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EXECUTIVE SUMMARY

1.0 INTRODUCTION

The proposed Project is the development of a 372 MW Ulu Jelai Hydroelectric Project (UJHEP) at Cameron Highlands by Tenaga Nasional Berhad (TNB). The location of the proposed Project is at the eastern edge of the Central Belt mountain range with a geological makeup of mainly granite. The Project Proponent is Tenaga Nasional Berhad (TNB). The DEIA Study is carried out by Universiti Teknologi Malaysia (UTM).

2.0 LEGAL REQUIREMENTS

The development of the 372 MW Hydroelectric Project is a Prescribed Activity under Item 13 (b) (i) and (ii) of the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987, as follows:-

13. Power Generation and Transmission:

*(b) Dams and hydroelectric power schemes with **either or both** of the following:*

(i) dams over 15 metres high and ancillary structures covering a total area in excess of 40 hectares

(ii) reservoirs with a surface area in excess of 400 hectares

The proposed Project involves the construction of an 85 m high dam and a reservoir covering an area of approximately 124 hectares. The proposed Project is expected to involve an area of approximately 544 hectares.

Hence, a Detailed Environmental Impact Assessment (DEIA) is required to be conducted for this project and a DEIA report to be approved by the Director General of Environmental Quality before any development can take place [Section 34A, Environmental Quality Act (Act 127), 1974].

3.0 STATEMENT OF NEED

The key reasons for the need for hydroelectric power plant are as follows:-

a) To Meet Peak Power Demand

The electricity load profile in Peninsular Malaysia has a large portion of base load, at approximately 10,000 MW with about 4,000 MW of peak demand. To provide for a safe and reliable power system, electricity demand must be met by a combination of base-load and peaking power plants.

Base load demand is usually supplied by power plants that operate on long duty cycle providing power output at a constant load. Most of these power plants are either coal-fired steam plants or gas-fired combined cycle plants.

Peaking plants usually operates on short duty cycle at varying loads. These stations have fast start-up capability that would be able to come into the system in a very short time and would be taken off once the peak periods are over.

Currently the power plants that are capable of providing peaking duty, in terms of technology and economics, are the open cycle gas turbines (OCGT) and hydroelectric power plants.

The limited supply of gas by Petronas for the power sector, capped at 1,350 million std. cubic feet per day (mmscfd), means that there will be very little spare capacity to meet additional requirement for the power sector. It is therefore the strategy of the Government and TNB to meet the growth in base-load and peak-load power by non-gas fuel sources.

New coal-fired thermal plants (Tanjong Bin and Jimah) and possibly hydro resources from Sarawak will be expected to meet base-load demand growth in the next 10 years.

As for **peak-load**, the only economic non-gas option will be to harness the remaining hydroelectric resources in Peninsular Malaysia.

b) To Improve Power System Security

Unique to hydroelectric plants is the capability to provide fast start-up and spinning reserve duties, features that are critical to the overall security of the power system by preventing massive black-outs arising from the sudden loss of large generation capacities.

The proposed Project, in particular, is ideally suited to provide these functions due to the high geodetic head presented by the site's natural topography. Out of the remaining potential hydroelectric sites in Peninsular Malaysia, only the Ulu Jelai site is blessed with this natural gift.

c) To Provide an Economic Fuel Option and To Reduce Carbon Emission

The alternative to the proposed Project would be an OCGT plant using gas as fuel. Apart from the limitation of gas supply alluded to earlier, the potential increase in gas price due to possible removal of government subsidies, makes the OCGT option not viable.

Another advantage in opting for hydropower instead of OCGT is the potential reduction in carbon emission. For example, the Ulu Jelai Hydroelectric Project is capable of generating an annual energy of 394 GWh, which can be translated to an equivalent carbon reduction of approximately 250,000 tons/year

d) To Develop Project with Least Environmental Impacts

Throughout the years, TNB has been continuously studying and updating the potential hydro project sites. To date, the latest Hydro Ranking Appraisal

conducted in year 2005 has elucidated some of the most viable projects in Peninsular Malaysia which are still untapped. Amongst all the potential sites surveyed (i.e. Hulu Terengganu, Ulu Jelai, Nenggiri, Telom High Dam, Lebir and Tekai), Ulu Jelai is ranked the highest index value with 372 MW/km^2 of reservoir area, which from an environmental perspective is the best option, at this point in time. It should be noted the rest of the potential sites remain options that will be developed as and when required.

A stable power system should consist of base load and peak load power plants. In Peninsular Malaysia, the base load power plants are consisting mainly of thermal power plants utilising, coals, distillate fuels, gas etc as their prime mover or fuels. Peaking power plants are still limited to OCGT and hydropower plants due to proven technology, reliability and economics.

However, with the limited supply of gas, coupled with increasing price, keeping cost and price of electricity at its most economic and global warming have left TNB with little option but to harness the remaining potential hydropower sites. This would benefit the country both economically and environmentally in the long run.

4.0 PROJECT DESCRIPTIONS

4.1 Project Location

The proposed Project area is located at Ulu Jelai in the district of Cameron Highlands, Pahang. Cameron Highlands lies in the highland area about 80 km east of west coast (Butterworth) and about 140 km north of Kuala Lumpur, the Malaysian capital. The project catchments area of 157.90 km^2 is located between latitudes of 4^o 22’ to 4^o 30’ N and longitudes of 101^o 24’ to 101^o 33’ E.

The Project site can be accessed by road from Tapah to Ringlet and Tanah Rata or through the East-West Link from Simpang Pulai to Brinchang and Tanah Rata. The Sg. Koyan – Ringlet Highway at the Raub District is in the process of being constructed. Phase I to III of the Betau-Bertam Valley Highway are nearly completed with some bridges yet to be completed for Phase III. Phase III is from Kg. Susu to Ringlet, which is going through a major construction phase. Phase III and IV of the highway will pass near the Project site, thereby causing cumulative impacts on both environmental and social issues.

4.2 Project Components

The main features of the Project comprise Susu Dam, an 85 m high Roller Compacted Concrete (RCC) dam on Sg. Bertam, two diversion weirs on Sg. Lemoi and Sg. Telom for the diversion of flows from adjacent catchments via 7.5 km and 8.4 km long transfer tunnels into Sg. Bertam, a 372 MW Underground Power Station and the required associated water conveyance and access road system. The hydroelectric development will generate peaking energy to the national grid.

Key components of the proposed project are as follows:-

i) Dam and Reservoir
   i) Susu Dam
   ii) Reservoir
   iii) Spillway
   iv) Power Intake
ii) Diversion Tunnels
iii) Power Station
iv) Switchyard
v) Access Roads and Bridges
vi) Quarry and Disposal Areas
vii) Transmission Lines

The operations of the proposed Project incorporate the management of sediment at the dam and transfer tunnels; management of low flow and management of outfall flow. The proposed Project is expected to be completed by the end of 2012.

5.0 PROJECT OPTIONS AND SITE SELECTION

5.1 Project Options

5.1.1 Selection of the Best Available Project Option

The available project options i.e. project that could meet the peaking power demand are open cycle gas turbine (OCGT) power plant and hydroelectric power plant.

Hydroelectric power plant is chosen as the best project option due to the following reasons and which has been described in details in the Statement of Need and summarised as follows:-

i) Ability to Meet Peak Power Demand
ii) Ability to Improve Power System Security
iii) Ability to Provide an Economic Fuel Option
iv) Ability to Reduce Carbon Emissions

5.1.2 No-Project Option

Without the Project, TNB's dependence on the fossil fuel, primarily gas and coal, for generating energy will continue. Since the cost of fossil fuel has been on the increase for the past ten (10) years and particularly in recent years, the cost of generating energy will also increase and ultimately the users need to pay more for every unit that they used.

In addition, this Project also provide peaking demand requirement for power supply. Without the peaking plant, supply of power to the country might be disrupted in particular during high demand of electricity.

5.1.3 Selection of Best Available Technology Options for Hydroelectric Power Plant

The available technological options for the dam structures include the following:-

a) Masonry dam – Arch or gravity types
b) Embankment dam – Rockfill or earthfill types

The gravity dam built using the RCC method was selected as the most suitable project option due to the following factors:-

a) ***Ease of Construction***

Construction techniques used for RCC placement often result in a much lower unit cost per cubic yard compared with conventional concrete placement methods. The dry, non-flowable nature of RCC makes the use of a wide range of equipment for construction and continuous placement possible. End and bottom dump trucks and/or conveyors can be used for transporting concrete from the mixer to the dam. Mechanical spreaders, such as caterpillars and graders, place the material in layers or lifts. Self-propelled, vibratory, steel-wheeled, or pneumatic rollers along with the dozers perform the compaction. The thickness of the placement layers, ranging from 8 to 24 inches, is established by the compaction capabilities. With the flexibility of using the above equipment and continuous placement, RCC dams can be constructed at significantly higher rates than those achievable with conventional mass concrete.

b) **Economic Benefits**

RCC construction techniques have made gravity dams an economically competitive alternative to embankment structures. The following factors tend to make RCC more economical than other dam types:-

i) ***Material Savings***

Construction cost histories of RCC and conventional concrete dams show the unit cost per cubic yard of RCC is considerably less. The unit cost of concrete for both types of dam varies with the volume of the material in the dam. As the volume increases, the unit cost decreases. The cost savings of RCC increase as the volume decreases. RCC dams have considerably less volume of construction material than embankments of the same height. As the height increases, the volume versus height for the embankment dam increases almost exponentially in comparison to the RCC dam. Thus, the higher the structure, the more likely the RCC dam will be less costly than the embankment alternative.

ii) ***Rapid Construction***

The rapid construction techniques and reduced concrete volume account for the major cost savings in RCC dams. Maximum placement rates of 5,800 to 12,400 cubic yards/day have been achieved. These production rates make dam construction in one construction season readily achievable. When compared with embankment dams, construction time is reduced by

1 to 2 years. Other benefits from rapid construction include reduced construction administration costs, earlier project benefits, and possible selection of sites with limited construction seasons. Basically, RCC construction offers economic advantages in all aspects of dam construction that are related to time.

iii) Spillway and Appurtenant Structures

The location and layout alternatives for spillways, outlet and hydropower works, and other appurtenant structures in RCC dams provide additional economic advantages compared with embankment dams. The arrangements of these structures is similar to conventional concrete dams, but with certain modifications to minimise costly interference to the continuous RCC placement operation. Gate structures and intakes should be located outside the dam mass. Galleries, adits and other internal openings should be minimised. Spillways for RCC dams can be directly incorporated into the structure. The layout allows discharging flows over the dam crest and down the downstream face. In contrast, the spillway for an embankment dam is normally constructed in an abutment at one end of the dam or in a nearby natural saddle. Generally, the embankment dam spillway is more costly. For projects that require a multiple-level intake for water quality control or for reservoir sedimentation, the intake structure can be readily anchored to the upstream face of the dam. For an embankment dam, the same type of intake tower is a freestanding tower in the reservoir or a structure built into or on the reservoir side of the abutment. The economic savings for an RCC dam intake is considerably cheaper, especially in high seismic areas. The shorter base dimension of an RCC dam compared with an embankment dam reduces the size and length of the conduit and penstock for outlet and hydropower works.

iv) Diversion and Cofferdam

RCC dams provide cost advantages in river diversion during construction and reduce damages and risks associated with coffer dam over-topping. The diversion conduit will be shorter compared with embankment dams. With a shorter construction period, the size of the diversion conduit and cofferdam height can be reduced. These structures may need to be designed only for a seasonal peak flow instead of annual peak flows. With the high erosion resistance of RCC, if overtopping of the cofferdam does occur, the potential for a major failure would be minimal and the resulting damage would be less.

v) Others

The smaller volume of an RCC dam makes the construction material source less of a driving factor in site selection of a dam. Furthermore, the borrow source will be considerably smaller and more environmentally-acceptable. The RCC dam is also inherently safer against internal erosion, overtopping, and seismic ground motions.

c) Safety

Compared to traditional concrete dams, RCC dams have thinner layers which lead to increased safety during construction by reducing the differences in levels between placement. Safety is also enhanced in RCC due to reduced dependency on formwork.

