EXECUTIVE SUMMARY

1.0 INTRODUCTION

The title of this Project is THE PROPOSED DEVELOPMENT OF BENGOH DAM ACROSS SUNGAI SARAWAK KIRI, KUCHING SARAWAK. The proposed water reservoir dam (Bengoh Dam) across Sg. Sarawak Kiri, an upper tributary of Sg. Sarawak in Kuching Division is located approximately 30 km upstream of existing Batu Kitang Water Treatment Facilities. This project was initiated by the Government of the State of Sarawak through Jabatan Kerja Raya.

Treated water demand of Kuching and surrounding areas have been increasing steadily at an average annual growth rate of 8.2% and currently stands at about 282 million litres per day (MLD) from 1990 production of 109 MLD. The Matang Water Treatment Plan (WTP) produce an average of 7.45 MLD with the remainder coming from the Batu Kitang WTP.

The Batu Kitang Water Treatment Plant extracts raw water from Sg. Sarawak Kiri that has a catchments size of approximately 633 square kilometres, and Sg. Sarawak Kiri has been serving as an adequate water source for Kuching. However, recently several incidents of serious salinity intrusion occured. The amount of raw water being extracted for treatment at Batu Kitang Water Treatment facilities has therefore reached a level until the balance of low flows in Sg. Sarawak Kiri downstream of the water intakes at Batu Kitang are no longer sufficient in preventing the saline front from advancing beyond the water intake point. As the raw water extraction rate increases in the future, the incidents of salinity intrusion are expected to increase both in terms of severity and frequency. It is therefore, imperative that alternative raw water resource development works need to be planned and carried out to meet the long-term water consumption volume needed by Kuching City and its vicinity areas.

In 1994, a study was conducted to determine the technical and financial feasibilities of constructing a dam in the upper reach of Sg. Sarawak Kiri, i.e., approximately 2.2 km west of Kampung Bengoh. The catchment of the proposed Bengoh Dam is approximately one quarter the size (approximately 127 km^2) of the entire Sg. Sarawak Kiri catchments size. This study concluded that it is both technically and financially feasible to construct a water reservoir dam near Kampung Bengoh for meeting the long-term water supply need of Kuching City and its vicinities.

The construction of a dam across Sg. Sarawak Kiri is a Prescribed Activity and under Section 4 (ii) of The Natural Resources and Environment Ordinance (Prescribed Activity) Order, 1994, this Project requires the submission of an Environmental Impact Assessment (EIA) report to the Natural Resources and Environment Board (NREB), Sarawak for approval.

The objectives of this EIA study are to fulfil the environmental legislative requirement of the Natural Resources and Environment Ordinance (Prescribed Activity) Order, 1994 and to integrate environmental considerations into the decision making process in the planning of the Project.

The study methodologies have included the collection and review of data related to the physical-chemical environment, the biological environment, the socio-economic or the human environment and the public health aspect. The environmental impacts on each of these components were assessed and mitigation and abatement measures were recommended.

2.0 PROJECT DESCRIPTION

The proposed Project is designed to operate as a water reservoir dam. Some of the specific functions of the proposed Bengoh Dam are as follows:-

- Storage of raw water for water supply,
- Release of raw water during droughts to provide sufficient raw water supply for Batu Kitang TP, and to prevent back flow of saline water from reaching the existing Batu Kitang intake point, and
- Flood mitigation during wet seasons

The Project components include the preliminary studies (feasibility study, vegetation survey, and the EIA study), biomass removal (reservoir preparation), construction and operation of the dam approximately 62 m high and to store 144.1 million m^3 of water, construction of the concrete lined open channel spillway and the construction and operation of an outlet works with a peak release capacity of 32 m^3/s.

The proposed mode of biomass disposal is by smokeless incineration. The total area of clearing is estimated at 127 Km^2. One of the key issues in the reservoir preparation highlighted include timber extraction and biomass removal. A Biomass Removal Plan (BRP) is proposed in this study to be incorporated into the master plan of the Project.

