - * PPT
    - * BP4D
    - * Plantation Agency.

2. Construction stage.

- Mobilisation of heavy equipment and materials.

a. Significant impact.

Environment affected by the significant impact :

Sorong - Makbon existing road network (road section from Sorong Port to Malano bridge, adjoin of existing road and access road)

Significant impacts :

- Damage of road pavement, traffic jam and traffic accident frequency.

Derivative impacts :

- Decrease of mobility level, complaints and contradiction/ conflict.

Significant impact :

- Health/tranquility disturbance due to noise level of heavy equipment.

Derivative impacts :

- People complaint and conflict.

b. Source of impact :

- Mobilisation of heavy equipment and materials.

c. Measuring standard :

- Area of pavement damage of Sorong - Makbon existing road section.
- Mobility level and complaint of road user (number) of Sorong - Makbon existing road.
- Traffic jam and trafic accident frequency in Sorong - Makbon existing road section.
- Duration of heavy equipment mobilisation in day time (< 2 hours) and night time (< 10 minutes) continuously and noise level (< 55 dBA - 65 dBA)
- Number of people complaint reside along the mobilisation road.

d. Objective :

- Improve/betterment the pavement of Sorong - Makbon existing road network (mobilisation road) up to properly grade for heavy equipment mobilisation.
- Prevent the traffic jam and traffic accident caused by the mobilisation.
- Prevent the health/tranquility disturbance due to noise of heavy equipment.

e. Environmental management measures :

- Improve/betterment the pavement of Sorong - Makbon existing road network.
- Regulate the smoothness rate of traffic and follow the traffic sign and maximum permissible speed.
- Sympathetic care properly of traffic accident victim, if happen.
- Repair the exhaust pipe leaks/broken.
- Regulate the time of material transportation by interval at least 15 minutes.
- Regulate the duration of heavy equipment mobilisation not more than 2 hours in day time and 10 minutes in night time continuously during passing the Sorong city area.

f. Location :

- Sorong - Makbon existing road section in Sorong City area from Sorong Port up to Malano Village.

- Location of pavement damage along the existing road section for road betterment.

g. Periods :

- At the commencement of mobilisation of equipment until termination of construction activity. Frequency of management :

  ° During implementation of heavy equipment mobilisation for regulation of smooth traffic flow and mobilisation duration.
  ° Before and after mobilisation activity for road betterment.

h. Financing :

- PT. PLN (PERSERO)
- Contractor

i. Institutional :

- Executor of environmental management :
  ° PT. PLN (PERSERO).
  ° Contractor.
  ° DLLAJR.
  ° Traffic Police.

- Supervisor of environmental management :
  ° Ditjen. LPE - DPE

- Reporting of environmental management result :
  ° PT. PLN (PERSERO).
  ° Local government (Sorong).
  ° Concern institutions :
    * DLLAJR.
    * Traffic Police.
    * PUK.

- <u>Construction of office, repair shop and base camp.</u>

a. Significant impact.

Environment affected by the impact :

Water quality of Warsamson River and its tributaries downstream the base camp.

Significant impact :

- Deterioration of river water quality (BOD, coliform and fecal coli).
- Breeding places for mosquito vector.

Derivative impact :

- Increase of BOD, coliform and fecal coli contents in river water, increase in morbidity rate and perhaps mortality rate of local people, raise the conflict and disturbance on smooth running of project construction.

b. Source of impact :

- Construction and operation of office, repair shop and base camp.

c. Measuring standard :

- Coliform (10,000 MPN/100 ml)*), fecal coli (2,000 MPN/100 ml)*), and BOD (6 mg/l)*).
- Trend of morbidity rate.
- Number of people complaint.

d. Objective :

- Control water quality of Warsamson River and tributaries downstream the base camp (coliform, fecal coli and BOD contents) so that not exceed the water quality standard for raw drinking water requirement (Group B) as specified in Government Regulation No. 20, 1990.

- Control, drain and remove inundation places, lagoon, ruins and secondhand goods and so forth as the breeding places for mosquitoes.

e. Environmental management measures :

- Medical test for new employee.
- Construct waste water and solid waste treatment plant and toilet, prepare trash cans and oil collection.
- Drain and remove inundation places, lagoon, ruins, and secondhand goods.
- Extension about hygiene and sanitation.
- Vector control by insecticide spraying of base camp, residential area, repair shop, and office.

f. Location :

- Area around the base camp.

g. Periods :

- Environmental management will be commenced since the operation of office, repair shop and base camp until the completion of construction work for construct treatment plant and toilet, prepare trash cans and oil collection).

*) Source : Government Regulation No.20/1990.

- Period of management.
  - ° Every month for extention.
  - ° Every week for drain/remove lagoon, ruins, and secondhand goods and vector control.

h. Financing :

- PT. PLN (PERSERO)

i. Institutional :

- Executor :
  - ° PT. PLN (PERSERO)
  - ° Contractor
  - ° Health Agency

- Supervisor :
  - ° Ditjen. LPE - DPE

- Reporting of environmental monitoring result :
  - ° PT. PLN (PERSERO)
  - ° Local government (TKP2LH).
  - ° Concern institutions :
    - * Health Agency.

- <u>Impoundment activity.</u>

a. Significant impact.

Environment affected by significant impact :

Sorong - Makbon road (road section from just before Malano bridge until saddle dam site), see Figure 2 - 1.

Significant impact :

- Damage of existing road condition.

Derivative impacts :

- Hamper the land communication/people mobility of Sorong and Makbon people, decrease in social economic activity, people/road user complaint, and conflict.

b. Source of impact :

- Impoundment activity of proposed reservoir area (plugging of diversion tunnel).

c. Measuring standard.

- Smoothness rate of people mobility (vehicle traffic) passed Sorong - Makbon road.
- Number of people complaint.

d. Objective :

- Improve the damage of existing road before impounding date of proposed reservoir area.

e. Environmental management measures :

- Improve the damage of existing road.
- Prepare temporary raft or boat or other crossing facility.

f. Location :

- Location of environmental management is in area just before Malano bridge up to saddle dam site and existing road which used for construction road (Figure 2 - 1).

g. Periods :

- Environmental management will be commenced since termination of the project construction work until the impoundment date.

h. Financing :

- PT. PLN (PERSERO)

i. Institutional :

- Executor of environmental management :
  - PT. PLN (PERSERO).
- Supervisor of environmental management :
  - Ditjen. LPE - DPE.
- Reporting of environmental management result :
  - PT. PLN (PERSERO).
  - Local government (Kabupaten Sorong)
  - Concern institutions : PUK.

3. Post Construction Stage.

- Management and operation of reservoir.

a. Significant impact.

Environment affected by significant impact :

- Shoreline of reservoir area.
- Reservoir water quality.
- Public health.

Significant impact of reservoir shoreline area:

- Landslides owned by local people.

Derivative impacts :

- Claim by land owner and conflict if indemnity cost not correspond with negotiated cost or land owner request.

Significant impact of reservoir water quality :

- Deterioration of reservoir water quality.

Derivative impacts :

- Increase in N, P, NH3 contents, blooming of aquatic weed, DO depletion up to below the 3 mg/l, fisk kills, claim by the aquaculture owner.

- Increase in BOD and fecal coli, Mn, and Fe contents, increase in morbidity rate, and raise the conflict.

Significant impact of public health :

- Decrease of public health.

Derivative impacts :

- Increase in morbidity and perhaps mortality rates of local people due to deteriorate of reservoir water quality and raise the conflict because reservoir area as a source of communicable disease (breeding place for malaria mosquitoes, source of diarrhoeal disease).

b. Source of impact :

- Operation and management of reservoir.

c. Measuring standard :

- Acreage and location of landslides owned by local people.
- Number of people claim
- Dissolved oxygen (> 6 mg/l)*), fecal coli (2,000 MPN/100 ml)*), Fe (5 mg/l)*) and Mn (0.5 mg/l)*), N (1.3 mg/l)**), P (0.09 mg/l)**), NH3 (0.5 mg/l)*).
- Blooming of aquatic weeds
- Number of fish kills.
- Trend of morbidity and mortality rates.

d. Objective :

- Prevent the landslides in the shoreline of reservoir area, particularly area owned by the local people and not yet compensated.
- Control reservoir water quality, especially DO, fecal coli, Fe, Mn, N, P, NH3 contents, so that no exceed the Water Quality Standard for fisheries requirement as specified in Government Regulation No. 20, 1990.
- Prevent the increase of morbidity and mortality rates, due to the project activity includes water borne diseases and arthropod borne diseases.

e. Environmental management measures.

For landslides :

- Construct the slope protection.
- Pay indemnity with the proper price in case of landslide.