Compared to fill dams, RCC dams has lower flood risk due to shorter river diversions (both in terms of length and time) during construction and reduced cofferdam requirements. With the reduced risk in flooding, the size of diversion is relatively smaller. RCC dams also have shorter penstock and conduit and the construction of any intake tower is possible against the dam face rather than being free-standing. Thus, RCC dams are less sensitive to earthquake loading. In addition, RCC dams are also capable of passing flood during constructions by overtopping without damage.

5.2 Site Option

Recognising the need to develop peaking hydroelectric power, TNB, in 2004, commenced a study to rank potential hydroelectric project sites in Peninsular Malaysia. Six (6) sites were identified as potential sites for peaking plant development, as summarised in **Table ES-1**.

Table ES-1: Site Options for Peaking Hydroelectric Plant

Potential Sites	Capacity (MW)	Annual Energy Production (GWh)	Reservoir Area (km^2)	Capacity per Reservoir Area (MW/km^2)
Hulu Terengganu	212	406	61	3.5
Ulu Jelai	372	394	1	372.0
Nenggiri	416	733	104	4.0
Telom	132	262	76	1.7
Lebir	274	389	154	1.8
Tekai	156	274	82	1.9

Source: Hydro Ranking Appraisal Final Report prepared by SMEC (M) Sdn. Bhd. and SMEC International Pty. Ltd for Tenaga Nasional Berhad, February 2005.

The Ulu Jelai site was found to be the most economically- and environmentally-viable project and was selected for implementation. The Ulu Jelai site provides the highest power generation per area of reservoir amongst the potential sites. For a reservoir of about 1 km^2, the site could generate 372 MW of power. In terms of environmental perspective, the site at Ulu Jelai is the most suitable since the area affected by the dam reservoir is relatively small compared to the other sites.

6.0 EXISTING ENVIRONMENT

6.1 GEOLOGY AND GEOTECNICAL

According to geological settings, Cameron Highlands is located within the central part of the Main Range Granite that consists predominantly of intrusive igneous and roof pendants of Lower Paleozoic sedimentary rocks. The following rocks found in this region: slate, phyllite, schist and granite, together with associated varietal forms.

The proposed Project area is underlain by highly weathered igneous rock consisting of biotite granite. Based on the drill holes data in the area, the granite bedrock has undergone severe chemical weathering, producing a thick residual soil of various consistencies. The residual ferruginous material in the soil is frequently in the form of laterite. The soil is classified as Renggam Series. The overburden soil above bedrock comprises of materials ranging from Grades V and IV. The thickness of the residual soils (Grade V to IV) in this area may exceed 30 m. From the field mapping, fresh to slightly weathered granite (Grades I to II) bedrock crop out on the spread of some 100 m to the up- and downstream on both the right and the left riverbanks near the proposed dam site. The rock provides a good foundation for the construction of the dam.

The granites in the area have been subjected to regional stress. It is dominated by a number of sets of joint traces or lineaments and has no major faults except sheared or fractured zones in some places. With respect to local and regional tectonic activity, the dam site is located in a region with overall low seismicity.

The upper parts of Sg. Telom and the Sg. Bertam valleys have been developed for agriculture. These upland valleys comprise mainly colluvial/alluvial infill with little competent rock. The forestation in the valleys for agriculture development has led to instability in the valley slope, rapid erosion of the valley sides and frequent land slides and has resulted in increased silt loads in the rivers. Generally, the soil erosion loss before the construction period is considered at a moderate level as the Project area are mainly covered with forest, with 71.3% of the area having soil losses of 0-50 tonne/ha/yr. However, during construction stage, the dam site can be considered to fall under high risk of soil erosion. Another probable impact to the surrounding are based on activities such as construction of the dam, reservoir, water in-take and diversion tunnels and quarry operation for construction materials. Hence, proper erosion and sediment control measures need to be employed in the design and implemented during construction of the proposed project to minimise the negative impacts.

6.2 AIR QUALITY

The baseline air quality study was conducted at eight (8) monitoring stations for parameters of nitrogen dioxide (NO_2), sulphur dioxide (SO_2), hydrogen sulphide (H_2S), carbon monoxide (CO) and particulate matters less than 10 microns (PM_{10}). Comparisons made between the air monitoring results with the values in the Recommended Malaysian Ambient Air Quality Guidelines and relevant standards showed that the environmental air quality at all sampling locations especially the *Orang Asli* settlements are acceptable and can be considered as safe. The results indicate that the concentrations of PM_{10} and other gaseous parameters were too low to yield any known environmental health effects.

6.3 SURFACE WATER QUALITY

Water quality assessment of selected rivers in Cameron Highlands, near and around the Project site and in the vicinity of Kuala Medang, in the District of Raub, Pahang was carried out to determine the level of pollution of the rivers.

In general, the water quality of the rivers surveyed is affected by the land use of the watershed upstream. The weather conditions also affect water quality especially rainfall patterns. On the other hand, the Bertam Valley farming activities affected the turbidity and total suspended solids (TSS) as well as the nutrients of Sg. Bertam near Kg. Mensun even when it was not raining. Sg. Telom at the proposed Telom diversion could similarly be affected by the farming activities upstream (Kg. Raja, Sg. Ikan, Kg. Kuala Terla, Kea Farms and Tringkap), but the effects were dampened by the dilution factor from Sg. Wi, which watershed is an undeveloped forested area.

Organic pollutants and nutrients from human settlements due to semi-treated domestic waste and farming activities could be detected at the sampling sites closest to the settlements. Sg. Bertam at Kg. Mensun, Sg. Telom at Batu 49 and Sg. Mensun at Ulu Mensun all indicated relatively higher than normal nutrients levels (nitrogen and phosphorus) although BOD and COD levels are still acceptable. High nitrogen and phosphorus levels were probably due to the use and over-application of fertilisers in the watersheds upstream of the sampling stations. For Sg. Mensun at Ulu Mensun the inorganic salts were so high that in indicated a salinity level of 0.1 ppt and the highest level of electrical conductivity for among all the sampling sites.

Other parameters such as dissolved oxygen (DO) ranged from 5.7 to 8.55 mg/L (63.6 - 99.6 % saturation), which relatively high compared to lowlands rivers in developed and urban settings. Using the National Water Quality Standards for Malaysia, the sampling sites water quality could be classified as Class I (such as Sg. Lemoi at Lemoi diversion) while most of the other sites would be in Class II.

6.4 NOISE AND VIBRATION

6.4.1 Noise

Noise measurements were carried out in the *Orang Asli* villages within a kilometre radius around the proposed dam. The noise measurement was also conducted at a school compound, which is near to the road, which iscurrently the only established access to the proposed dam site. A total of eight (8) monitoring stations were selected with measurements session conducted twice at each location i.e. day-time (DT) measurement session (7 am to 10 pm) and night-time (NT) measurement session (10 pm to 7 am).

It has been found that the equivalent time-averaged noise levels measured at the stations vary from 52 dB(A) to 57 dB(A) during day-time and 47 dB(A) to 58 dB(A) during night-time. From the results of maximum time-averaged sound level, there was no transient or repetitive high impulse noise found in the measured residential areas. A 61 dB(A) night-time (NT) noise level recorded at Kg. Cheros is not a representative noise level compared to other measured locations. During the measurements the dogs was

barking endlessly. Also, many residents in that village took turn to turn on the radio very loudly.

The nature of noise in all villages was found to be continuous steady state. Slow-paced residential activities, children playing in the background, a few vehicles passing by were the contributors of noise during the day-time. On the other hand, night-time baseline noise levels were contributed by noise from generator sets, river and streams flowing nearby the village, and sound of insects.

With the exception of NT noise level at Kg. Cheros, it can be concluded that the baseline noise level during day-time (DT) and night-time (NT) at all measured locations are within the limit of in the schedule of Permissible Sound Level. The limits are 55 dB(A) for DT and 45 dB(A) for NT with permissible ±3 dB(A) (Annex A: Schedule 1 and Schedule 3 as in The Planning Guidelines for Environmental Noise Limits and Control of DOE).

6.4.2 Vibration

The baseline vibration study at was conducted at the same locations as the baseline noise study (i.e. at eight locations). In conclusion, the baseline vibration levels in the *Orang Asli* villages and at other locations measured near the proposed dam site is the type of steady state vibration, small and safe. The measured peak particles velocity vibration levels which range from 0.2 mm/s to 0.6 mm/s is much below the prescribed Caution Level peak particles velocity vibration level of 3 mm/s (Annex A Schedule 1 in Planning Guidelines of Noise Limits and control of DOE).

6.5 FLORA

The vegetation of the study area is very diverse with several vegetation types identified ranging from intact forests, to disturbed forest and agricultural areas. The forest types present include Upperhill Dipterocarp forest, Hill Dipterocarp forest, mixed regeneration forest and secondary forests. In total there were 420 tree species from 65 families found in the whole study area. The mean density of trees with diameters more than 15 cm is 187 trees/ha. There are also a large number of non-timber trees found in the study area consisting of 63 species from 22 families. The sampling indicated a high diversity of palms and orchids amounting to 22 and 9 species respectively. These two groups (non-timber and palms) represent the understorey and the ground cover vegetation and consist mainly of climbers, orchids and herbaceous plants.