The construction components of this Project include the main dam, the saddle dams, the embankment zone, cofferdams and diversion channels, spillway and its control structures, outlet and intake towers, and the ancillary structures.

3.0 EXISTING PHYSICAL ENVIRONMENT

Geological Features and Soil

The reservoir area of Bengoh catchment is an area of complex geology involving a whole range of sedimentary rocks, igneous intrusive and extrusive rocks with associated metamorphism. The dam site lies within the Kayan Sandstone Formation of Tertiary Age, which has an unconformable contact with the Pedawan Formation within a distance of 1km towards the east. Both these formations are basically sedimentary sequences deposited under different environment.

The Kayan Sandstone Formation composes predominantly of hard and massive sandstones, with secondary mudstones and occasional massive conglomerate beds. The mudstone beds occur at reasonably regular intervals in the project area and are

sometimes bounded by siltstones/clayer sandstones, and/or by more thinly bedded (flaggy) sandstones.

Pedawan Formation is a thick sequence of moderately to steeply dipping marine shales, mudstones, and sandstones with subordinate beds of conglomerate, limestone and radiolarite. Some igneous rocks such as andesite, dacite, rhyolitic lavas and tuffs are also associated with this formation. This formation has been estimated to be at least 5000 m thick and is of Upper Jurassic to Upper Cretaceous age.

The Padawan overlies, probably unconformably, the Bau Limestone, which is now readily defined to the east of the project area as a series of isolated steeply sided hills, or short chains of hills. The topography is typical of an advanced stage of karst development. Various siltstone, conglomerate, mudstone, sandstone and alluvium were also found in this region.

A considerable number of normal faults are associated with the orogenic folding of the Kayan and Padawan formations which trend northerly or north-westerly. However, most of these faults occured well to the south of the dam site and present geological information do not show any major faults in the immediate vicinity of the dam site.

The permeability of the dam in residual soil and in highly fractured bedrock ranges from 8.8×10^{-5} cm/sec to 7.9×10^{-3} cm/sec. Leakage analysis on the boreholes indicated a low to average leakage in the area. The orientation and dips of the bedding planes are favoring the dam alignment, i.e. the beds dip upstream. As such there will be very small leakage across the dam.

In Sarawak, there are a number of faults criss-crossing one another in this region. Such a situation may be a source of tremor of up to M=6. However, most of the faults in Sarawak are inactive.

Meteorology

The climate of Sarawak is equatorial type with warm and humid weather throughout the year. The mean annual rainfall in the Bengoh catchment is approximately 3,990 mm, with a high proportion falling during the northwest monsoon season, from November to February. The driest period occurs from June to August. Due to its distance from the coast and partial rain shadowing of the two mountain ranges on either side of the catchments, the annual rainfall is less than the average for the Sarawak River Basin.

The mean temperature is approximately 26.6 °C and means relative humidity is around 85.3%. The wind pattern in this area generally shows relatively calm condition with 33.9% of the time without wind blowing and light breezes (<1.5 m/s) were recorded for 42% of the time. Evaporation follows a cyclical pattern within a year, and is on average of 3.5 to 4.0 mm/d, about 1450 mm per year. The amount of mean sunshine experience is 5.8 hr/day and ranges from 5 to 7 hr/day.

Land Use

The Bengoh Range is situated to the north and west of the catchment area where it is constituted mainly of hill forest. Kalimantan lies to the south of the catchments area. Areas to the east and south of the catchment area constitute of mainly shifting cultivation and agricultural plots. A large part of the basin is now either farmland, secondary or regenerated forest or barren ground. Hill paddy and other mixed crops such as tapioca and maize are cultivated on the hill slopes. In recent years, more permanent cash crops such as rubber, pepper and cocoa are also planted in the area. There is minimal cultivation activity to the upper range of Bengoh Range. However, the hill forest to the south west of the catchment area had been logged selectively and under regeneration.