For reservoir water quality and public health :

- The thorough clearance of new reservoir area prior to impounding.
- Cleaning the reservoir periodically from garbage/rubbish and aquatic weeds.
- Building interception ditches to carry away from the reservoir any land run-off liable to contain traces of fertilizer, particularly compounds of nitrogen and phosphorus.
- Aeration on place of aquaculture activity.
- Raising and lowering reservoir level weekly during egg-laying season (See excerpts of magazine in Appendix - C as a reference).
- The traditional use of small predatory fish to eat mosquito larvae have been supplemented by the use of larger Tilapia fish. In Rawa Pening lake (Central Java), use of small predatory fish (tin head, *Panchax - panchax*) to eat mosquito larvae.
- Management on deposit of garbage and rubbish, human and domestic wastes by prepare the trash cans and toilet.
- Medical check up for the project compleyee periodically.
- Educating local people in health, hygiene, community awaraness, and medical prophylaxis.
- Vector control by insecticide spraying of houses and residential area.

*) Source : Government Regulation No.20/1990
**) Source : Feasibility Study on the Warsamson HEPP Development Project in the Repoublic of Indonesia, Interim Report, May 1995, Pacifics Consultants International.

f. Location.

For landslides :

- Area of landslide potential (Figure 2 - 2).

For reservoir water quality and public health :

- Area entire of reservoir water surface (Figure 2 - 1).

g. Periods :

- Environmental management will be commenced at the time of impounding date up to reservoir operation and maintenance with period once in every month.

h. Financing :

- PT. PLN (PERSERO)

i. Institutional :

- Executor of environmental management :
  - ° PT. PLN (PERSERO)
  - ° TKP2LH
- Supervisor of environmental management :
  - ° Ditjen. LPE - DPE
- Reporting of environmental management result :
  - ° PT. PLN (PERSERO)
  - ° Local government (TKP2LH).
  - ° Concern institutions :
    - * PPT.
    - * Health Agency.
    - * Fisheries Agency.
    - * HPH Intimpura.

Matrix of Environmental Management Plan (RKL) for Warsamson HEPP is presented in Table 2 - 1.

Table 2 - 1 Matrix of Environmental Management Plan (RKL) for Warsamson HEPP

Source of impact	Environment affected by the impact	Objective	Environmental management measures	Location	Period	Institutions of Management		
						Executor	Supervisor	Reporter
1. Preconstruction								
- Land compensation	- People reside in proposed reservoir area - Owner of land located in reservoir and construction area	- Prevent unsatisfaction	- Pay indemnity with proper price - Extension	Project site	1 x a month	- PT.PLN (PERSERO) - PPT	Ditjen. LPE - DPE	- PT.PLN (PERSERO) - Local Government - PPT
- Resettlement	- People reside in proposed reservoir area	- Prevent anxiety	- Resettled to appro - priate location - Extension	Resettlement area	1 x 4 months	- PT.PLN (PERSERO) - BP4D - Plantation Agency	Ditjen. LPE - DPE	- PT.PLN (PERSERO) - Local Government - BP4D - Plantation Agency
2. Construction								
- Mobilisation of heavy equipment and materials	- Sorong - Makbon existing road network	- Improve the road pavement - Prevent traffic jam and accident	- Improve pavement of existing road - Regulate the traffic - Sympathetic care of traffic accident victim	Existing road	During mobilisation - ditto -	- PT.PLN (PERSERO) - DLLAJR - Traffic police	Ditjen. LPE - DPE	- PT.PLN (PERSERO) - DLLAJR - Traffic Police - PUK
- Construction of office repair shop and base camp	- River water quality	- Control water quality (fecal coli, coliform content, and BOD)	- Construct waste water treatment plant - Remove ruins	Base camp and repair shop	1 x a week 1 x a month	- PT.PLN (PERSERO) - Contractor - Health Agency	Ditjen. LPE - DPE	- PT.PLN (PERSERO) - DLLAJR - Health Agency
- Impoundment	- Sorong - Makbon road	- Improve the existing road	- Improve the damage of existing road - Temporary raft	Relocation road		- PT.PLN (PERSERO)	Ditjen. LPE - DPE	- PT.PLN (PERSERO) - PUK
3. Post Construction								
- Operation and mana - gement of reservoir	- Shoreline of reservoir area - Reservoir water quality - Public health	- Prevent landslide in reservoir shoreline area - Control reservoir water quality - Prevent the increase of morbi - dity rate	- Slope protection - Cleaning reservoir water - Regulate reservoir water level - Spraying with insecticides	Landslide po - tential area Reservoir area Reservoir area	1 x a month 1 x a month 1 x a month	- PT.PLN (PERSERO) - PPT - Fisheries Agency - PT.PLN (PERSERO) - Health Agency - PPT	Ditjen. LPE - DPE Ditjen. LPE - DPE Ditjen. LPE - DPE	- PT.PLN (PERSERO) - Fisheries Agency - PT.PLN (PERSERO) - PT.PLN (PERSERO) - Health Agency - PPT

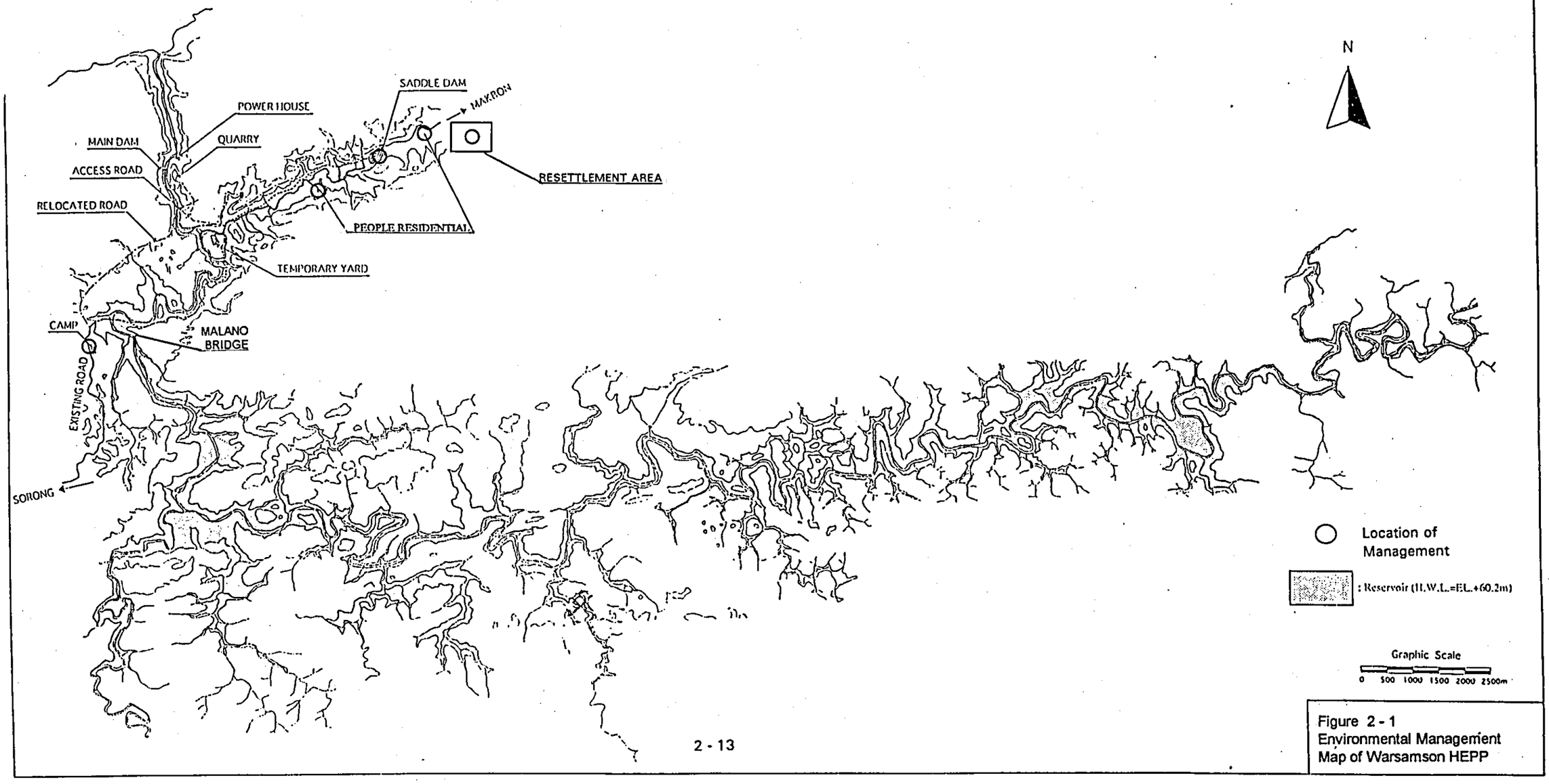
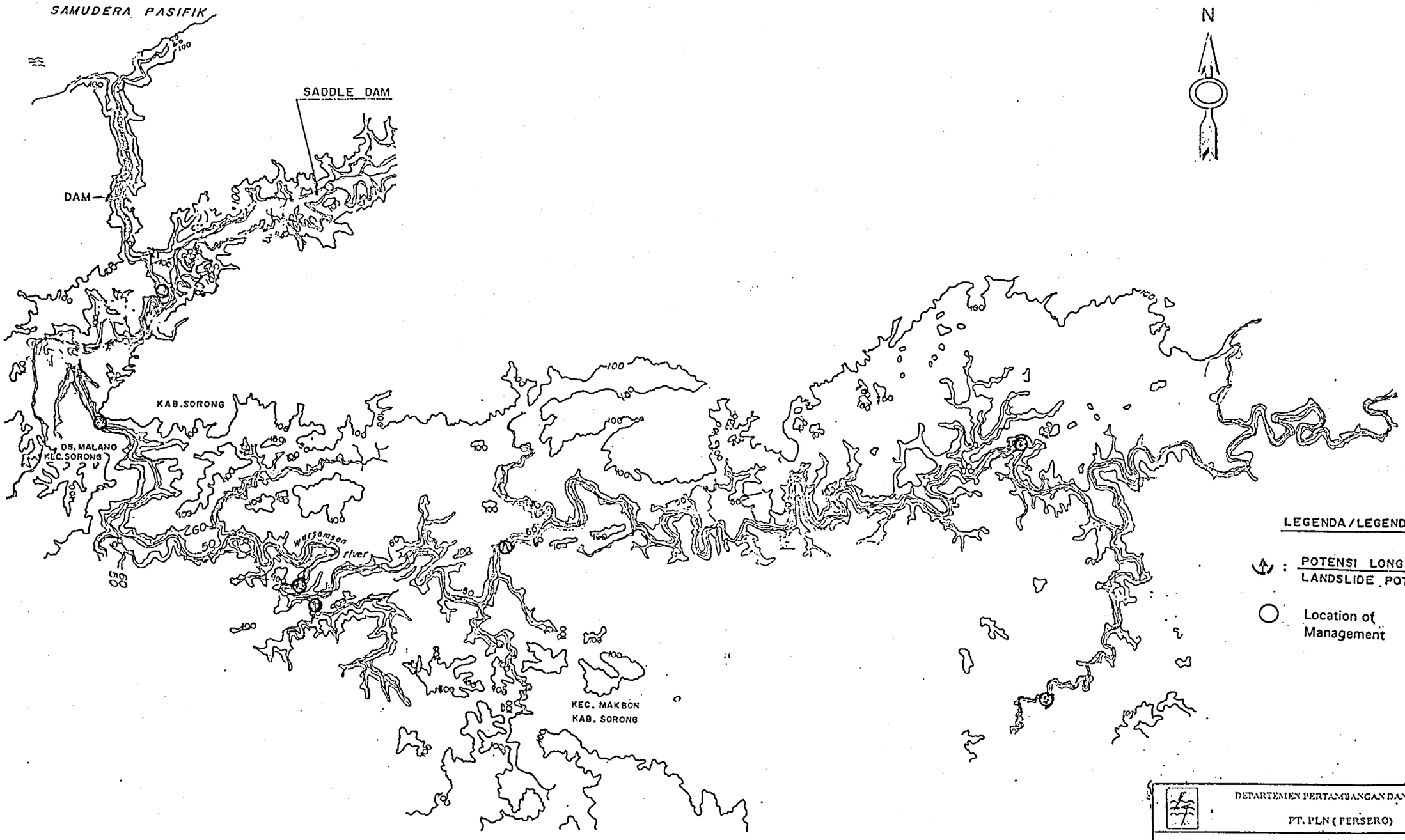