The dam site area that will be submerged mainly consist of agricultural lands and secondary vegetation. The total biomass for the vegetated areas in the dam site was about 290 tons/ha. In terms of stocking, the intake at Sg. Telom is significantly richer than the intake at Sg. Lemoi with a density of about 182 trees/ha giving an overall volume 208 m^3/ha and biomass of 331 tons/ha. The density of trees for the Sg. Lemoi Intake is only 42 trees/ha giving an overall volume 116 m^3/ha and biomass of about 185 tons/ha.

A comparison with list of endemic and rare species based on IUCN report and other relevant studies by experts shows that the study area does not have any rare, threatened or endangered species of flora. The study area includes 43 endemic species mainly from the

lower plant group. Four are considered to have high level of endemicity but were not found in the areas that will be impounded or affected during the dam construction.

Therefore in conclusion, although impacts are expected most critically during the construction phase, the species composition in the heavier construction areas such as Kg. Susu, Kg. Leryar and Kg. Renglas are relatively low in species composition richness (diversity) and importance (rare, threatened and endangered) with low crown density (Forest Canopy Density Class 2 – 30-50%), thus is of less concern.

6.6 FAUNA

A total of 191 vertebrate species were recorded through trappings, sightings, vocalization and tracks within the survey period. These comprise 56 species of mammals, 38 species of amphibians and reptiles and 97 species of birds. Further records from previous literature conducted around Brinchang in Cameron Highlands increased the list of mammals to 97 species, 106 species of amphibians and reptiles while there were no additional bird species recorded. Relatively, this is not a typically high diversity figure for such diverse habitats (belukar, regenerating, regenerated and matured hill forests) that exists in the project area. Some of the areas particularly in the proposed dam sites are located near *Orang Asli* settlements, which were highly degraded thus reduces the habitat quality.

Although a large number of the species recorded within the study areas are protected or totally protected, these are not seen as critical factor for the development plan. These protected species consisted mainly from the avian fauna and large mammals that have a large home range and a wide geographical region within the peninsular. Their populations are quite common in other areas including those areas set aside for conservation in the country. None of the species identified so far is either threatened or endangered, however due to their legal protected status, these species or parts of an individual cannot be caught, kept and/or traded.

Though initially the development projects will certainly have some impacts on the fauna populations, with proper mitigation and management the impacts can be reduced within the sustainable level. The proposed development within the pristine habitat is considerably very small in relation to the forests in the area. Thus, threat of habitat destruction is expected to be localised and minimal.

6.7 STREAM ECOLOGY

The proposed project area is drained by three major river systems that are Sg. Bertam, Sg. Telom and Sg. Lemoi. Sg. Bertam is joined by Sg. Telom and Sg. Lemoi about a few kilometers downstream of the proposed dam site. The river is known as Sg. Telom as it reaches Kg. Tiat. Further downstream where it is joined by Sg. Jelai Kechil and Sg. Serau the river near Kg. Kuala Medang is known as Sg. Jelai. The stream ecology survey was conducted at Sg. Relong, Sg. Mensun, Sg. Bertam (near Pos Mensun), Sg. Teji, Sg. Bertam (near Kg. Teji), Sg. Telom (near Kg. Terakit), Sg. Telom (near Kg. Tiat) and Sg. Lemoi.

a) Fishes

The fish survey yielded a total of 16 species belonging to 4 famlies with Cyprinidae being the dominant family. The total number of fish specimens caught were 105 individuals. Other families collected were Channiidae, Clariidae and Bagridae. The most common and abundant species occurring in the study area were *Accroscheilus hexagonolepis* (Tengas), *Accroscheilus deauratus* (Daun) and *Puntius binotatus* (Tebal Sisek). Stations which showed high number of species were at Sg. Lemoi and Sg. Telom (near Kg. Tiat) with a total of 9 and 6 species, respectively.

Fishes caught in the study area are more likely to represent a community belonging to middle reaches of a big river system. Most of the fish species recorded here are common to science. There are also no 'rare' and 'endangered' species found. The 'endangered' species *Probarbus jullieni* (Temoleh) and *Scleropages formosus* (Kelesa) which are native to the Pahang River were not found, and not even reported by local resident. However, the highly prized Golden Mahseer or *Tor Tambraides* were caught at stations Sg. Lemoi and Sg. Telom (near Kg. Terakit).

b) Plankton

The survey conducted at both zones yielded a total of 5 divisions and 81 taxa of plankton. The Bacillariophytes (filamentous brown-algae) formed at least 40% of the total species found followed by the Chlorophytes (green-algae). *Tabellaria*, *Navicula* and *Diatoma* of the Bacillariophytes were among the most dominant species occurred. Sampling site at Sg. Bertam and Sg. Telom near Kg. Terakit were represented by 43 taxa which is higher when compared to the other sites. The lowest number of algal taxa recorded were at Sg. Relung. Generally, the study area shows high diversity of phytoplankton.

c) Macroinvertebrate

From the sampling conducted, 27 species of macroinvertebrates from 21 families, 15 orders and 7 classes were identified. The highest number of species was recorded at Sg. Lemoi followed by Sg. Teji while the lowest total number of species was at Sg. Telom and Sg. Mensun. In general, high number of species was recorded at streams that are considered to have good water quality (Sg. Lemoi and Sg. Teji). The other stations showed high number of individuals but represented by low number of species. These types of occurrences are commonly associated in community of disturbed habitat. All of the species (except Naididae) sampled from the sampling sites are species commonly inhabiting clean water streams. Species commonly used as biological indicator are Leptophlebiidae, Baetidae, Chironomidae and Hydropsychidae.

6.8 SURFACE WATER HYDROLOGY

Average rainfalls for 19 stations surrounding the project site vary between 1901 mm/yr and 2745 mm/yr. The monthly rainfall pattern shows two peaks, in April/May and from September to November. The highest rainfall usually occurs between October and December. Based on long term rainfall records of 38 to 60 years, monthly rainfalls at most stations show slight increase over time. Increasing trends were also detected for the

minimum monthly temperature. In contrast, no discernible pattern was observed for the long term evaporation rate.

The proposed Susu Reservoir system constitutes of Sg. Bertam, Sg. Lemoi and Sg. Telom catchments with a total area of 378 km^2. The upstream sections of the Telom and Bertam catchments are more disturbed compared to the downstream area. The land use includes townships, resorts, farmland, villages and secondary forest. A large portion of Lemoi cachment is still forested.

The catchment system and the hydrological regime of the Sg. Bertam and Sg. Telom are already affected by the operation of the existing Cameron Highlands hydropower scheme. Streamflow from the upper section of Sg. Telom catchment is diverted to Robinson Falls Power Station in the Bertam catchment via Telom/Kial/Kodol intake tunnel. The upper reaches of Sg. Bertam are impounded by the existing Sultan Abu Bakar Dam. Therefore the proposed Susu Dam has unregulated catchment area of 158 km^2. Inflow to the Susu reservoir will be augmented by intakes from Sg. Telom (122 km^2) in the north and Sg. Lemoi (82.8 km^2) in the south through tunnels.

Suspended sediment concentration during lowflow was highest in the most disturbed catchment of Sg. Bertam with a mean of 40.5 mg/l compared to the less disturbed catchment of Sg. Telom (6.3 mg/l) and the forested catchment of Sg. Lemoi (4.3 mg/l). The sediment concentration is expected to be much higher during storms. The bedload sediment was also highest at Sg. Bertam confluent (65.8 kg/min), followed by Sg. Lemoi intake and relatively small at Kg. Susu and Sg. Telom intakes.

Lowflow was estimated using both gauged and ungauged catchment methods. For the gauged catchments, the lowflows for various return periods were first determined by frequency analysis from the annual minimum series following the GEV Type I and Type III distributions. The estimated $Q_{7,10}$ was strongly related with the basin areas ($Q_{7,10}$ = $0.0571*AREA^{0.7087}$, R^2 = 0.95). This equation was then used to estimate $Q_{7,10}$ at the ungauged sites. The resulted estimates of $Q_{7,10}$ at the dam site, Telom and Lemoi intakes are 2.06 m^3/s, 1.72 m^3/s and 1.31 m^3/s, respectively.

6.9 SOCIO-ECONOMY

In total, 13 *Orang Asli* villages located along Sg. Bertam, Sg. Telom and Sg. Lemoi were surveyed and out of this, 11 villages were inhabited by the sub-ethnic Semai group. There were altogether 212 *Orang Asli* households in the 13 villages, of which the number of household surveyed was 114. Out of this, 50% was under the age of 15 in 2007 and about 1% was above the age of 64. The overall age compositions showed that the *Orang Asli* population was relatively younger than the average Malaysian population. In terms of household size, the average household size of the 13 villages was 7. This average household size was higher than that of 4.7 persons in Malaysian households in 2000. It is estimated the total population of the area studied is 1,419 people. With regards to religious beliefs, 51% are animists, 48% Muslims and 1% Christians.

With respect to formal education, the study showed that the *Orang Asli* is relatively less educated, where between 16% – 98% percent of population aged six and above in the 13 *Orang Asli* villages have no schooling. The reasons for differences among the villages are

related to the accessibility to primary schools. Furthermore, the data also show that many of the *Orang Asli* students drop out after primary education. Hence, the proportion of *Orang Asli* villagers attaining primary education was between 2% -61%. This trend is similar to secondary educational attainment among the *Orang Asli*.

Basically, most of the *Orang Asli* in the study area practise subsistence economy, comprising hill padi cultivation, fishing, hunting/trapping and NTFP (Non-Timber Forest Products) gathering. In the 13 villages, the households cultivate land for three purposes, i.e. for hill padi, orchard and rubber. Of the total 114 households in the 13 villages, 74% cultivated hill padi and 91% had fruit orchards. The sizes of hill padi farms operated by the *Orang Asli* were generally small. The average size of hill padi land operated per household was 1.5 hectares and the average size of an orchard farm operated per household was 1.3 hectares. Hill padi cultivation which provides the basic staple food for the *Orang Asli* communities is the main form of economic activity. Fishing and hunting were carried out during their free time.

The practise of subsistence economy among the *Orang Asli* has led to different perceptions on their current living condition. The respondents were asked whether they were satisfied with the current living condition. Only 36% felt comfortable which explained that availability of forest and river resources is getting less thus increasing more difficult to sustain their livelihood

The study shows that there were 77 migrants from the 114 households in the 13 villages. Three reasons can be given here. Of these, 58% were working, 32% studying and 10% were married to outsiders. A majority of them have migrated out to look for employment. However, their stay was often short as they found it difficult to adjust to the job conditions and discipline in the working place.

The result of survey showed that the average monthly household income of the *Orang Asli* was less than RM 400. Only 4% said that their income increases yearly This is because they worked in the government or plantation sector and have fixed salary whereas the other 94% said that their income were the same as the year before or fluctuates yearly. The remaining 2% said that their income decreases yearly.