Hydrology and Water Quality

The Sg. Bengoh dam site is located at the narrowest point of the gorge with catchment area at the upstream of approximately 120.4 km² respectively. The runoff factor from the mixed type of catchment is estimated to be between 0.4 and 0.7. An infiltration rate is estimated to be between 0.25 to 2.5 mm/h for the subsurface conditions. The rate is considered as low to intermediate. An intensity duration frequency (IDF) curve for Bengoh catchment had been computed in this report. The mean annual evaporation in 1995 standed at 1450 mm. The figures were high but are typically of the Sarawakian conditions.

An annual runoff of 2156 mm was estimated for the Bengoh catchment. River discharge of 1.2 to 27 m³/s were recorded from a gauging practice over a 3.5 m range in river flow at the Sg. Bengoh Gorge. PMP at Bengoh Reservoir were obtained from the reviewed studies undertaken both in Sarawak and Peninsular Malaysia. Maximization of the Marudi storm event using a maximization factor of 1.42 would amount to 795 mm for this regions. The maximum gross yield at Batu Kitang is approximately 1967 MLD with Bengoh reservoir storage at 180 MCM. (130.2 million m³)

Water quality of the Sg. Sarawak Kiri can be summarised as good and complies with Class IIB of the Interim National Water Quality Standards for Malaysia (INWQSM). However, the Faecal Coliform Count is on the high range. The Dissolved Oxygen, pH and other parameters were normal and in good levels. Nutrients were detected in the water sample but the levels conform to Class IIB compliance limit. These nutrients might originate from the fertilizers applied to the farmlands in the upstream regions. At the lower reaches of the river at Sg. Sarawak Kiri water quality still conform to Class IIB of INWQSM, except for Faecal Coliform Count that might be contributed by effluent wastes from residential areas located near the river.

The ambient air and noise qualities of the Proposed Project site were good with TSP level relatively lower as compared to DOE compliance limit. The noise levels were low and the main sources of noise are from insects and vehicles running along the access road of Kpg Bengoh.

4.0 EXISTING BIOLOGICAL ENVIRONMENT

Terrestrial Flora

On flood plains, **riverine forests** are encountered structurally and floristically similar to the secondary forest, abandoned rubber stands, orchards or MDF on the hills. The vegetation has total above ground biomass of approximately 736.8 tons/ha and leaf area index of 1.56 ha/ha. The total above ground biomass mainly comprised of *Shorea macrophylla, Durio zibethinus, Hevea brasiliensis,* and *Artocarpus elasticus*. **Secondary forests** are mainly the fallows of shifting cultivation. This vegetation has different stages of succession. The forest types are classified according to structure (physiognomy), as Temuda I, Temuda II, Belukar I and Belukar II. These forests offer a distinct contrast to the primary forests, both structurally and floristically.

Terrestrial Fauna

The area is reasonably rich in bird diversity. A total of 50 species of birds from 22 families were recorded. Seven species of birds are protected and two species are totally protected under Schedule 1 of the Sarawak Wildlife Protection Ordinance 1998. In general, the river basin is not rich in mammals. The species found are common to higher ground as well as to other parts of Sarawak. Part of the reason for this low diversity is the extensive disturbance caused by years of shifting cultivation and hunting by the settlers. A total of 14 species of mammals representing 9 families were recorded. The most common mammals are plantain squirrel and bat. Seven species of bats, a species flying squirrel (Horsefield's flying squirrel). common porcupine, pangolin and a palm civet are protected under Schedule 1 of the Sarawak Wildlife Protection Ordinance 1998.

Aquatic Resources

A total of 12 families represented by 52 species of fishes and crustacean were recorded from at Sg. Sarawak Kiri, its tributaries of Sg. Semadang. Sg. Semadang (area that will not be affected by the proposed dam) recorded 18 species from 10 families mainly from the Palaemonidae family (64%). In area downstream of the dam that will not be inundated but will be affected during construction and operation of the dam, a total of 8 families from 14 species of fishes were recorded with majority of Palaemonidae family (67%). Areas that will be inundated recorded 30 species from 8 families. Area upstream that will not be inundated recorded 25 species from 4 families.