Figure 2 - 1
Environmental Management Map of Warsamson HEPP



SUMBER : PETA TOPOGRAFI DAERAH PLTA WARSAMSON
PT. AEROKARTO SKALA 1 : 10.000
OKTOBER 1994

DEPARTEMEN PERTAMBANGAN DAN ENERGI
PT. PLN (PERSERO)

PEKERJAAN STUDI ANDAL PLTA WARSAMSON

POTENSI LONGSOR DI DAERAH PROYEK
LANDSLIDE POTENTIAL IN PROJECT AREA

III. ENVIRONMENTAL MANAGEMENT IMPLEMENTATION

1. Institutional and organisation.

Environmental management is required since preconstruction, construction, and post construction activities. Activity that related directly to the planning of Warsamson HEPP development which occur in project area and surrounding area as a responsibility of PT.PLN (PERSERO), and environmental management that closely related to Warsamson HEPP development and environmental management which involve the demography, government and other environmental aspect sectorally outside the PT.PLN (PERSERO) responsibility and cooperation with other concern institutions/sectoral. This institutional covers executor institution of environmental management and user/report receiver of environmental management results.

Executor institution and user/report receiver of environmental management sectorally covers institutions as the following.

1) Land Compensation Committees (PPT).
This committee will compensates the land acquired by Warsamson HEPP project development. Structure and task of the committee are described in Appendix - A.

2) Regional Settlement and Housing Development Management Agency (BP4D).
Proposed structure of this agency is described in Appendix - B.

3) TKP2LH : Coordination Team for Environmental Pollution Control as a coordination in environmental pollution control and overcoming.

4) Health Agency, in-charge of health aspect, sanitation, air quality, water quality, spreading of communicable diseases, and their overcoming.

5) Manpower Agency, in-charge of manpower, manpower recruitment and severance of work relations.

6) BPN, Agrarian Affair Agency, in-charge of land, agrarian and land compensation.

7) DLLAJR, Highway Transportation and Traffic Agency and traffic police, in-charge of running smoothness flow of traffic, traffic jam and traffic accident.

8) Social Agency, in-charge of social problems include resettlement.

9) PUK, Public Works of Kabupaten, in-charge of road construction, road betterment and relocation road of Kabupaten level.

10) Other sectoral (concern) institutions which required in implementation of environmental management covers :

- Plantation Agency in-charge of development of cacao plantation cultivation in new resettlement area.

- HPH Intimpura, coordination institution in case of landsllide occur in shoreline of reservoir area.

- Fisheries Agency in-charge of development of aquaculture in reservoir area.

Organisation structure of environmental management implementation is represented in Figure 3 - 1.

2. Financing

Financing for environmental management of Warsamson HEPP which related to activity and operation and maintenance of Warsamson HEPP development will be in-charge of PT.PLN (PERSERO) Region X Jaya Pura and other environmental management cost which related to Warsamson HEPP and in-charge of other concern (sectoral) institutions will be in-charge of local government (Sorong). The project benefit and risk of Warsamson HEPP should be informed to the concern institutions by the coordinating of Local Government of Sorong to prepare the program to anticipate the negative side effect of the Warsamson project development, so the concern institutions ready to develop their programs (inclusive financing) correspond to their tasks and responsibilities.

Total cost of environmental management implementation is Rp.445,671,200 as broken down in Table 3 - 1.

3. Supervision of environmental management

Function and task of supervision in environmental management implementations covers :

a. Supervises and establishes toward the implementations of environmental management and monitoring during project construction and operation and maintenance of Warsamson HEPP and reservoir.

b. Evaluates report and advises of the results of management and monitoring, particularly if any discrepancy.

The government institution as structural supervises the all environmental management and monitoring carried out by PT.PLN (PERSERO) is Directorate General of Electric and Energy Development Department of Mines and Energy (Ditjen. LPE - DPE).

Environmental management supervision which related to the environmental pollution will be carried out integrally by the coordination of TKP2LH.