In the past, some *Orang Asli* used the forest extensively for collecting rattan and agarwood (*gaharu*), and hunting animals. However, these activities have decreased in the last decades as a result of depletion in forest products. The dam project may affect these activities further if there is no control and proper planning.

6.9.1 Acceptance to the Proposed Project

Almost all head of households in the study area have heard about the proposed dam project either from the Batin or their neighbours. About 86% of them accepted the project, and all the residents of Kg. Susu were willing to be resettled elsewhere. They accepted the project in anticipation of getting employment from the dam construction. In addition, they felt that the project would bring in more development into the area including social amenities and infrastructures.

The 114 households were also asked on their acceptance of both local and foreign

workers working in the area. In general, the local communities have no problems interacting with Malaysian workers but about half the respondant (49%) are not prepared to accept the presence of foreign workers such as the Indonesians and Bangladeshis as they have preconceived ideas that these foreign workers will disturb their families especially the females.

After an extensive study of the *Orang Asli within* the study area, it is concluded that the majority of them are receptive to the project especially with the possible compensation for loss of fruit trees, land and other properties. Due to the unmarked territorial land ownerships between the villages, it would be advisable the villages identified to be relocated due to inundation of the reservoir (Kg. Susu) and out-fall vacinity (Kg. Pinang and Kg. Tiat) to new villages within their territorial boundaries. Therefore, single village-single relocation community instead of a combined relocation community for all the affected villages should be implemented. The plan would allow the *Orang Asli* to remain close to their lands and at the same time prevent possible disputes in the future.

6.9.2 PUBLIC HEALTH STUDY

A public health study was conducted in the 13 villages in vicinity to the proposed project in the Cameron Highlands district. This study aimed to update the existing health conditions of the local population, to identify the mosquito population and their distributions and to determine the prevalence of water, vector-borne and zoonotic diseases in the area and finally to assess the possible impact of the proposed project to the public health. Several methodologies were carried out to address these objectives.

This study is divided into 3 sections; community health, parasitological (inclusive of rodent trapping) and entomological sections. The baseline information shows that the health problem of this community is related to sanitation and water resources. A total of 93.0% of the residents' water supply came from the Gravity Feed System (GFS) and 12.3% were from the rivers. The health conditions of the communities showed a lower prevalence of the communicable and chronic diseases as compared to the previous surveys. The parasitological survey showed that the intestinal parasitic infection is still an important public health problem in the local population especially *Giardia duodenalis* and *Ascaris lumbricoides* whereas in the 2004 survey, *Blastocystis hominis* and *Trichuris trichiura* were the dominant infections.

7.0 IMPACTS AND MITIGATION MEASURES

The potential environmental impacts that may arise from the development of the proposed project, including the proposed mitigation measures and residual impacts, are summarised in **Table ES-2**.

8.0 COST BENEFIT ANALYSIS (CBA)

With the increase in the fuel (oil) prices the role of hydropower has become increasingly appealing. The proposed Project ensures that the cost of generating electrical power is kept as low as possible, subsequently keeping electricity tariff at a reasonable level thus

ensuring that our local industries remain competitive. The proposed Project is expected to be able to achieve this objective by its ability to meet peak power demand, improving power system security, providing economic fuel option and reducing carbon emission. The proposed Project will also give rise to adverse environmental impacts that cannot be completely mitigated thus justifying the need to quantify the degradation in services obtainable from the displaced forest. The main goal of the economic analysis is to determine as to whether the project will bring a net overall gain or loss to society from the socio-environmental standpoint. This study adopts the impact pathway approach (IPA) where the physical environmental impacts are linked to an economic valuation process.

Several environmental impacts have been identified to be significant enough to be considered for valuation. The direct impact concerns with the loss in timber and non timber resources. The indirect impact concerns with the possible loss of carbon storage and sequestration of carbon. In the case of the non-use value loss we have identified possible loss in biodiversity and in existence value. The identified impacts were subsequently quantified (timber and carbon sequestration, tourism), the two non-use impacts were estimated using benefit transfer approach. The rest are considered insignificant.

In the most optimistic and environmentally conservative scenario, after discounting at the rate of 10% the proposed project is estimated to bring about a net gain amounting to 206 millions ringgit over a 50-year period. The corresponding value is equal to 478 million ringgit if a 4% rate of discount is used. In this case, the lowest value obtained is 120 millions ringgit if a 16% discount rate is used. Nevertheless, in the most pessimistic scenario, at a 10% discount rate, the proposed project is estimated to bring about a net economic gain amounting to 13 millions ringgit.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 Physical Environment

9.1.1 Geology and Geotechnical

Geologically, Cameron Highlands located within the central part of the Main Range Granite that consists predominantly of intrusive igneous and roof pendants of Lower Paleozoic sedimentary rocks. However, the proposed Project area is underlain by highly weathered igneous rock consists of biotite granite. The area is rugged (500 to 1300 m high), in its natural condition, mainly jungle covered. Based on boreholes data in the area, the granite bedrock has undergone severe chemical weathering, producing a thick residual soil of various consistencies. The soil is classified as Renggam Series. The thickness of the residual soils (Grade V to IV) in this area is varied and may exceed 30 m.

The available information obtained from the geological mapping and exploration programme indicated that the proposed project area appeared suitable for the proposed hydroelectric plant construction, however borehole data also indicates the presence of a number of weakness zones within the rock mass at depth. Among the critical ones include *shear zone* observed at multiple depths, from 35 m to 80 m depth (UJ2/21D) at the proposed site for Susu Dam, and thick *fractured zone* (9 m) at depth from 16 m to 25

m (UJ6/20D) at the proposed quarry site. Meanwhile, with respect to local and regional tectonic activity, the damsite is located in a region with overall low seismicity.

The deforestation in the upper parts of the Telom and the Bertam river valleys for agriculture development has led to instability in the valley slope, rapid erosion of the valley sides and frequent land slides and has resulted in increased silt loads in the rivers. Generally, the soil erosion loss before the construction period is considered at a moderate level as the project area are mainly covered with forest, with 71.3% of the area having soil losses of 0-50 tonne/ha/yr. However, during construction stage, the damsite area can be considered to fall under the high risks soil erosion.

Any development that involves clearing of the jungle and the excavation of earth material may produce the following effects:-

- Denudation of soils and rocks due to weathering and erosion.
- Mass wasting, slope failures, rocks falls and debris flow.
- Increased sedimentary load in the river.

Hence, proper erosion and sediment control measures need to be employed in the design and implemented during construction of the proposed project to minimise the negative impacts. The original slope and stream must be conserved, maintained and improved.

During the impounding stage and also operation stage, the progressive raise of the reservoir level (or by the reservoir level fluctuations) will primarily have an impact on slope stability and erosion of the shoreline. Appropriate monitoring and protecting measures must be undertaken, as part of the *reservoir management plan*, to control the impounding rate in such a way that the reservoir water level is not raised faster than the saturation rate of the sensitive substrata material along the reservoir slopes. This will help to reduce erosion and landslide along the reservoir banks. In order to monitor Reservoir Induced Seismicity (RIS), installation of a seismological network in the reservoir, at the dam site and downstream for monitoring the seismic activity is suggested during construction and operational phases.

9.1.2 Surface Water Hydrology

Activities during preconstruction stage are not likely to pose any significant impact on the hydrological attributes in particular the streamflow regime and lowflow.

During normal flow condition the accumulated daily volume is estimated at 1.27 million m^3 which can only be used to operate the two turbines at full capacity for 2.7 hours. During dry periods the daily inflow can only operate the two turbines for not more than one hr. This situation is expected to occur on an average once in seven years. For $Q_{7,5}$ and $Q_{7,2.33}$, the daily flows would be able the run the two turbines for only 1 and 1.2 hrs, respectively.

The expected monthly inflow to the Susu Dam ranges from 16 to 114 million m^3 with an average of 39.23 million m^3 and a median of 38 million m^3. About 74% of the monthly inflow is less than the required volume of 46.2 million m^3 to run two turbines for three hours.

It will take about 33 days to fill up the Susu Reservoir. During this time the streamflow between Kg. Susu and Kuala Bertam will be very much reduced. The estimated $Q_{7,10}$ at Kampung Susu, prior to dam construction is 2.06 m^3/s. The $Q_{7,10}$ at Pos Telanok will be reduced from 2.22 m^3/s to 0.16 m^3/s or only 7% of the original values. After the confluent of Sg. Telom and Sg. Lemoi, the $Q_{7,10}$ will increase again to 1.43 m^3/s or about 41% recovery. Further downstream, the lowflow shows a more rapid recovery as the main river receives more flow from its tributaries.

Insufficient flow during dry days can be offset by the reservoir storage. Under normal flow conditions and without rainfall, the maximum reservoir storage can last for 18 days to run the two turbines at full capacity.

$Q_{7,10}$ is usually used as a basis for sustaining lowflow requirement especially water quality maintenance. However, in this project the major concern is on the conservation of aquatic fauna. This provision can be achieved by maintaining the water depth at about 30 cm. It is suggested that a series of check dams or in-stream barriers to be constructed between the Susu Dam and Kuala Bertam.

A major hydrological issue that would arise from the present project is reduction in lowflow. During the operational stage, the low flow along the river stretch between the proposed Susu Dam and Kuala Bertam is expected to reduce by about 93%. Similarly, significant reductions in low flow are expected at downstream of Telom and Lemoi intakes. Maintenance of low flow is required to protect the aquatic habitat especially between the proposed dam site and Kuala Bertam. This can be achieved by constructing in stream barriers or check dams to regulate the water level.

Impact of outfall from the power tunnel which would cause sudden increase in discharge can be ameliorated by regulating the flow through detention ponds. A warning system is also suggested to alert villagers prior to operating the turbines.

9.1.3 Surface Water Quality

A large project such as the Ulu Jelai Dam project would inevitably cause both positive and negative impacts on the environment. This DEIA study is to assess the probable impacts on the social and physical environments. The study also would decide the necessary mitigating measures needed to minimise the impacts on the environment and the affected communities.

Judging from the present data collected for the DEIA study, the Project is viable and can be carried out as long as several major impacts or issues are handled with considerations and care. These major issues are:-

a) Environmental Factors

According to the Interim National Water Quality Standards (INWQS), the water quality of the rivers within the study areas indicated mostly Class I and Class II streams and rivers with the exception of a few sampling sites on Sg. Bertam and Sg. Telom which are considered Class III, singularly due to the elevated total suspended solids (TSS). The source of the problem is the agriculture land use of the upstream area of Sg. Bertam (Bertam Valley vegetables and flower farms) and

Sg. Telom (Tringkap, Sg. Ikan, Kg. Raja, Kuala Terla and Bt. 49 agricultural areas). Very recently some new vegetable farms were opened within Sg. Telom watershed after Kg. Terisu until the Sg. Wi confluence. The TSS and the related sediment issue would create problems in the operation of the dam and reservoir due to the sedimentation, which would shorten the reservoir life span. The scenario is similar to the present problem facing the Sultan Abu Bakar Dam near Habu, Cameron Highlands.