Thirteen species of fish caught from the area that will be inundated once the dam has been built were not caught from the other areas; this does not imply that they are not present in these areas. Their absent from the samples may be due to their low population in the river. Similarly, thirteen species of fish and crustacean caught from the area that will not be affected or inundated.

5.0 POTENTIAL SIGNIFICANT IMPACTS

Major foreseeable environmental impacts from the activities of this Project could be generalized into three main categories. They are the impacts on 1) water quality, 2) aquatic resources and 3) the socio-economic issues (will be discuss in detail in Vol 2-Social-economic Impacts)

The downstream water quality of Sg. Sarawak Kiri would be adversely impacted during the earthwork and construction stages of the Project. The main water quality parameters of concerned are turbidity, suspended solids, BOD, nutrients and microbial counts. The deterioration in water quality is expected to be of short-term in nature, and could be of high intensity if proper measures are not taken. This deterioration may lead to further impacts on water supply and the survival of many aquatic fauna.

Once the reservoir is filled, the potential of thermal stratification of the water body is high. This stratification will create two types of water; the epilimnion and the hypolimnion water. The former is the water from the top 10 - 15 m while the later is the water from the lower part of the reservoir. The epilimnion water will be of good quality while the hypolimnion water will have very poor water quality (low DO). The hypolimnion water will not be suitable for use as raw water for the public water supply.

The high turbidity and suspended solids levels in Sg. Sarawak Kiri, would result from the earthwork and the dam construction are not favourable for healthy aquatic life. These unfavourable conditions could be improved when the dam has been completed. Water turbidity would be reduced drastically upon completion of the impoundment, and hence primary productivity of the water body will increase. This will sustain a higher fish population density and species diversity. Migratory fish species would be hindered from going upstream once the dam is constructed.

The socioeconomic issues arise from the land acquisition for the development of this Project has been identified as the major issues that need to be handled properly. Land compensation need to be addressed so that present landowners would be willing to release their plots of land for the Project. Some residents would prefer relocation of their farmland and suitable sites agreeable by both parties (the local residents and the Project Proponent). The beneficial impacts of the Project will be the generation of work and business opportunities for local residents during the construction phase particularly on the retail and catery business.

The significant adverse impacts resulting from this Project are mitigatable and most of these impacts are of short-term in nature. Most, if not all, of these impacts can be eliminated or at least minimized to a sustainable level, which are tolerable by the existing environment.

6.0 RISK ASSESSMENT

The associated risks are on the construction workers only. The standard JKR guidelines and statutory requirements of construction activities guide the dam

construction works. The main contractor will be liable for any event of harmful accidents involving loss of lives or permanent disability. The Tender Documents should be specific and in full details as to the associated liability.

The Sg. Bengoh dam is to be constructed as a roller compacted concrete (RCC) dam. The dam will be basically used as water retention reservoir. Considering the location and size of the reservoir and dam, it is considered as a large dam. The category falls under Class I as per the classification of US Federal Guidelines on Dam Safety.

The Sg Bengoh dam is considered a low risk dam as it is located away from populated area. The nearest residential area is approximately 2.2 km from the dam site (Kpg. Bengoh). The nearest populated area is approximately 40 km from the dam site (Kuching City). In this context the dam does not posed a major hazard to the residents living in the down stream city area but would cause a major treat to the resident at Kpg. Bengoh. The downstream area is mainly low lying and most of the residential areas are in the flood plain area. The impact of the dam failure is considered moderate to low as the distance to the populated area is some 40 km away from the dam site. Under this category it is considered as a medium to low risk dam.