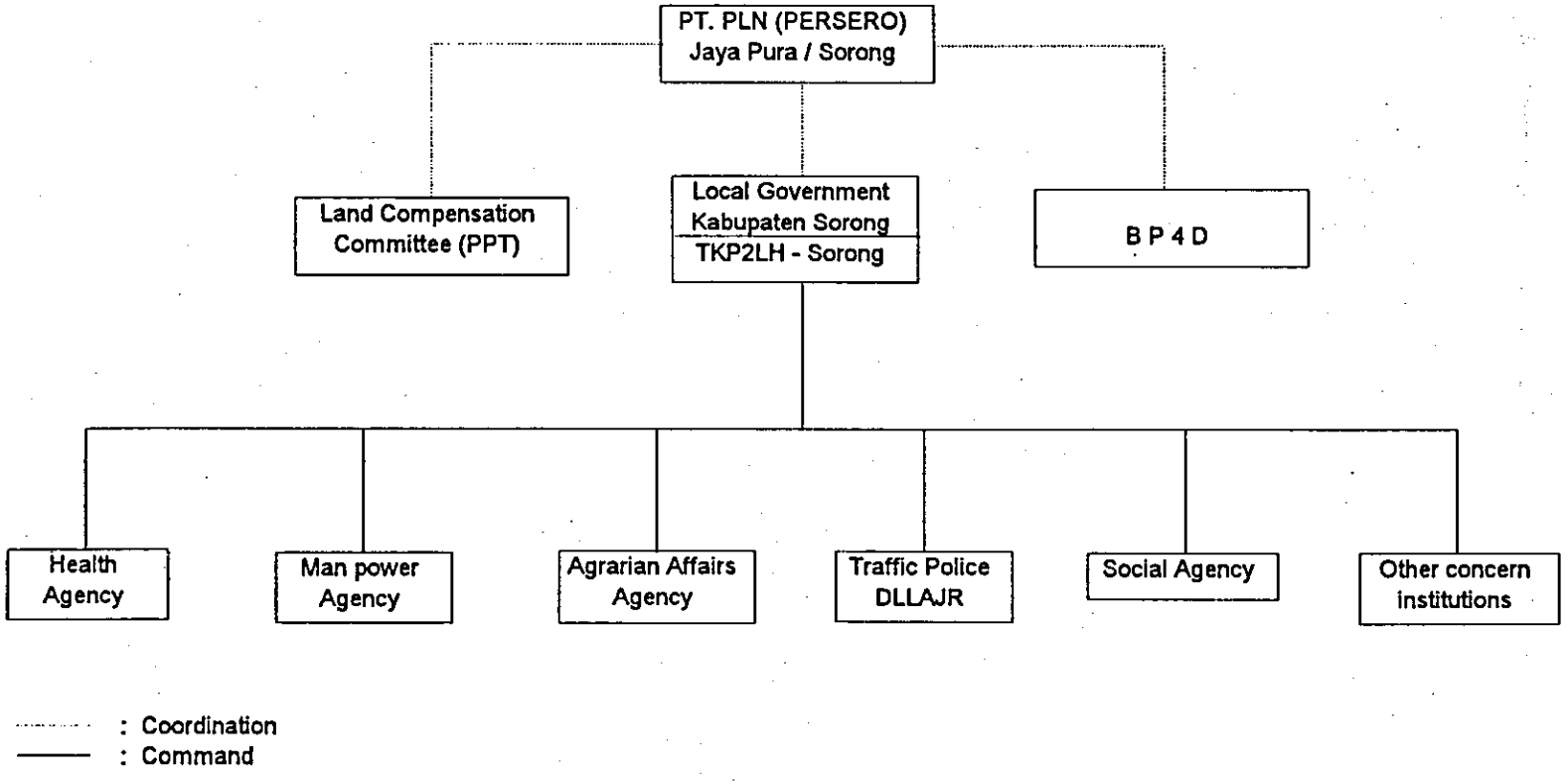


Figure 3 - 1 Organisation Structure of Environmental Management Implementation for Warsamson HEPP

Table 3 - 1 Cost of Environmental Management

No.	Description	Vol.	Unit	Time (Day)	Frequency (Year)	Unit Cost (Rp.)	Amount (Rp.)
I.	Pre-Construction Stage The extention and deliberation cost including in the land compensation cost.						
II.	Construction Stage						
2.1	Training of the local labour	200	man	22	2	10,000	88,000,000
2.2	Installation of Road Sign	10	Pcs	1	1	150,000	1,500,000
	Sub total (a)						**89,500,000**
III.	Post Construction Stage						
	Training course of EIA for PLN staff	4	man	60	2	80,000	38,400,000
	- Slope protection	10	ha			30,277,120	302,771,200
	- Temporary health centre	2	nos			7,500,000	15,000,000
	Sub total (b)						**356,171,200**
	Total (a + b)						**445,671,200**

Lap-Ing\Conenvir.xls-dok-3

IV. REFERENCES

1. Anonymous, Law No.4,1982 describing Basic Provinsions on Environmental Management, Jakarta .

2. Anonymous, Government Regulation of the Republic of Indonesia No.51, 1993 describing Environmental Impact Assessment, Jakarta 1994.

3. Anonymous, State Ministerial Decree of Environmental (Appendix III) No. KEP 14/MENLH/3/94 describing Guideline of Environmental Management Plan (RKL) Arrangement, Jakarta 1994.

4. Anonymous, Government Regulation No.20, 1990 describing Water Pollution Control, Jakarta 1990.

5. Anonymous, Presidential Decree No.55, 1993 describing Land Acquisition for Development Implementation of Public Interest.

6. Anonymous, Decree of State Minister of Population and Environmental No. KEP-02/MENKLH/I/1988 about Guideline on Stipulation of Quality Standard for Water in Water Source and Air.

7. Anonymous, Health Ministerial Regulation No.718/Menkes/Per/XI/87 describing noise level in relationship with health, Jakarta 1987.

8. Anonymous, Ministrial Decree of Mines and Energy No.103 K/008/MPE/1994, about Supervision on Implementation of Environmental Management and Monitoring Plans for Mines and Energy Sector.

9. Anonymous, Presidential Decree No. 37, 1994 describing National Settlement and Housing Development Policy and Management Agency.

Appendix - A

Structure of Land Compensation Committee in Kabupaten Level as specified in clause 6 paragraph (2) consist of :

1. Regent of Sorong, Head of Regional Level II as Chairman and holds the position of member;

2. Head of Agrarian Affairs Office (BPN) of Sorong as deputy and holds the position of member;

3. Head of Land and Building Tax Service as member;

4. Head of Local Government institution in charge on building division as member;

5. Head of Local Government institution in charge on agriculture division as member;

6. Head of subdistrict (Kecamatan) which the area covers piece of land where the development will be experienced as member;

7. Head of villages which the area covers piece of land where the development will be experienced as member;

8. Head of Government Section of Regency Office as Secretary I, not member;

9. Head of Section in Agrarian Land Affairs Office of Sorong as Secretary II, not member.

Source : Presidential Decree No.55, 1993 describing Land Acquisition for Implementation Development of Public Interest.

Tasks of Land Compensation Committee :

1. Survey/research and inventory of land. building, tree, and other structures/goods which related with land that the right will be released or surrendered.

2. Observes the law status of land and supporting documents.

3. Estimates and proposes the amount of land indemnity.

4. Explains and informs/extension to the land owner/rightholder of land about plan and purpose/objective of land acquisition.

5. Deliberation with the land owners/rightsholders of land and government institution who requires the land in stipulating the form and/or amount of indemnity.

6. As the witness in payment of indemnity to the land owner/righholder of land, building, tree and other structures/goods to be compensated.

7. Prepare minutes of meeting of release and surrender of land righ/land ownership.

Source : Clause 8 of Presidential Decree No.55, 1993 describing Land Acquisition for Development Implementation of Public Interest.

Appendix - B

Proposed structure of Regional Settlement and Housing Development Management Agency for Warsamson HEPP of Sorong :

1. Regent, Head of Sorong Regional Level II as Chairman and holds the position of member;

2. Head of Bappeda of Sorong as Deputy and holds the position of member;

3. Head of Local Government Institution in charge on demography as member;

4. Head of Local Government Institution in charge on social sector as member;

5. Head of Local Government Institution in charge on plantation sector as member;

6. Head of Agrarian Land Affairs Office, as member;

7. Head of Public Works of Kabupaten Sorong, as member;

8. Head of Subdistrict (Camat) which some people will be resettled, as member;

9. Head of Villages which some people will be resettled, as member;

10. Head of Government Section of Regency Office as Secretary, not member.

Based on the Presidential Decree No. 37, 1994, describing National Settlement and Housing Development Policy and Management Agency, Clause 2, the main task of the agency (in national level) is to formulate the policy, problem solving, and supervise and manage on development of settlement and housing.

Appendix - C

Excerpt of Magazine : Water Power & Dam Construction November 1986, p. 21

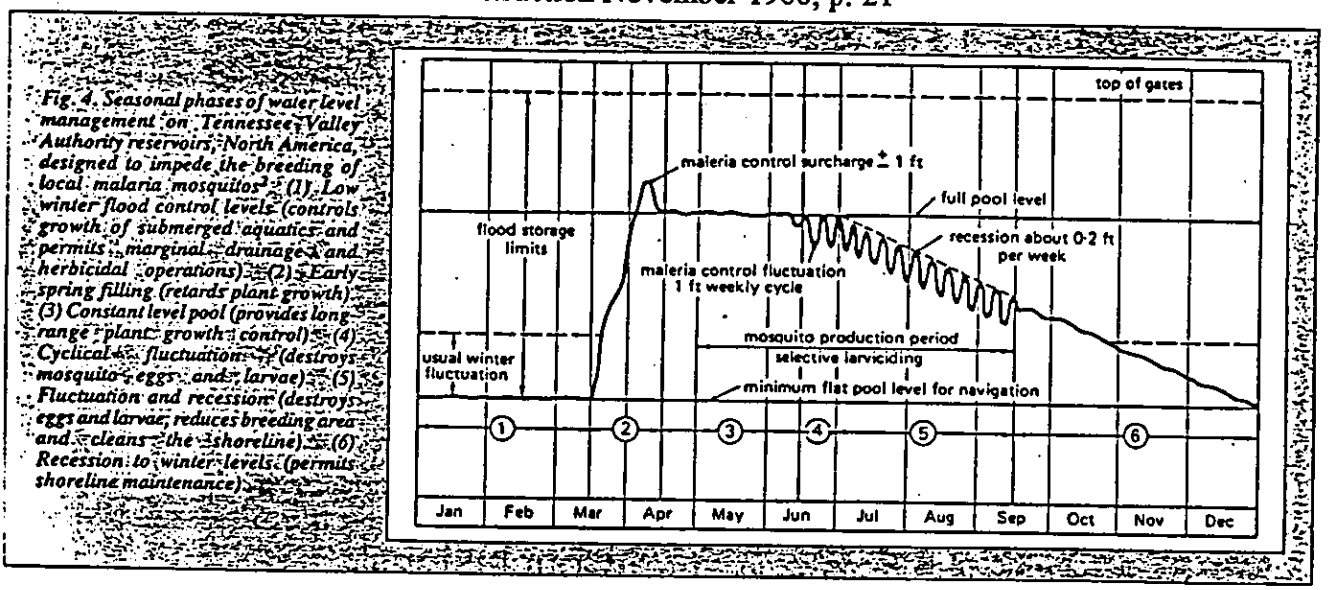


Fig. 4. Seasonal phases of water level management on Tennessee Valley Authority reservoirs, North America, designed to impede the breeding of local malaria mosquitos[2]. (1) Low winter flood control levels (controls growth of submerged aquatics and permits marginal drainage and herbicidal operations). (2) Early spring filling (retards plant growth). (3) Constant level pool (provides long range plant growth control). (4) Cyclical fluctuation (destroys mosquito eggs and larvae). (5) Fluctuation and recession (destroys eggs and larvae, reduces breeding area and cleans the shoreline). (6) Recession to winter levels (permits shoreline maintenance).