The high sediment content in the water to generate power also would be detrimental to the turbines due to the highly abrasive nature of the sediment particles. Maintenance and replacement costs would quadruple and has to be considered in the operational cost. Environmental-wise, the scheduled flushing of the sediments downstream will also affect the water quality downstream as well as the sedimentation of fish habitats.

The water quality expectedly affected the stream ecology whereby most of Sg. Bertam and Sg. Telom near the agricultural areas have little species diversity. Conversely, Sg. Lemoi, a Class I river which is spared from extensive agricultural activities upstream has a relatively richer species diversity. The presence of the new but still incomplete highway from Sg. Koyan-Pos Betau-Bertam Valley also brings in new threats in the form of fishermen from the other side i.e. Sg. Koyan, Kuala Lipis and Raub, who used all means to obtain fishes from the relatively less affected Sg. Lemoi. All the rivers in the study areas already suffered from over-fishing and even the occasional usage of poison for fishing purposes.

Both Sg. Telom and Sg. Lemoi were considered for the possible additional water source for the reservoir through the construction of diversions. The Sg. Lemoi watershed is proposed to be managed as Pahang state park although the Orang Asli is allowed to continue with their way of life. No commercial agricultural activities similar to the neighbouring Bertam Valley would be allowed in Sg. Lemoi watershed. The fisheries in Sg. Lemoi should be revitalized with restocking of important native species such as the *kelah* (*Tor tambroides)*, sebarau, tengas and other native species. Sport fishing and ecotourism should be the income generators for the area in the future.

9.1.4 Air Quality

During the pre-construction and construction stages, the potential air quality impacts are due to the generation of dust from earthworks and vehicular movements on unpaved surfaces as well as exhaust fumes from heavy vehicles and machineries. However, these impacts are insignificant and temporary in nature. The use of water sprays and water jets are necessary to suppress the dust suspension especially during the dry seasons. To prevent excessive generation of dark smoke in exhaust fumes, the heavy vehicles and machineries shall be subjected to regular maintenance and servicing. The generation of methane and hydrogen sulphide at the reservoir are not expected to occur as the vegetation at the area to be inundated will be removed as completely as possible.

During the operational stage, there will be no significant impacts on air quality.

The air quality impacts during the decommissioning stage are due to the generation of dust from dismantling / demolition works and transportation of debris out of the Project site. There will also be some degradation of air quality due to generation of exhaust fumes from heavy vehicles and machineries involved in the demolition works. However, these are also insignificant and temporary in nature.

9.1.5 Noise and Vibration

Noise is a major issue during construction phase. Activities such as land clearing, operation of quarry, construction of tunnels and power plant will generate noise that will be a nuisance to the nearby residents. During the operational phase of the dam, noise is not an issue. At this phase noise to the residential areas will come only from traffic on access roads. Noise pollution and its effect during pre-construction, construction and operational phase of the dam have to be minimised from being permeated to the residents living nearby. Therefore, it is proposed that noise mitigation measures are as follows:-

- All vehicles, machinery and equipment used for the construction works must be serviced regularly to reduce noise they may generate.
- Streamline and schedule operation of vehicles, machinery and noisy equipment so that the residents will be exposed to noise only on the certain hours during day time.
- No operation of heavy machinery and noisy equipment allowed near residential areas after sunset.
- Erect noise barriers if equivalent continuous sound level to the residents from 7.00 am to 7.00 pm is over maximum permissible sound levels which are L_{max} of 90 dB(A) and L_{90} of 60 dB(A) (Table 7-24 and Schedule 6 of The Planning Guidelines for Environmental Noise Limits and Control DOE, 2004).

9.2 Biological Environment

9.2.1 Habitat and Fauna

Despite having diverse habitats (*belukar*, regenerating, regenerated and matured hill forests) that exists in the project area, the fauna assessments did not result high diversity of what would be typically expected. Some of the areas particularly in the proposed dam sites are located near *Orang Asli* settlements, which were highly degraded thus may have reduced the habitat quality.

Although a large number of the species, recorded within the study areas are protected or totally protected, these are not seen as a critical factor for the development plan. These protected species consisted mainly from the avian fauna and large mammals that have a large home range and a wide geographical region within the peninsular. Their populations are quite common in other areas including those areas set aside for conservation in the country. None of the species identified so far is either threatened or endangered, however due to their legal protected status, these species or parts of an individual cannot be caught, kept and/or traded. Therefore, more significant potential

impacts of concern would be the control of limited access into forested areas using roads built in the pre-construction and maintained during the operational phase.

Though initially the development projects will certainly have some impacts on the fauna populations, with proper mitigation and management the impacts can be reduced within the sustainable level. The proposed development within the pristine habitat is considerably very small in relation to the forests in the area. Thus, threat of habitat destruction is expected to be localised and minimal.

9.2.2 Flora

The vegetation of the study area is very diverse with several vegetation types identified ranging from intact forests, to disturbed forest and agricultural areas. The forest types present include Upperhill Dipterocarp forest, Hill Dipterocarp forest, mixed regeneration forest and secondary forests. In total there were 420 tree species from 65 families found in the whole study area. There is also a large number of non-timber trees found in the study area consisting of 63 species from 22 families. The sampling indicated a high diversity of palms amounting 22 species. There is also a large diversity of orchids in the study area with 9 species identified. The mean density of trees with diameters more than 15cm is 187 trees/ha. A comparison with list of endemic and rare species based on IUCN report and other relevant studies by experts shows that the study area does not have any rare, threatened or endangered species of flora. In terms of endemic species, the study area has 43 species under this category. It should be noted that 4 species mainly from the lower plant group were considered to have high level of endemicity. However, all the 4 species were not found in the areas that will impounded or disturbed during the dam construction.

The greatest impact on the vegetation is expected during the construction Phase. The dam site area that will be submerged mainly consist of agricultural lands and secondary vegetation. The total biomass for the vegetated areas in the dam site was about 290 tons/ha .In terms of stocking, the Telom intake is significantly richer than the Lemoi intake with a density of about 182 trees/ha giving an overall volume 208 m^3/ha and biomass of 331 tons/ha. The density if trees for the Lemoi intake only 42 trees/ha with a total biomass of about 185 tons/ha. The other areas with which will also be impacted but need not necessarily be permanent loss are the temporary roads, areas adjacent to the permanent developments and the power station. The potential impacts have been elaborated and mitigation measures have been suggested.. With proper implementation of the mitigation measures, the project is expected to have minimum detrimental impacts that is tolerable

It is proposed that the area be rehabilitated to enhance the recovery of the disturbed site during the construction phase. If undertaken properly, in addition to increasing the vegetation cover and reducing environmental impacts, the aesthetic value of the site can also be enhanced.

9.2.3 Stream Ecology

The scope of work for the stream ecology study includes the description of the existing ecological environment of the streams. Ecological environment of the stream covers major physical and biological environments.

The main existing biological environments of the streams are fishes, macro invertebrates, plankton and algae and aquatic plants. Literature review was conducted to collect biological information of the subject and study area. More information was gathered through field surveys to achieve a better understanding of biological system of the study area. This ecological survey covers the following elements.

i. Fish survey
ii. Plankton sampling (zooplankton and phytoplankton)
iii. Macro invertebrates sampling
iv. Periphyton sampling.

A total of 8 sampling stations were established in this study. These stations were located at Sg. Mensun, Sg. Bertam, Sg. Relong, Sg. Teji, Sg. Bertam near Kg. Tiat, Sg. Telom near Kg. Terakit, Sg. Lemoi and Sg. Telom near Kg. Tiat.

Generally, the study has shown that Sg. Lemoi is rich with species diversity when compared to the other rivers in the study area. However, there is a marked decrease of fish species when compared to a similar study conducted in the same area in 2003. This decrease in total diversity can be attributed to the major changes in landscape that is currently taking place in the study area. At many parts of the study area, large tracts of the jungle are being cleared to build a new highway connecting Kuala Lipis to Cameron Highlands. Therefore, it is possible that this land clearing and construction activities have affected much of the riverine habitats causing a decrease in fish population and diversity.

Most of the impacts from the proposed project are long term in nature. Among the most significant impacts is the loss of water at Sg. Bertam immediately after the Susu Dam, and also the diversion of Sg. Telom and Sg. Lemoi into the Susu Dam. It is anticipated that the aquatic habitat at the above mentioned rivers will be severely affected resulting in the loss of aquatic life. However, mitigation measures such as the construction of check dams at Sg. Lemoi and Sg. Telom can help to retain water flow and volume enough to propagate life in the river. The project proponent will also compensate for the expected loss of fish population at the rivers (Sg. Bertam, Sg. Lemoi and Sg. Telom) by restocking the river with fingerlings. The fingerlings may comprised of species common in the rivers such as Tengas, Daun Sebarau and Kelah.

It is also expected that impacts will arise further downstream of the dam. In this regard, the project proponent will work closely with the Department of Fisheries to monitor the impacts on fisheries in the area of Kuala Medang and Kuala Lipis.

9.3 Human Environment

9.3.1 Socio-Economic

After an extensive study of the *Orang Asli* within the study area, it is concluded that the majority of them are receptive to the project especially with the possible generous compensation for loss of fruit trees, land and other properties. Due to the unmarked territorial land ownerships between the villages, it would be advisable the villages identified to be relocated due to inundation of the reservoir (Kg. Susu) and out-fall vacinity (Kg. Pinang and Kg. Tiat) to new villages within their territorial boundaries. Therefore, single village-single relocation community instead of a combined relocation community for all the affected villages should be implemented. The plan would allow the *Orang Asli* to remain close to their lands and at the same time prevent possible disputes in the future.

In the near future, the major developments that could affect the *Orang Asli* would not be limited by the dam project but also by the new Pos Betau to Bertam Valley highway. The highway would allow for the rapid movement of people between Cameron Highlands to the Lipis District (Sg. Koyan, Raub, Kuala Lipis) and the destinations in between. There are many positive impacts of a highway project, i.e. better medical services and better transportation of produces from the *Orang Asli* areas. The negative impacts would include water pollution as the highway cuts through multiple river valleys and illegal land clearing/logging in the vicinity of a highway due to the better accessibility.

9.3.2 Cost Benefit Analysis

Substitution of the existing natural environment with an artificially created hydropower related environment has not resulted in an overly adverse net economic impact. Some of the environmental conditions in the displaced environment were highly degraded thus may have reduced the value of the environmental losses.

Although the existing environment capacity to generate goods and services will be lost to the hydropower structures, these must not be taken as a critical factor to vote against the proposed Project. The lost in the identified environmental product is well compensated by the identified environmental benefit to be garnered from a reduction in the carbon emission compared to the do-nothing condition.