The damage that could occur if the dam fails would be loss of life, crops and some property lying in the lowland of the flood plain. The risk of loss of life due to dam break scenario is low at the city and its surrounding area as there would be ample time to evacuate the people that would be affected by the flood waters but resident at Kpg. Bengoh would be under a more serious treat of being swept away by the flood flow. The population build up starts from approximately 2 km from the dam site. This is mainly along Sg. Sarawak Kiri and the Kuching-Serian road leading to Kuching city. The most exposed area would be the resident at Kpg Bengoh.

The low lying area of Kuching city and its surrounding area would be affected. The most severe area affected would be the South and West of Kuching city where the river Sg. Sarawak and Sg. Sarawak Kiri run through. The degree of impact would depend on the tide level.

7.0 DAM BREACH / FAILURE ANALYSIS

Potential catastrophes of flooding due to dam breach/failure have being forecast using BOSS DAMBRK software which is capable to provide the peak water surface elevation, peak discharges and the timing of these peak elevation and discharge at various locations downstream of the dam.

From the information and data accumulated in the investigation, the following findings were made:

- Reservoir reaches it peak discharge after 1.30 hrs, at Q = 14,000 m^3/s.
- Total duration of out flow is approximate 7 hours. After 7 hours, the flow comes to a steady-state of about 368 m^3/s.
- The discharge drops sharply from 7 km (Q = 13,500 m^3/s) to 10 km (Q = 5,500 m^3/s).
- After 10 km, discharge losses resulting from floodplain infiltration are less, about 3,500 m^3/s over a distance of 20 km (from 10 km to 30 km).

- The simulated results show a max flow velocity of 9.44 m/s with a discharge value (Q) of 13,502 m^3/s at 2 km downstream.
- The max discharge (Q) dropped from 13,949 m^3/s (at max velocity = 6.88 m/s at 0.5 km) to 1,605 m^3/s (max velocity = 0.69 m/s, at 30 km). This is a 90% reduction in flow velocity over a distance of 30 km.
- The discharge (Q) stabilizes or attained a constant value of approximately 1,600 m^3/s at 25 km and 35 km downstream of Bengoh Dam as compared to initial flow of 368.12 m^3/s.
- The area covered from 0.0 to 11 km is subjected to danger zone
- Downstream hazard and economic loss are classified as "Low" and "Minimal"

8.0 MITIGATION AND ABATMENT MEASURES

The inundation of this area and the construction of the dam will prohibit the current land use and resources extraction, such as timber, crops and wildlife. The area concerned should be gazetted as water catchment area and encroachment into the area for either sporting, gaming and agriculture activities should be prohibited. The lost of this land use could be compensated

- Villagers that have claims on the right to the existing land should be partially compensated in monetary terms and partially with agricultural land that will allow them to continue with their existing land use practices.
- Rehabilitation of the presently disturbed ecosystem by ways of reforestation with indigenous species as well as some commercial species will help in restoring the water catchment characteristics of the area.
- A systematic sustainable extraction of resources from the rehabilitated area should be allowed.

This Project has been identified to cause some amount of traffic increase along Kuching-Serian Road leading to Padawan and Kpg. Bengoh during the construction phase of the project development. The slow moving heavy machinery that enter and leave the Project site may cause increase in traffic. Road safety for the travelers along this stretch of road should be maintained.

The impact on water quality through the discharge of untreated sewage is a temporary impact. The main source of this pollutant is anticipated to be from the workers' camp. The following mitigation measures are recommended.

- Proper sanitation should be provided to the workers' camp. The contractor(s) should provide toilets fitted with septic tanks for their employees;
- Proper drainage at the vicinity of the workers' camps to prevent any stagnation of wastewater that may encourage breeding of mosquitoes; and
- The septic tanks should be desludged at regular intervals (probably every six months or whenever the discharge does not meet the requirements) to maintain the tanks efficiency.