A Chinese grass carp being tested in Sudan for control of aquatic weeds, and also as a means of reducing mosquito and snail populations.

3. Environmental Monitoring Plan (RPL)

ABBREVIATIONS

AMDAL	Environmental Impact Assessment (EIAs)
ANDAL	Environmental Impact Analysis (EIA)
BAPPEDA	Regional Development Planning Agency
BAPEDAL	Environmental Impact Management Agency
BP4D	Regional Settlement and Housing Development Management Agency
Ditjen. LPE - DPE	Directorate General of Electric and Energy Development Department of Mines and Energy.
DLLAJR	Highway Transportation Traffic Agency
HPH	Forest Concession
PT.PLN (PERSERO)	State Electricity Corporation
PPT	Land Compensation Committee
PUK	Public Works of Kabupaten (Sorong)
RKL	Environmental Management Plan (EMaP)
RPL	Environmental Monitoring Plan (EmoP)
TKP2LH	Coordination Team for Environmental Pollution Control

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I. INTRODUCTION

1. Background.

Development of Hydroelectric Power Project (HEPP) of Warsamson for capacity 46.5 MW in Kabupaten Sorong Irian Jaya Province, as the government effort to fulfill the electric power demand in Irian Jaya, especially for Sorong Regency. The development of this project will, without doubt, gives the impacts toward the environment, negative as well as positive, as concluded by the Environmental Impact Analysis (EIA/ANDAL) of Warsamson HEPP. The basics directive of mitigation measures to prevent, control and overcome the negative impact has been described in Environmental Management Plan (EMaP/RKL) for Warsamson HEPP. To understand the phenomena occur on several levels, from the project level (to understand the characteristic of impact as a result of the project), sectoral level until regional level, depending on the scale/ size of the problem encountered, so the arrangement of Environmental Monitoring Plan (EMoP/RPL) for Warsamson HEPP is required. According to the government policy about development implementation with the environmental concept, as mentioned in Government Regulation No.51, 1993, about Liability Activity List for Environmental Impact Assessment (EIAs/AMDAL), it is contained in the list that HEPP of any type and size, except Minihydro Electric Power Plant and run-off-river type, should carry out EIAs, and this statement also valid to the Warsamson HEPP, and accordingly, the proponent is compulsory to conduct Environmental Impact Assessment, arrangement of RPL is to fulfill the government regulation.

2. Relevant laws and regulation.

Activities of the Warsamson HEPP construction will give effect on the environment. To arrange the management and utilization of natural resources and living environment based on national policy standard integrally and comprehensively, principal laws and regulations are made being the principles for natural resources management and living environment. Principle laws and regulations enacted by the government is closely related to the development of hydroelectric power project and used as the guideline in preparing RPL, namely :

a. Law No. 4, 1982 describing Basic Provinsions on Environmental Management, Jakarta 1993.

b. Government Regulation of the Republic of Indonesia No.51, 1993 describing Environmental Impact Assessment, Jakarta 1994.

c. State Ministerial Decree of Environmental (Appendix IV) No. KEP 14/MENLH/3/94 describing Guideline of Environmental Monitoring Plan (RPL) Arrangement, Jakarta 1994.

d. Government Regulation No. 20, 1990 describing Water Pollution Control, Jakarta 1990.

e. Presidential Decree No.55, 1993 describing Land Acquisition for Development Implementation of Public Interest.

f. Decree of State Minister of Population and Environment No. KEP-02/MENKLH/I/1988 about Guideline on Stipulation of Quality Standard for Water in Water Source and Air.

g. Health Ministerial Regulation No.718/Menkes/Per/XI/87 describing noise level in relationship with health, Jakarta 1987.

h. Ministerial Decree of Mines and Energy No.103 K/008/MPE/1994, about Supervision on Implementation of Environmental Management and Monitoring Plans for Mines and Energy Sector.

i. Ministerial Decree of Mines and Energy No.1894 K/09/DPE/1994 about Implementation of Environmental Monitoring of Mines and Energy Sector.

j. Presidential Decree No.37, 1994 describing National Settlement and Housing Development Policy and Management Agency.

3. Objective of environmental monitoring.

Objective of environmental monitoring which will be implemented by the proponent in relation with management of Warsamson HEPP is to monitor implementation of environmental management, so that the environmental management able to be useful. Negative impact able to be controlled, prevented, or overcame and positive impact able to be developed and give the additional benefit to the proponent and concern institutions which will relish the positive impact.

4. Necessity.

Necessity of environmental monitoring implementation for the proponent, concern institutions and for people can be described as below :

- Necessity for the proponent.
  - ° To understand the characteristic of impact as a result of the project activities.
  - ° To know the constraints in environmental management so that the environmental management will be carried out smoothly (after overcoming the constraints).
- Necessity for concern institutions.
  - ° To assist the concern institutions in environmental monitoring to understand their tasks and responsibilities, hoping that any coordination and cooperation between concern institutions and data and information collected then distributed to the varies user, able to be effective, on time and reliable.

- Necessity for the people.

    - Informs to the people about environmental monitoring of Warsamson HEPP development, hoping that the people know the Warsamson HEPP is managed with the environmental concept and then the people able to participate actively in environmental management activity (participate in monitoring the implementation of environmental management).

II. ENVIRONMENTAL MONITORING PLAN

This Environmental Monitoring Plan of Warsamson HEPP covers brief and clear description about sort of each impact caused by the project activities, source of impact, environmental parameter to be monitored, objective, method of environmental monitoring (data collection and analysis method, location, duration and monitoring frequency), financing and institutional are described as below.

1. Preconstruction stage.

- Land compensation and resettlement.

a. Parameter of significant impact to be monitored :

- Anxiety level, disappointed and/or unsatisfaction level.
- Perception and attitute of affected people and resettled people (positive/negative) toward the project.

b. Source of impact :

- Land compensation activity.
- Resettlement activity.

c. Objective :

- Monitor the attitude and people perception of affected/resettled people (positive/negative) toward the project.
- Monitor the production of cacao plantation in resettlement area.
- Monitor the number of local people recruited in project construction.
- Monitor the morbidity and mortality rates.
- Monitor the smooth running of development implementation and project operation (people participate in environmental management).

d. Method :

- Methods of data collection and analysis :
  - Field observation.
  - Interview by using questionnaires for selected respondents (at least 10% of affected people).
  - Tabulation of frequency distribution.
  - Visualisation and interpretation.

- Location :
  - In location of residential area : Malawor, Batu Lubang, and Malano (Figure 2 - 1).

- In location of resettlement area (Figure 2 - 1).

- Duration and frequency :

  - Duration during 5 years after land compensation and/or resettlement.
  - Period every 4 (four) month for land compensation and for resettlement, respectively.

e. Financing.

Institution in-charge in financing of environmental monitoring implementation is PT. PLN (PERSERO).

f. Institutional.

Institutions who concern and related to environmental monitoring activity, according to the relevant laws and regulation in national and regional level (environmental monitoring institutions) covers :

- Executor :
  - PT. PLN (PERSERO)
  - PPT
  - BP4D
  - Plantation Agency

- Supervisor.
  - Ditjen. LPE - DPE.

- Reporting of environmental monitoring results.
  Institutions who will be reported the environmental monitoring results periodically :
  - PT. PLN (PERSERO)
  - Local government of Sorong
  - Concern institutions :
    * PPT
    * BP4D
    * Plantation Agency

2. Construction stage.

- Mobilisation of heavy equipment and materials.

a. Parameter of significant impact to be monitored :

- Pavement damage of Sorong - Makbon existing road section.

- Traffic jam and traffic accident frequency.
- Mobility rate.
- Noise level of heavy equipment
- Duration of mobilisation.
- People complaint.

b. Source of impact :

- Mobilisation of heavy equipment and materials.

c. Objective :

- Monitor the pavement damage of Sorong - Makbon existing road section.
- Monitor mobility rate.
- Monitor the traffic accident and traffic jam frequency.
- Monitor the duration and noise level of heavy equipment mobilisation.
- Monitor the number of people complaint.

d. Method :

- Methods of data collection and analysis :
  - Site visit.
  - Interview with the road users and affected people approximately 25 respondents.
  - Tabulation of frequency distribution.
  - Visualisation and interpretation.
  - Noise sampling at 3 (three) locations.