Though initially the proposed Project will result in a decline in the economic value of the environmental product, with a fully operational hydropower facility, the decline will be compensated by the project ability to offer carbon credit for sale. Furthermore, the negative economic impact on the environment will be reduced with proper mitigation and management of impacts within a reasonable limit. Thus, the possible cost of the proposed hydropower infrastructure development on the environment is expected to be fully compensated by the corresponding economic benefit to the environment.

9.3.3 Public Health

The potential impacts of this hydroelectric project to the health of the local communities are mainly on water and vector-borne diseases especially to *G. duodenalis* dengue and dengue haemorrhagic fever and malaria The risks to schistosomiasis, zoonotic diseases and tuberculosis were predicted to be low. However, introduction of a new infected case to this area through population migration during construction and operational phases would facilitate disease transmission and could trigger a disease outbreak. These impacts could be minimised through proper mitigation as outlined above and summarised in **Table ES-3**. There should be good cooperation and coordination between the project proponent and the local health authorities to minimise any potential health impact from the proposed Project.

9.4 Dam Break Modelling and Quantitative Risk Assessment (QRA)

9.4.1 Dam Break Modelling

Dam provides many benefits to the society such as providing renewable energy and flood protection, but it can also cause extensive damage to downstream area if the dam fails. Dam failure may not only cause extensive damage to properties but also it can cause loss of human life due to short amount of warning time available. The consequences of dam failure to the downstream area vary depending on the type of dam and cause of failure. The objective of the study is to determine the spatial and temporal variation of flood depth, flood inundation limit and flood peak at various important locations downstream of the dam. The study area covers the river length of about 123 km between the dam site and the downstream area. This area covers about 7 *Orang Asli* villages which are located along Sg. Bertam between 2 km and 8.6 km from the proposed dam site, and many more villages as the river flows further downstream until Kuala Lipis town.

Sunny day (piping failure) and wet day dam failure (overtopping) are typical modes of dam failure for earthfill dam. These types of failures will yield different results, and therefore requires different ERP. Even though sunny day failure will not produce bigger flood inundation map, but the warning time available (prior to breach formation) is shorter. The wet day failure is normally more catastrophic, but the warning time is longer. However, the proposed dam is a Roller Compacted Concrete Dam (RCC). RCC is much safer compared to earth fill dam. Overtopping and piping failures is unknown for RCC dam. The type of failure for RCC dam is slipping or joint failure. This type of failure provides little warning time. However, cracks at structural joints and slips of the foundation can be detected early by scheduled maintenance. This will provide enough warning time for authorities to take necessary remedial actions or in the worst case to evacuate the public that are living in the downstream area of the dam. Nevertheless, in the event of dam failure the time available for evacuation will be very short which ranges from 15 to 30 minutes for the 7 *Orang Asli* villages discussed earlier.

The first scenario of dam failure is considered the worst case scenario where the dam fails due to slipping. The assumed water level during failure is 545 m where the water level starts overflowing the crest. It is assumed that slipping failure has similar breach formation as failure due to overtopping except that the breach formation and completion is faster. It is assumed that it takes about 20 minutes from the time that initiates the breach

process until the dam to completely fail. It is assumed that the breach begins at the bottom and proceeds upward. The breach bottom width is about 50 meter with side slope of 1.00. The peak outflow hydrograph through the dam is about 29,859 m^3 and time to peak of about 15 minutes. As the flood flow proceeds to the downstream area, it will inundate the *Orang Asli* villages that are located on both side of river bank except for Kg. Loon and Kg. Terakit. Kg. Loon is is situated on higher ground, while Kg. Terakit is located far from river bank. The rest of the villages will be under water between 5 to 8 m and between 20 to 30 minutes. As for other villages located along Sg. Telum/Sg. Jelai downstream of Kg. Pinang, and at Kuala Lipis town, the results shows that these villages are not affected as they are located further downstream and most of the flood flow have spread in the flood plain. The analyses shows that at Kuala Lipis town, the water level rises to about 5 m and this is still below the bund level which is about 10 m high.

9.4.2 Quantitative Risk Assessment (QRA)

The use of RCC for the dam has gained many interests in the worldwide due to several safety features such as higher strength than the normal concrete. Dunstan (2003) reported that at the end of 1996 there were 157 completed RCC dams in 20 countries. By the end of 2002, that figure had risen to 251 completed dams (and further 34 were under construction) in 35 countries. Thus in the six years between 1997 and 2003, 94 RCC dams had been completed and a further 15 countries had built RCC dam.

The QRA on the proposed Ulu Jelai RCC dam has been carried out based on the worst case scenario of a normal concrete dam. This is due to incidents related to RCC are not found in the literature, despite the increase of the number of RCC dams in the worldwide. Three initiating events that can led to dam failure namely (1) Erosion (2) Maximum Flood and (3) Structural fault have been considered in the failure pathway analysis to determine the accident scenario and failure probability.

QRA pathway failure analysis initiated by internal erosion give the probability for the proposed Ulu Jelai dam failure (consider total fatalities) is **3.46×10^{-6}**. The probability of failure of **3.46×10^{-6}** is slightly higher than to the tolerable risk level based on As Low as Reasonably Practical (ALARP) principle that is **1.0×10^{-6}**. Thus the risk of failure associated with internal erosion can be categorized as medium.

For the maximum possible flood, the QRA analysis shows the subsequent failure and success of 4 main safety functions (1) Powerhouse in operation (2) Spillway in Operation (3) Overtopping and finally (4) Piping. The total probability of failure is **3.46×10^{-7}.** According to the ALARP criteria, the risk associated with flood inflow in the proposed Ulu Jelai dam is significantly low, within the acceptable range in the ALARP criteria.

The probability of failure initiated by the structural fault mainly during construction is **1.8×10^{-6}**. Again, this value is considered as medium compare to the tolerable value of **1.0×10^{-6}** set by ALARP.

In overall, the predicted probability of failure with fatality is **5.3×10^{-6}**. This value is considered the worst case scenario for RCC dam. Based on the consequence analysis, the existing settlement, with exception of Kg. Terakit and Kg. Cheros will be flooded between 15m and 18m. At these locations, water will reach its peak between 20 to 30

minutes. If this incident does occur, 100% fatality is expected based on the worst case scenario. However, with proper warning and evacuation process, it would expect that the fatality rate will reduce.

The societal risk associated with this failure falls within the ALARP region. However, since RCC has many safety features than the normal concrete dam, it would be expected that the RCC dam will yield the individual risk close to **1.0×10^{-6}**. With the new value of **1.0×10^{-6}**, it could be predicted that the societal risk will close to border of the "Broadly Acceptable Region" if 100% fatality is considered. On the other hand, the societal risk will be on the border region of "Broadly Acceptable Region" if 50% fatality is considered.

Recommendations such as the installation of non structural i.e early warning and monitoring system as well as reviewing the procedures during construction have been made to ensure that the risk of failure of the proposed Ulu Jelai dam remain minimal.

9.5 Emergency Response Plan (ERP)

The general ERP of the proposed Ulu Jelai dam has been developed. If the plan is properly followed during the real emergency, the loss of property and life could be minimised or avoided.

9.6 Recommendations

Based on the analysis of this DEIA study, the Project is viable and can be carried out as long as the identified major impacts or issues are handled with considerations and care, as the proposed mitigation measures are duly implemented.

Table ES-2: Summary of the Potential Environmental Impacts that May Arise from the Development of the Proposed Project, Proposed Mitigation Measures and Residual Impacts

ACTIVITY	POTENTIAL IMPACTS	[+]SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
I. PRE-CONSTRUCTION STAGE				
1.0 SITE INVESTIGATION AND SURVEY				
1.1 People in the Field	*Habitat and Fauna* - Increase hunting pressure and reduce fauna populations	S, Si	- Minimise cutting - Enforcement of rules to prevent removal of forest products - Activities of the workers must be limited to the construction and lodging sites to prevent these workers from practicing hunting in the areas	
1.2 Base Camp(s)	*Habitat and Fauna* - Possible influence on the present fauna populations due to increase human activities and garbage	S, Si	- Garbage must be properly disposed - Minimise size of base camps to reduce land clearing	
1.3 Access Roads	*Geology and Geotechnical* - Erosion of soils and rock at roadworks may occur during raining season - - Slope failure at the road cut and road embankment	S, Si S, Si	- Drainage ditches must be well-designed and road should be built during dry season - Slope must be reinforced	- An environmental protection, conservation and monitoring (EPCM) during project construction should be established before construction is started

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ACTIVITY	POTENTIAL IMPACTS	[+]SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	Noise and Vibration - Kg. Mensun, Kg. Leryar and Kg. Renglas residences are the closest to the proposed access roads - Noise from heavy machineries such as bulldozers, steamrollers, pneumatic hammer, truck and lorries. - Expected continuous noise level of not more than 100 dB(A) at 7.5 m from the activities	S, Si	- The construction activities should be at least 300 m from the residential areas - Expected noise level at 300 m is 52 dB(A)	
	Fauna - Increase of pest population	S, Si	- Minimise number of access roads to only one access road for each site	
	- Clearing for access roads may create disturbances to the roaming trails of the large animals in the area and disrupt their local migrating routes and activities	P, Si	- Minimise number of access roads to only one access road for each site - Practicing good cutting schemes where the animals are guided to disperse to the surrounding forest areas	- Changes in animal roaming patterns
	Flora - Clearing of vegetation - Better access by public may increase encroachment into forests - Vegetation is cleared for construction of road - Fruit trees of villagers in Kg. Kuala Boh, Kg. Leryar and Kg. Susu had to be cleared to make way for the road - Hill padi cultivation for few	S, Si P, Si P, Si P, Si P, Si	- Provide compensation to the villagers based on the number of tress to be affected - Compensation shall be given to affected villagers for loss of padi cultivation - Reserve trees or bamboo uprooted by the side of the access roads for sources of firewood to	- Permanent loss of vegetation - Loss of land for hill

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	households in Kg. Leryar, Kg. Susu and Kg. Teji affected - In Kg. Susu and Kg. Teji, the source of firewood (timber and bamboo poles) will be affected.	L, Si	the nearby villages	padi and fruit cultivation
1.4 Drilling activities for site survey	*Air Quality* - Dust generation *Noise and Vibration* - The activities are in small scale and will involve only small areas. It is expected that noise issue is negligible	S S, N	- Water spray as necessary to control dust - None required	
2.0 LAND ACQUISITION				
2.2 Relocation and Resettlement of Villages	*Socio-Economy* - The proposed dam project will require relocation of residents in Kg. Susu (which will be inundated), Kg. Tiat and Kg. Pinang (very near to the out-fall) *Public Health* - Changes in the health conditions of these people. Improper provision of the basic necessities such as water supply, solid waste disposal system and sewage treatment facilities and overcrowded housing could lead to increase in communicable diseases among these communities.	P, Si P, Si	- Relocation of villagers with suitable accommodation and amenities. All residents in the villages involved are willing to be relocated. - The basic necessities like water supply and sewage treatment and proper housing during relocation of *Orang Asli* must be provided.	- Change of village locations