Solid wastes handling and disposal should follow the following guidelines:

- All wood-based material discarded from the construction activities should be collected and be transported out of the Project site to a proper and legal dumpsite. No open burning of such material should be allowed to protect the air quality.
- Concrete blocks, which are to be discarded from the construction structures should be collected and transported for disposal at proper dumping site.
- Biomass from the reservoir clearing should be removed away from the inundated area. Disposal of the biomass should be done properly and three alternatives are recommended:

  a) The biomass could be removed from the reservoir area and properly stacked in areas above the inundated areas.
  b) The biomass should be collected and chipped into small pieces for use as mulching material during the reforestation exercise,
  c) The use of incinerator to combust all biomass under high temperature may also be used.

This incineration may be the cleanest option in terms of air pollution. However ost nutrients from the biomass will be lost. Proper garbage and disposal system should be provided for the workers so that to prevent improper disposal of garbage indiscriminately. Sewage treatment system should also be provided for the workers quarters to avoid sewage from flowing into water resources that are used by the villagers.

All parcels of land to be acquired for the Project should be compensated. Before the relevant authorities pay out money for land compensation to the villagers affected by the Project, they should first have a dialogue with the representative of the villagers. It is important that a fair amount should be paid so that the villagers will be satisfied and will not have any resentment towards the Project. If there is to be a forced resettlement, a resettlement committee should be formed to discuss the issues relating to resettlement. The members of this committee should comprised officials from the relevant government departments, such as the Land and Survey Department, Agriculture Department, Resident and District Office, and the representatives of the villagers, such as the Ketua kampong. The contractors should advise their workers to behave themselves and to be responsible and not to disturb the local people.

The workers quarters should be fenced to avoid the free movement of people and to block them from the public view. The contractors for the Project should open up job opportunities to the local people who want to work in the Project site. In order to prevent the spread of communicable diseases all the workers should be screened for communicable diseases, with particularly emphasis on waterborne diseases such as cholers and typhoid and various sexually transmitted diseases.

9.0 SOSIOECONOMIC IMPACT ASSESSMENT

Existing Socio-Economic Status

Approximately, there are 1,006 residents consisting of 199 families residing within the Bengoh catchment that comprises of Kpg. Pain Bojong with 54 families, Kpg.

Taba Sait with 54 families, Kpg. Semban with 50 families, and Kpg. Rejoi with 41 families. Kpg. Bengoh are located few km outside the Bengoh Catchment, with approximately 114 families.

Majority of the inhabitants are Bidayuh. Majority of the population are within the middle age of 31-50 years old (26.6%), followed by 11-20 years old (22.4%), 21-30 (19.1%), children less than 10 years old (18.3%). The younger generation are either schooling or working at nearby town and city. Approximately 86.4% of the community are farmers, 2.9% work in the private sector and 1.9% is government servants.

Majority of the inhabitants of the village seem to be dependent on farming as their primary economic activities. In general, they grow rubber, pepper, paddy, cocoa, fruit and vegetables and rear livestock. Others income comes from sales of forest product and small business. Hill paddy, fruit and vegetables were grown in small scale mainly for self-consumption. The monthly household income ranged from RM85 to RM4270. The mean monthly household income of the respondents was RM745.78, which was slightly below the PLI (Poverty Line Income). From the survey, it was also found that 98.5% of the households owned land on which they farm. However, the land size varies from one owner to another, ranging from a less than 10 acres to more than 50 acres. 96.1% of these land are categorized as native customary rights (NCR).

About 32.8% of the community had received at least education until primary school level. There is 1 primary school at Kpg. Bengoh (Sekolah Kebangsaan Bengoh), two primary schools are located in the catchment; SRK Taba Sait and SRK Rejoi. 97.6% of the inhabitants are Christians and 2.4% tradisional belief. There are 4 local churches within the Bengoh catchment and 2 in Kpg. Danu.

It is found that Kpg. Taba Sait is situated below RL60 and Kpg. Pain Bojong is below RL70, and both kampuns will be inundated when the dam is flooded up to FSL80m. Kpg. Rejoi is located between RL80 and RL90 on the grounds that are usually inundated during major flood events. However, Kpg. Semban is situated above RL370, which is well above major flood level of FSL80m. It is noted that the three kampungs; Kpg. Pain Bojong with 54 families, Kpg. Taba Sait 54 families, Kpg. Semban with 50 families, and Kpg. Rejoi with 41 families should be relocated on higher grounds.