Parameter	Equipment
Noise level	Sound level meter
Noise duration	Stopwatch

- Location.
  - Location of Sorong - Makbon existing road section : in front of Sorong Port, in front of PT.PLN (PERSERO) Sorong Branch Office and in front of Intercity Hotel or Sahid Mariat Hotel
  - Location of pavement damage monitoring along the existing road section.
- Duration and frequency.

  Duration of monitoring is at the commencement of mobilisation implementation until the completion of project construction. Monitoring frequency :

- Before and after mobilisation activity for pavement road condition, once every month.
- During implementation of heavy equipment mobilisation for smooth traffic flow and mobilisation duration/noise level, 3 x per day (morning, noon, and nigth).

e. Financing :

- PT. PLN (PERSERO).
- Contractor.

f. Institutional :

- Executor :
  - PT. PLN (PERSERO).
  - Contractor.
  - DLLAJR.
  - Trafic Police.

- Supervisor :
  - Ditjen LPE - DPE

- Reporting of environmental monitoring result :
  - PT. PLN (PERSERO)
  - Contractor
  - Local government (Sorong)
  - Concern institutions :
    - DLLAJR.
    - Traffic Police.

- <u>Construction of office repair shop and base camp.</u>

a. Parameter of significant impact to be monitored :

- BOD, coliform and fecal coli contents.
- Morbidity and mortality rates.

b. Source of impact :

- Construction and operation of office, repair shop and base camp.

c. Objective :

- Monitor the Warsamson River water quality and tributaries downstream the base camp, particularly BOD, coliform, and fecal coliform contents.
- Monitor morbidity and mortality rates.

d. Method :

- Methods of data collection and analysis.
  Water sampling in 6 (six) locations along the river downstream of base camp by laboratory analysis.

Parameter	Method of Analysis
BOD	Titration/Buret
Fecal coli and colilform	MPN table, filter holder and counter tunnel

  Site visit and interview with entire infected people or their familiy.
  Tabulation, visualisation and interpretation.

- Location.
  Location of water sampling in river downstream of base camp as specified in the map, A1 and A2, 3 samples respectively (See Figure 2 - 1).
  Base camp and residential area downstream the base camp.

- Duration and frequency.

  Duration of monitoring is at the time of commencement of office, repair shop and base camp operation until the completion of construction work, monitoring frequency once every 4 (four) months.

e. Financing :

- PT. PLN (PERSERO)

f. Institutional :

- Executor :
  PT. PLN (PERSERO)
  Contractor
  Health Agency

- Supervisor :
  Ditjen LPE - DPE

- Reporting of environmental monitoring result :
  PT. PLN (PERSERO)
  Local government (Sorong)
  Concern institutions :
  * Health Agency.

- Impoundment activity.

a. Parameter of significant impact to be monitored :

- People mobility rate from Sorong to Makbon (vice versa).
- People complaint.

b. Source of impact :

- Impoundment activity of proposed reservoir area where block the inland transport between Sorong and Makbon.

c. Objective :

- Monitor the mobility rate (smooth traffic flow) of people from Sorong to Makbon (vice versa).
- Monitor the percentage of people complaint.

d. Method :

- Methods of data collection and analysis :
  - Interview by using the questionnaires of selected respondents at least 10% of affected people.
  - Tabulation of frequency distribution.
  - Visualisation and interpretation
- Location :
  - At the beginning and end of impounded existing road section and existing road which used for construction road (See Figure 2 - 1).
- Duration and frequency :
  - Duration of monitoring since termination of the project construction work until the impoundment date, with the frequency of monitoring once in every week.

e. Financing :

- PT. PLN (PERSERO)

f. Institutional :

- Executor :
  - PT. PLN (PERSERO)
  - Contractor

- Supervisor :
  Ditjen LPE - DPE

- Reporting of environmental monitoring result :
  PT. PLN (PERSERO)
  Local government (Sorong)
  Concern institutions : PUK

3. Post construction stage.

- Management and operation of reservoir.

a. Parameter of significant impact to be monitored :

- Acreage and location of landslides owned by local people.
- N, P, NH3, DO, BOD, fecal coli, Mn and Fe contents.
- Morbidity and mortality rates.

b. Source of impact :

- Management and operation of reservoir.

c. Objective :

- Monitor acreage and place of landslides surrounding the shoreline of reservoir area owned by local people and not compensated yet.
- Monitor reservoir water quality, especially BOD, dissolved oxygen (DO), N, P, NH3, fecal coli, Fe and Mn contents.
- Monitor morbidity and mortality rates.

d. Method :

- Methods of data collection and analyze :

  Site visit and field observation.
  Water sampling and analyzing of 6 (six) water samples (A1, A3, A4, A5, A6, and A7), parameter : BOD, DO, fecal coli, Fe, Mn, N, P, and NH3.

Parameter	Method of Analysis
BOD	Titration/Buret
DO	DO meter
N-total & P total	Titration/Buret
NH3	Spectrophotometer.
Fecal coli	MPN, MPN table, filter holder and counter tunnel
Fe, Mn	Atomic Absorption Spectrophotometric.

- ° Tabulation of frequency distribution.
- ° Visualisation and interpretation.

- Location :
  - ° Shoreline of reservoir area (landslide potential) is shown in Figure 2 - 2.
  - ° Location of water sampling is shown in attached map (Figure 2 - 1).
  - ° Residential area surrounding the reservoir area (Figure 2 - 1)

- Duration and frequency :
  - ° Duration of monitoring during 5 (five) years with the frequency of monitoring once in every 4 (four) months, or follow the periodically patrol during maintenance work.

e. Financing :

- PT. PLN (PERSERO)

f. Institutional :

- Executor :
  - ° PT. PLN (PERSERO)
  - ° Fisheries Agency
  - ° Health Agency

- Supervisor :
  - ° Ditjen LPE - DPE

- Reporting :
  - ° PT. PLN (PERSERO)
  - ° Local government (TKP2LH)
  - ° Concern institutions :
    - * HPH Intimpura
    - * Fisheries Agency
    - * Health Agency

Matrix of Environmental Monitoring Plan (RPL) for Warsamson HEPP is presented in Table 2 - 1.

Table 2 - 1 Matrix of Environmental Monitoring Plan (RPL) for Warsamson HEPP

Parameter of significant impact to be monitored	Source of impact	Objective	Environmental Monitoring Plan					Institutions of Monitoring		
			Data collection method	Location	Duration	Frequency	Analysis method	Executor	Supervisor	Reporter
1. Preconstruction										
- Unsatisfaction level of affected people	- Land compensation	- Monitor attitude and people perception	- Interview	- Residential area	5 years	1 x 4 months	Tabulation visualisation Interpretation	PT.PLN (PERSERO) PPT	Ditjen. LPE - DPE	PT.PLN (PERSERO) PPT
- Anxiety level of resettled people	- Resettlement	- Monitor smooth running of project development	- Interview	- Resettlement area	5 years	1 x 4 months	Tabulation visualisation Interpretation	PT.PLN (PERSERO) BP4D Plantation Agency	Ditjen. LPE - DPE	PT.PLN (PERSERO) BP4D Plantation Agency
2. Construction										
- Pavement damage of Sorong - Makbon existing road	- Mobilisation of heavy equipment and materials	- Monitor pavement condition	- Site visit - Interview	- Existing road	During construction work	1 x month	Tabulation visualisation Interpretation	PT.PLN (PERSERO) Contractor DLLAJR Traffic Police	Ditjen. LPE - DPE	PT.PLN (PERSERO) Local Government DLLAJR Traffic Police
- Traffic jam & traffic accident frequency	- Mobilisation of heavy equipment and materials	- Monitor traffic jam and traffic accident frequency	- Site visit - Interview	- Existing road	During construction work	3 x a day	Tabulation visualisation Interpretation			
- BOD, fecal coli, and coliform content	- Construction of office, repair shop and base camp	- Monitor water quality, fecal coli, coliform, and BOD - Monitor morbidity rate	- Water sampling	- Downstream of base camp	During construction work	1 x 4 months	Laboratory analyze	PT.PLN (PERSERO) Contractor Health Agency	Ditjen. LPE - DPE	PT.PLN (PERSERO) Local Government Health Agency
- People mobility rate	- Impoundment activity	- Monitor mobility rate (smooth traffic flow)	- Interview	- Existing road/ construction road	Existing road improvement until impoundment	1 x week	Tabulation visualisation Interpretation	PT.PLN (PERSERO) Contractor	Ditjen. LPE - DPE	PT.PLN (PERSERO) Local Government (PUK)
3. Post Construction										
- Acreage & location of landslides	- Management and operation of reservoir	- Monitor acreage and place of landslides	- Site visit	- Shoreline of reservoir area	5 years 5 years	1 x 4 months 1 x 4 months	Field observation	PT.PLN (PERSERO) HPH Intimpura	Ditjen. LPE - DPE	PT.PLN (PERSERO) Local Government HPH Intimpura Fisheries Agency
- N, P, NH3, BOD, DO fecal coli, Mn & Fe	- Management and operation of	- Monitor reservoir water quality	- Water sampling	- Reservoir area			Laboratory analyze	PT.PLN (PERSERO) Fisheries Agency		
- Morbidity & mortality rates	- Management and operation of reservoir	- Monitor morbidity and mor - tality rates	- Site visit	- Residential area	5 years	1 x 4 months	Tabulation, visu-alisation, inter - pretation	PT.PLN (PERSERO) Health Agency	Ditjen. LPE - DPE	PT.PLN (PERSERO) Local Government Health Agency