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ACTIVITY		POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
II.	**CONSTRUCTION STAGE**				
1.0	**TEMPORARY OCCUPATION**				
1.1	Construction of Temporary Buildings, Storage Facilities and Working Areas	*Geology and Geotechnical* - Soil erosion	S, Si	- Site clearing must be carried out during dry season	
		Noise and Vibration - Noise from heavy machineries such as bulldozers, steamrollers, pneumatic hammer, truck and lorries. - Expected continuous noise level of not more than 100 dB(A) at 7.5 m from the activities	S, Si	- The construction activities should be at least 300 m from the residential areas. At this distance the expected noise level is about 52 dB(A)	
		Habitat and Fauna - Land clearing and tree cuttings cause destruction to faunal habitat, reduce ground cover and depletion of food resources	L, N	- Practicing good cutting schemes where the animals are guided to disperse to the surrounding forest areas	
		Flora - Removal of vegetation	S, Si	- Minimise extent of area and number of buildings	
1.2	Water Supply	*Public Health* - Sediment pollution and stream siltation could pollute the rivers which are the source for water supply to the local communities	S, Si	- Proper basic amenities such as the clean and safe water supply, proper solid waste disposal system and sewerage treatment system must be provided at the workers camp. - Pit latrines should be built for the workers and well maintained - A program for the safety and	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
			health of all workers during the construction phase must be instituted as they are subjected under the Factory and Machinery Act, 1967 with amendments 2006 and the Occupational Safety and Health Act, 1994.	
1.3 Solid Waste	*Public Health* - Improper disposal of solid wastes especially food wastes will attract rodents and other disease vectors	S, Si	- Proper solid waste disposal system is necessary, where all non-biodegradable waste should be collected by the third party (contractor) every week.	
1.4 Sewage Disposal	*Surface Water Quality* - Water pollution due to improper disposal of sewage *Public Health* - Health impacts due to improper disposal of sewage	S, Si S, Si	- Provide septic tank for sewage disposal - Provide septic tank for sewage disposal -	
1.5 Workforce Placement	*Habitat and Fauna* - Increase hunting pressure and reduce fauna populations - Possible influence on the present fauna populations due to increase human activities and garbage	S, Si S, Si	- Activities of the workers must be limited to the construction and lodging sites to prevent these workers from practicing hunting in the areas - Human garbage must be properly disposed as this garbage could contribute to the increase in population of pest species	

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ACTIVITY	POTENTIAL IMPACTS	[+]SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	Flora - Limited disturbance to adjacent vegetation	S	- Enhance awareness and enforcement	
	Socio-Economy - Influx of other local and foreign workers into the area thus affecting local employment opportunities	L, Si	- The *Orang Asli* are to be employed in suitable employment opportunities created	
	Public Health - Migration of people into the affected area usually associated in more man made reservoirs for certain mosquito species especially Aedes species. These could lead to the risk for increase dengue and dengue haemorrhagic fever	L, Si	- Carry out residual spraying of the workers' quarters with suitable insecticide in order to prevent outbreak of vector-borne diseases - Workers should be encouraged to use insecticide-impregnated bednets and personal protection measures such as personal protection such as repellents, and full body clothing - For the vectors of dengue, which are container breeders, it must be stressed that the environments surrounding the houses are clean. - People have to make sure that they cut the both ends of the tins before they discard them so that they would not collect water - Health screening of the workers especially for malaria and other communicable diseases - Prophylaxis of certain infectious diseases must be given to the workers who did not come from	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
			the endemic area	
1.6 Resource Abstraction	*Habitat and Fauna* - Land clearing and tree cutting cause destruction to faunal habitat, reduce ground cover and depletion of food resources	L, N	- Practice good cutting schemes where the animals are guided to disperse to the surrounding forest areas	
	Flora - Removal of vegetation	P, Si	- Enforce available guidelines on resource removals - Minimise extent of land clearing	
2.0 SITE PREPARATION				
2.1 Demolition & Removal of Structures	*Noise and Vibration* - Kg. Mensun and Kg. Leryar are the closest to the dam site area - Noise from machineries such as bulldozers (105 dB(A)), steamrollers (95 dB(A)), pneumatic hammer (90 dB(A)), tractors (92 dB(A)), chainsaw (110 dB(A)), truck and lorries are high - Expected continuous noise level of not more than 100 dB(A) at 7.5 m from the operation of these machineries	S, Si	- Limit hours of operation - Regular inspection and maintenance of the equipment - The operation of machineries is at least 300 m from the residential areas to maintain L_{max} of 90 dB(A) and L_{90} of 60 dB(A) at the residential areas from 7.00 am to 7.00 pm (Annex A: Schedule 6 of The Planning Guidelines for Environmental Noise Limits and Control DOE)	-
2.2 Removal and Disposal of Vegetation	*Geology and Geotechnical* - Might induces of slope failure *Surface Water Quality*	S, Si	- Exposed slopes should be covered with plastic and should not be standing for a long time	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	- Removal of vegetation and cutting, filling and excavation at the proposed area can have very significant effect on the soil erosion especially during heavy rain. Sediment carried in surface water will lead to siltation and high turbidity in major streams, which will affect aquatic life such as fishes and other vertebrates such as frogs and invertebrates	L, Si	- Sedimentation can be controlled by proper sediment control methods - Proper clearing and with specific procedure for the earthwork could minimise the impact:- i) Sedimentation (silt) traps ii) Riparian buffer zone implementation and control iii) Turfing of exposed areas iv) Replanting with soil-holding species	
	- Soil erosion	S, Si	- Minimise clearing - Carrying out construction in stages - Breaking up the slope into segments or terraces	
	Habitat and Fauna - Total lost of habitats will occur	P, Si	- The clearings of forest vegetations should be done from the centre of the sites and gradually move outward or from one side and gradually move toward the other side where the better stands of matured forests exist	- The lost of habitats in the proposed sites are permanent
	Flora - Permanent removal of vegetation	P, Si	- Proper planning and implementation of operations according to guidelines and minimising extent and earthworks	- Loss of vegetations
	Stream Ecology			

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	- Removal of vegetation and cutting, filling and excavation at the proposed area can have very significant effect on the soil erosion especially during heavy rain. Sediment carried in surface water will lead to siltation and high turbidity in major streams, which will affect aquatic life such as fishes and other vertebrates such as frogs and invertebrates - Soil erosion increases water turbidity and affect stream ecosystem	S, Si	- Sedimentation can be controlled by proper sediment control methods - Proper clearing and with specific procedure for the earthwork could minimise the impact:- v) Sedimentation (silt) traps vi) Riparian buffer zone implementation and control vii) Turfing of exposed areas viii) Replanting with soil-holding species - Minimise clearing - Carrying out construction in stages - Breaking up the slope into segments or terraces - Minimise clearing - Re-vegetate disturbed areas	- Source of eroded material will be deposited in the river channels. As a result the channels become shallower
2.3 Construction of Access Roads	*Geology and Geotechnical* - Erosion of soils and rock at roadworks may occur during raining season - Slope failure at the road cut and road embankment *Habitat and Fauna* - Clearing for access roads will create disturbances to the roaming trails of the large animals in the area and disrupt their local migrating routes and activities	S, Si S, Si P, Si	- Drainage ditches must be well-designed and road should be built during dry season - Slope must be reinforced - Minimise number of access roads to only one access road for each site - Avoid cutting big fruiting or ficus trees that are important food resources for the fauna all year round	- The lost of habitats in the proposed sites are permanent

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
			- Access roads must be guarded or closed to public access to prevent poachers from illegally hunting the fauna in the project area - After project completion, maintain only one access road to each site. All other access roads created for the pre-construction and construction phases must be re-planted with native species.	
	Flora - Removal of vegetation - Better access may increase encroachment into forests	P, Si S, Si	- Minimise clearing and earthworks - Re-vegetate disturbed areas - Enhance awareness and enforcement	- Permanent loss of vegetation as well as endemic species
2.4 Operation of Heavy Equipment (chainsaws, bulldozers, graders)	*Geology and Geotechnical* - Erosion of soils and rocks could occur with the removal of top soils - Slope failures may occur at cut and fill slopes	S, Si S, Si	- Earthworks and construction activities will be conducted in phases and preferably during dry season - Exposed soils should be covered with plastic and should not be standing for a long time - Slope must be properly be reinforced	
	Noise and Vibration - Kg. Mensun and Kg. Leryar are the closest to the dam site area - Noise from machineries such as bulldozers [105 dB(A)], steamrollers [95 dB(A)], pneumatic hammer [90	S, Si	- Limit hours of operation - Regular inspection and maintenance of the equipment - The operation of machineries is at least 300 m from the residential	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	dB(A)], tractors [92 dB(A)], chainsaw [110 dB(A)], truck and lorries are high - Expected continuous noise level of not more than 100 dB(A) at 7.5 m from the operation of these machineries		areas to maintain L_{max} of 90 dB(A) and L_{90} of 60 dB(A) at the residential areas from 7.00 am to 7.00 pm (Annex A: Schedule 6 of The Planning Guidelines for Environmental Noise Limits and Control DOE)	
3.0 FLOW DIVERSION - With RCC dam flow diversion is not necessary as flow will be allowed to pass under the dam body				
3.1 Diversion of Surface Water	*Surface Water Quality* - Increase of suspended solid in water - Disturbances on the riparian habitats *Stream Ecology* - Loss of aquatic habitat and reduction of fish population downstream of diversion point	S, Si L, Si L, Si, P	- Provide sediment traps by means of providing retention basins - Diversion of water/river into Susu Dam should not be done abruptly. The water level must be allowed to recede gradually and slowly to allow for faunas in the riparian habitat to adjust to changes to the micro habitats. - Construction of check dams at locations downstream of diversion point to maintain water depth and pools for fish to survive. - Project Proponent to compensate aquatic habitat and fish population reduction at Sg. Lemoi and Sg. Telom by releasing fish fingerlings.	- Fish community at downstream of diversion point will change according to new habitat formed
4.0 DAM CONSTRUCTION				
4.1 Operation of	*Geology and Geotechnical*			