A total of 52.4% of the respondents were supportive of the project. The reason why the remaining respondents were unhappy about the project were loss of their land ownership, loss of properties, loss of crop, loss of access to natural resources and have to be resettle. There was some concern on agriculture activities once the dam is constructed because some fertile land will be inundated and therefore can no longer be utilized.

Public Health

99.5% of the respondents used flush toilet system. Majority of the respondents (98.5%) used untreated gravity-fed piped water as their source of drinking water. There were five common methods used by the respondents to dispose their domestic

waste namely, by using a communal rubbish pit (43.2 percent), by burning (29.1 percent), using local council communal bins (23.3 percent), throw into forest, around house and drain (19.9%) and into river (12.1%).

The most common disease outbreak reported by respondents was malaria (25.7%) followed by dengue fever (17.0%), Japanese encephalitis (5.3%), tuberculosis (3.4%), and cholera (0.5%). A majority of the respondents obtained medical treatment at government clinics (83.5%) follow by government hospitals (75.2%), private clinics (47.6%) and tradisional *bomoh* (11.7%).

Compensation and Resettlement

89.8% of the respondents agree to give their land for the dam construction if they were fairly compensated for the land and crops that were grown on their land. They requested that they be compensated RM17,402.53 for an acre of land. The respondents also wanted to be compensated for their house and the house lot.

Approximately 36.0% of the respondents agreed to be resettled, while 41.3 % did not agree with resettlement. The other 22.3 percent of the respondents were not affected by the inundation of the dam (Kpg. Bengoh). 54.4% of the respondents felt that the most suitable site for them to be resettled was the one that is next to their present village, that is, in the area that will not be inundated and is outside the perimeter of the dam site. This is because they can continue with the present lifestyle (agriculture) without much disturbance and it is close to their present settlement, thus they have access to their agricultural land and crops, and natural resources.

Those respondents who were willing to be resettled gave conditions for resettlement besides being properly compensated for their land, crop and properties. Provision of facilities and amenities, proper resettlement site, new agricultural lands and job opportunities were other conditions given for resettlement.

Based on the SIA, the respondents generally perceived that the Bengoh Dam Project will have both positive and negative impacts on their livelihood.

10.0 RESIDUAL IMPACTS

The residual impacts identified above as a direct results of the Project activities are mostly minor in their intensities. Most of the impacts are acceptable to us as the losses could be replaced with equivalent or better substitutes. The permanent loss of the landownership by some residents at the Project site is the major setback of this project. It is believed that through honest and fair compensation packages, such psychological losses could be sufficiently relieved.

11.0 ENVIRONMENTAL MANAGEMENT PLAN

The framework for the environmental management plan for the Project was described. The framework addresses key construction and operational activities that comprise the source of environmental impacts, and outlines relevant compliance and best

management practices for each activity designed to mitigate adverse environmental effects and to facilitate positive benefits. Guidelines for the eventual decommissioning of the Bengoh Dam facility are also presented to provide guidance covering the full life-cycle of the Project.

A monitoring programme was recommended in this report. A listing of the various project activities affecting the catchment area, monitoring requirements and compliances were presented. Among the issues or activities listed, are the relocation of local inhabitants, assisted migration of protected animals (if possible), removal and disposal of biomass, adaptation of relocated people to the new environment, micro-climate changes in the catchment area, land rehabilitation in degraded areas and forest fallows and a catchment's protection plan.

The Proponent is recommended to conduct internal environmental audits as part of its overall management policy. The main objectives of the environmental audit are:

- To determine compliance of activities as conducted by Project Proponent; and
- To confirm the effectiveness of mitigative measures and management practices being carried out towards minimization of adverse environmental impacts.