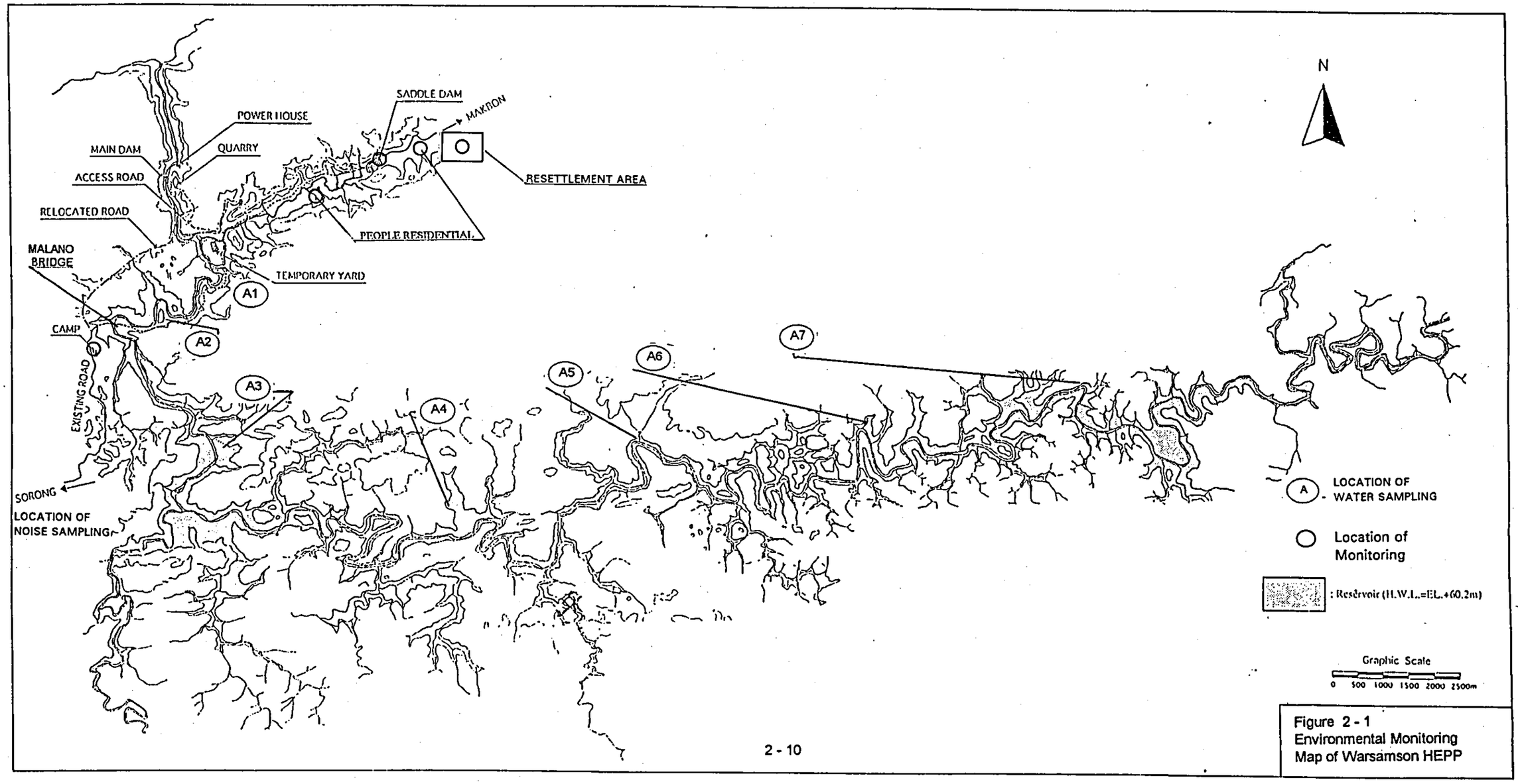
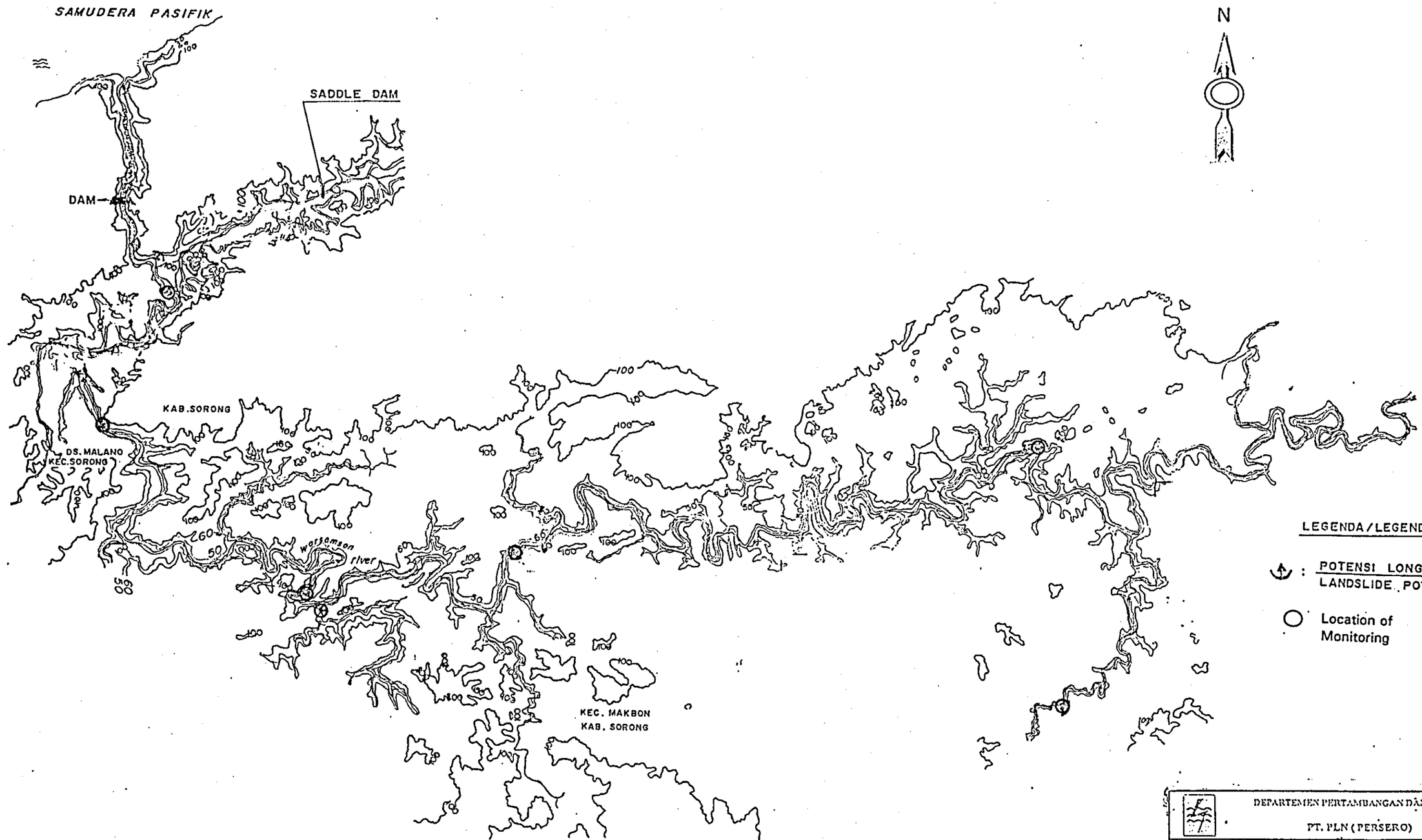


Figure 2 - 1
Environmental Monitoring
Map of Warsamson HEPP


SAMUDERA PASIFIK
SADDLE DAM
DAM
KAB.SORONG
DS. MALANO
KEC.SORONG
warsamson river
KEC. MAKBON
KAB. SORONG
N
LEGENDA/LEGEND :
: POTENSI LONGSOR
LANDSLIDE POTENTIAL
Location of
Monitoring
SUMBER : PETA TOPOGRAFI DAERAH PLTA WARSAMSON
PT. AEROKARTO SKALA 1 : 10.000
OKTOBER 1994
0 1 2 3 4 km
SCALE
DEPARTEMEN PERTAMBANGAN DAN ENERGI
PT. PLN (PERSERO)
PEKERJAAN STUDI ANDAL PLTA WARSAMSON
POTENSI LONGSOR DI DAERAH PROYEK
LANDSLIDE POTENTIAL IN PROJECT AREA

III. ENVIRONMENTAL MONITORING IMPLEMENTATION

1. Institutional and organisation.

Environmental monitoring is required since preconstruction, construction, and post construction activities. Activity that related directly to the planning of Warsamson HEPP development which occur in project area and surrounding area as a responsibility of PT.PLN (PERSERO), and environmental monitoring that closely related to Warsamson HEPP development and environmental monitoring which involve the demography, government and other environmental aspect sectorally outside the PT.PLN (PERSERO) responsibility and cooperation with other concern institutions/sectoral. This institutional covers executor institution of environmental monitoring and use/report receiver of environmental management results

Executor institution and user/report receiver of environmental monitoring sectorally covers institutions as the following.

1) PPT.
   This committee will compensates the land acquired by Warsamson HEPP project development. Structure and task of the committee are described in Appendix - A.

2) BP4H
   Proposed structure of this agency described in Appendix - B.

3) TKP2LH : Coordination Team for Environmental Pollution Control as a coordination in environmental pollution control and overcoming.

4) Health Agency, in-charge of health aspect, sanitation, air quality, water quality, spreading of communicable diseases, and their overcoming.

5) Manpower Agency, in-charge of manpower, manpower recruitment and severance of work relations.

6) BPN, Agrarian Affair Agency, in-charge of land, agrarian and land compensation.

7) DLLAJR, Highway Transportation and Traffic Agency and traffic police, in-charge of running smoothness flow of traffic, traffic jam and traffic accident.

8) Social Agency, in-charge of social problems include resettlement.

9) PUK, Public Works of Kabupaten, in-charge of road construction, road betterment, and relocation road of Kabupaten level .

10) Other sectoral (concern) institutions which required in implementation of environmental monitoring, covers :

- Plantation Agency in-charge of development of cacao plantation cultivation in new resettlement area.

- HPH Intimpura, coordination institution in case of landsllide occur in shoreline of reservoir area.

- Fisheries Agency in-charge of development of aquaculture in reservoir area.

Organisation structure of environmental monitoring implementation is represented in Figure 3 - 1.

2. Financing

Financing for environmental monitoring of Warsamson HEPP which related to activity and operation and maintenance of Warsamson HEPP development will be in-charge of PT.PLN (PERSERO) Region X Jaya Pura and other environmental monitoring cost which related to Warsamson HEPP and in-charge of other concern (sectoral) institutions will be in-charge of local government (Sorong). The project benefit and risk of Warsamson HEPP should be informed to the concern institutions by the coordination of Local government of Sorong to prepare the program to anticipate the negative side effect of the Warsamson project development, so the concern institutions ready to develop their programs (inclusive financing) correspond to their tasks and responsibilities.

Total cost of environmental monitoring implementation is Rp.76,800,000 as broken down in Table 3 - 1.

3. Supervision of environmental monitoring.

Function and task of supervision in environmental monitoring implementations covers :

a. Supervises and establishes toward the implementations of environmental monitoring and management during project construction and operation and maintenance of Warsamson HEPP and reservoir.
b. Evaluates report and advises of the results of management and monitoring, particularly if any discrepancy.

The government institution as structural supervises the all environmental management and monitoring carried out by PT.PLN (PERSERO) is Directorate General of Electric and Energy Development Department of Mines and Energy (Ditjen. LPE - DPE).

Environmental monitoring supervision which related to the environmental pollution will be carried out integrally by the coordination of TKP2LH.

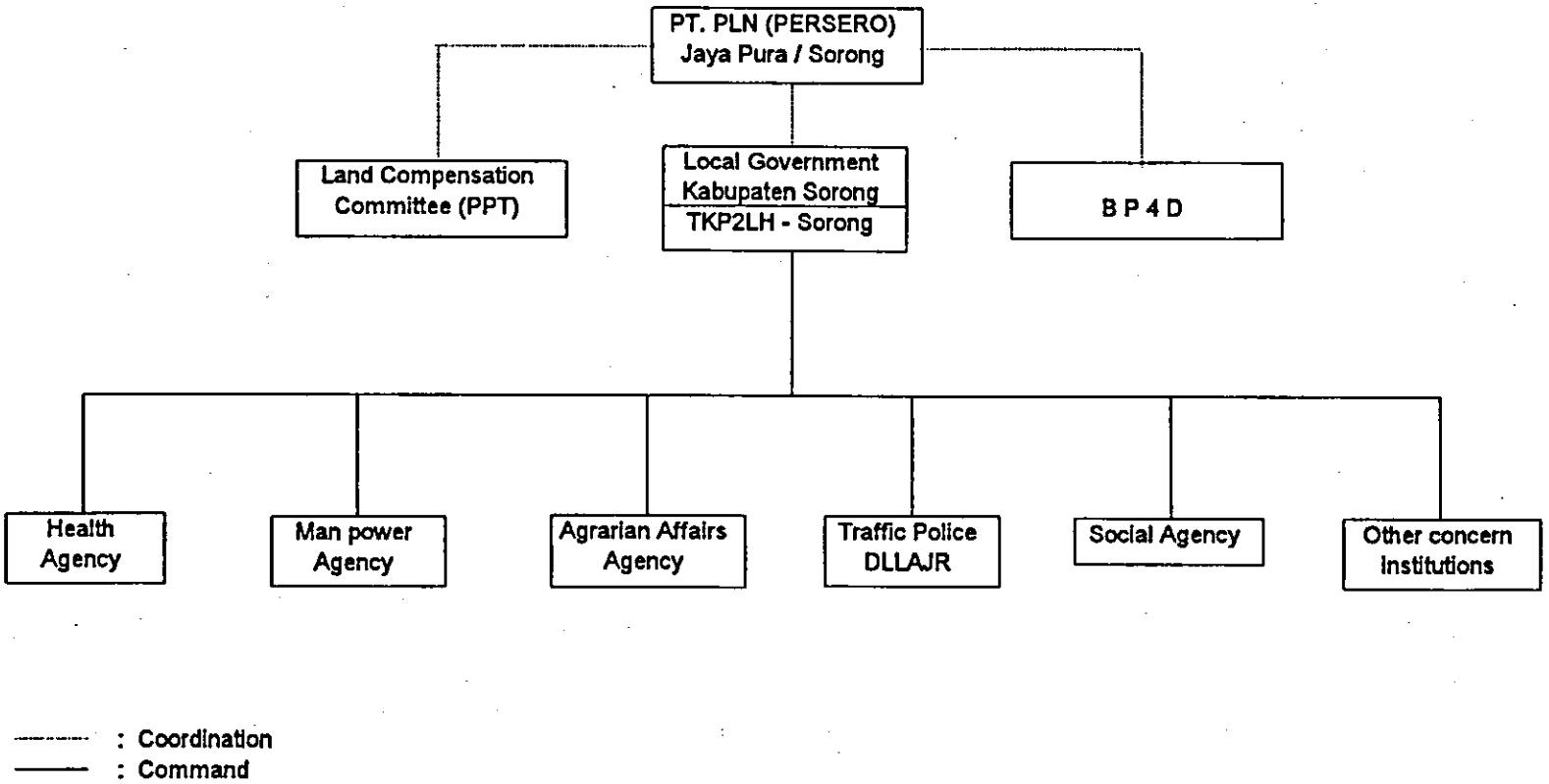


Figure 3 - 1 Organisation Structure of Environmental Monitoring Implementation for Warsamson HEPP

Table 3 - 1 Cost of Environmental Monitoring

No.	Description of Stage	Vol.	Unit	Time (Day)	Frequency (Year)	Unit Cost (Rp.)	Amount (Rp)
I.	Pre-Construction						
	Monitoring for social aspect	8	man	4	4	100000	12,800,000
					Sub total (a)		**12,800,000**
II.	Construction						
2.1	Air quality / noise	3	sml	2	4	250,000	6,000,000
2.2	Water quality	6	sml	2	4	250,000	12,000,000
2.3	Monitoring for social aspect	8	man	4	4	200,000	25,600,000
					Sub total (b)		**43,600,000**
III.	Operation						
3.1	Discharge, water qualities and garbages.	6	nos	2	2	350,000	8,400,000
3.2	Monitoring of critical area by the project	10	ha	6	2	100,000	12,000,000
					Sub total (c)		**20,400,000**
					Total (a + b +c)		**76,800,000**

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IV. REFERENCES

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4. Anonymous, Government Regulation No.20, 1990 describing Water Pollution Control, Jakarta 1990.

5. Anonymous, Presidential Decree No.55, 1993 describing Land Acquisition for Development Implementation of Public Interest.

6. Anonymous, Decree of State Minister of Population and Environmental No. KEP-02/MENKLH/I/1988 about Guideline on Stipulation of Quality Standard for Water in Water Source and Air.

7. Anonymous, Health Ministerial Regulation No.718/Menkes/Per/XI/87 describing noise level in relationship with health, Jakarta 1987.

8. Anonymous, Ministrial Decree of Mines and Energy No.103 K/008/MPE/1994, about Supervision on Implementation of Environmental Management and Monitoring Plans for Mines and Energy Sector.

9. Anonymous, Ministrial Decree of Mines and Energy No.1894 K/09/DPE/1994 about Implementation of Environmental Monitoring of Mines and Energy Sector.

10. Anonymous, Presidential Decree No. 37, 1994 describing National Settlement and Housing Development Policy and Management Agency.