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ACTIVITY	POTENTIAL IMPACTS	[+]SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
Equipment (bulldozers, diggers, trucks, scrapers) and Earthworks	- Exposed soils and rocks will increase intensity of erosion	S, Si	- Earthworks and construction activities will be conducted in phases and preferably during dry season - Exposed soils should be covered with plastic and should not be standing for a long time	
	- Slope failures may occur at cut and fill slopes	S, Si	- Slope must be properly be reinforced	
	Air Quality - Air pollution i.e. dust from vehicular movements and gaseous pollutants from heavy equipment machineries	S, Si	- All vehicles handled should be properly maintained and serviced for efficient operation to keep air pollution to the minimum level. - Avoid over loading of construction materials by transportation trucks. - Speed limit should be strictly observed	
	Noise and Vibration - Heavy vehicles are expected to pass through Kg. Mensun and Kg. Leryar resulting in noise pollution in the areas	S, Si	- Limit hours of operation - Regular inspection and maintenance of the equipment	
	- For construction of access tunnels, heavy vehicles are expected to pass through Kg. Renglas resulting in noise pollution in this area	S, Si	- The activities are at least 300 m from the residential areas to maintain L_{max} of 90 dB(A) and L_{90} of 60 dB(A) at the residential areas from 7.00 am to 7.00 pm (Annex A: Schedule 6 of The Planning Guidelines for Environmental Noise Limits and Control DOE)	
	- For construction of power plant, the activities will about 200 meter deep in the hill near Kg. Renglas. The expected continuous noise level of not more than 60 dBA at the portal of access tunnel	S, N		

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	Socio-Economy - More heavy vehicles are expected to pass through the nearby *Orang Asli* villagers resulting in air and noise pollution as well as endangering local safety, especially children	S, Si	- Limit hours of operation - Heavy vehicles should not be allowed to pass through Kg. Mensun. Instead, a new by-pass should be constructed. - All vehicles handled should be properly maintained and serviced for efficient operation to keep air pollution to the minimum level. - Avoid over loading of construction materials by transportation trucks. - Speed limit should be strictly observed	
4.2 Construction of Haul Roads	*Noise and Vibration* - The activities will affect the residence in Kg. Renglas and Kg. Cheros resulting in noise pollution in the areas - The expected continuous noise level of not more than 100 dB(A) at 7.5 m from the operation of these machineries	S, Si	- Limit hours of operation - Regular inspection and maintenance of the equipment - The activities are at least 300 m from the residential areas to maintain L_{max} of 90 dB(A) and L_{90} of 60 dB(A) at the residential areas from 7.00 am to 7.00 pm (Annex A: Schedule 6 of The Planning Guidelines for Environmental Noise Limits and Control DOE)	
	Habitat and Fauna - Clearing for access roads will create	P, Si	- Progressive rehabilitation of site - Minimise number of access roads	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	disturbances to the roaming trails of large animals in the area and disrupt their local migrating routes and activities		to only one access road for each site - Roads must be guarded or closed to public access to prevent poachers from illegally hunting the faunas in the project area	
	Flora - Temporary removal of vegetation	S, Si	- Adherence to road specifications	
4.3 Cutting, Quarrying / Blasting at Borrow Areas	*Surface Water Quality* - Erosion on exposed surfaces and sedimentation at water bodies	S, Si	- Turfing of exposed ground - Limit height of cut or fill slopes to 6m before benching - Reduce slope angle if soils are weak	
	Air Quality - Dust pollution	S, Si	- Worker exposed to dust to use masks - Water spray, temporary (mesh, plastic, matting) and permanent (turfing, hydroseeding) on over-exposed soil	
	Noise and Vibration - Kg. Mensun and Kg. Leryar are expected to be the closest to this activity - The expected continuous noise level of not more than 125 dB(A) at the operation areas	S, Si	- Limit operation only during daylight which is from 7.00 am to 7.00 pm - Plan and schedule the operation - Notify the residences about the scheduled blasting - The activities are at least 1 km from the residential areas to maintain L_{max} of 90 dB(A) and	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
			L_{90} of 60 dB(A) at the residential areas from 7.00 am to 7.00 pm (Annex A: Schedule 6 of The Planning Guidelines for Environmental Noise Limits and Control DOE)	
	Habitat and Fauna - Land clearing and tree cutting cause destruction to faunal habitat	P, N	- Minimise the extent of the site and dumping of waste into forested areas - Practice good cutting schemes where the animals are guided to disperse to the surrounding forest areas	- Permanent loss of vegetation
	Flora - Loss of vegetation	P, Si	- Minimise extent of affected area	
4.4 Transportation of construction material	*Air Quality* - Dust generation	S	- Cover trucks, put in wheel-wash facilities as appropriate	
	Noise and Vibration - The expected continuous noise level of not more than 75 dB(A) at 7.5 m from the operation road	S, Si	- Limit hours of operation - Regular inspection and maintenance of the vehicles - The roads are at least 100 m from the residential areas	
4.5 Filling/pouring/ grouting	*Air Quality* - Dust generation	S, Si	- Dampen the ground, temporary (mesh, plastic, matting) and permanent (turfing, hydroseeding) on over-exposed	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
			soil, planting protection	
4.6 Building Structures	*Noise and Vibration* - The expected continuous noise level of not more than 100 dB(A) at 7.5 m from the activity area if the construction involves piling works	S, Si	- Limit hours of operation - The piling work is at least 300 m from the residential areas	
5.0 INTAKES & DIVERSIONs				
5.1 Operation of Machineries (bulldozers, diggers, trucks, scrapers)	*Geology and Geotechnical* - Exposed soils and rocks during earthworks will increase intensity of erosion	S, Si	- Earthworks and construction activities will be conducted in phases and preferably during dry season - Exposed soils should be covered with plastic and should not be standing for a long time	
	- Slope failures may occur at cut and fill slopes	S, Si	- Slope must be properly be reinforced	
5.2 Alteration of Surface Flow	*Surface Water Hydrology* - Reduction of flow downstream of the dam	P, Si	- Construct check dams or stream barrier along the stretch between the proposed Susu Dam and Kuala Bertam to create permanent water pools to sustain aquatic life during dry period	- Without water pools generated from check dams, it could lead to loss of stream ecosystems downstream as well
	- Reduction of flow at the downstream of Lemoi and Telom intakes	P, Si	- Provision of 10% streamflow at any time including during dry periods at downstream of Lemoi and Telom intakes	
6.0 RESERVOIR FILLING				
6.1 Inundation of Land	*Flora*			

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	- Permanent loss of all vegetation in the inundated areas	P, Si	- Appoint field managers to safeguard the integrity of both land and forest at all stages of operations through thoughtful planning and implementation of forestry operations - Adhere to all necessary measures in accordance to the existing guidelines for development projects in hill - Clear vegetation prior to flooding	
	Stream Ecology - Creation of new aquatic habitat at the reservoir	B, Si	- The reservoir should be monitored for algal bloom	- Formation of new ecosystem at the reservoir -
6.2 Decomposition of Vegetation	*Surface Water Quality* - Formation of extensive oxygen free (anaerobic) water layer in the depth of the lake (in the hypolimnion) resulting in generation of the hydrogen sulphide (H_2S) due to the anaerobic breakdown of the organic mass.	L, Si	- Clear vegetation prior to flooding - Increase aeration such as increase water circulation.	
	Air Quality - Formation of extensive oxygen free (anaerobic) water layer in the depth of the lake (in the hypolimnion) resulting in generation of the hydrogen sulphide (H_2S) due to the anaerobic breakdown of the organic mass. Area with low oxygen and high in hydrogen sulphide	L, Si	- Clear vegetation as completely as possible prior to flooding	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	(H_2S) is unsuitable or uninhabitable for aquatic organisms especially fishes and benthos.			
6.3 Alteration of Surface Water Hydrology	*Surface Water Hydrology* - Flow reduction especially between the proposed Susu dam and Kuala Bertam. Insufficient flow during dry spell may threaten aquatic habitat, and reduce flow capacity to dilute pollution	L, Si	- Construct check dams or instream barriers to raise the water level to at least 30 cm from the bed - Release about 10% of the streamflow especially during dry period to maintain the water level between Kg. Susu and Kuala Bertam.	
III. POST-CONSTRUCTION (OPERATIONAL STAGE)				
1.1 Wetlands Formation	*Habitat and Fauna* - Upon project completion, the Dam site will be completely converted to new ecosystems where two new water bodies exist. This will bring about new composition of fauna population in the area. However, this should not be viewed as negative impacts as in many cases creation of water bodies bring advantages to fauna species especially the herpeto-faunas	B	- None required	- Creation of wetlands ecosystem
1.2 Dam Operation	*Noise and Vibration* - The operation of power plant will generate noise of not more than 60 dB(A) at the portal of the access tunnel	S, N	- None required	
	Socio-Economy - Creation of employment opportunity	B, L	- Priority should be given to local	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	for dam operation.		residents, in particular *Orang Asli*	
	<u>*Public Health*</u> - The slowing down of the stream flow downstream during the drought season may increase the concentration of faecal contamination. Thus, increasing the risk for parasitic infection.	L, Si	- The downstream water flow is essential to be regulated to ensure sufficient water flow downstream particularly during the drought season. - The supply of treated water needs to be improved in these communities in order to prevent dependence on untreated water, including the GFS system.	
	- Potential increase in tuberculosis and other communicable diseases due to recruitment of foreign workers - Increase in job opportunities to the local communities, thereby improving the socio-economic status and may indirectly improve their health status and well-being in general	L, Si B	- All workers must undergo proper medical screening before working in this area to prevent transmission of any communicable diseases.	
1.3 Provision of habitat for disease vectors	<u>*Public Health*</u> - Emergence of vector-borne diseases resulting in high risk of transmission on dengue and dengue haemorrhagic fever and Japanese Encephalitis (JE) to the local affected communities in this area	L, Si	- Regular monitoring of the abundance and species composition of the vectors and non-vector species in the area are needed in order to assess the impact of ecological changes as a result of the dam construction	
	- In the current small mammals trapping, the trapped animals were found to be infected with nematodes and cestodes and none with trematodes. The	L, Si	- The monkeys if present are kept away from the human population. This measure could prevent the transmission of zoonotic diseases	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	nematodes, *Angiostrongylus and* the cestodes can be of medical importance. Three species of cestodes were identified in the survey, two of which were *Taenia taeniaformis* and one each of *Hymenolepis sp* and *Raillietina sp. T. taeniaformis* and *Hymenolepis* sp have the potentials to be transmitted to man directly.		to man and transmission of malaria through unforeseen malaria vectors	
1.4 Fisheries	<u>*Stream Ecology*</u> - High yield of fish in reservoir especially during the initial years. The high increase in fish production is predicted only within several years of operation and followed by a decline in catch that corresponds to a change from eutrophy to oligotrophy conditions. - Fish yield from Sg. Bertam downstream from the dam may be reduced due to the drop in water level	B L, Si	- None required - Water pools with minimum water level of 0.3 m along the stretch from the dam face to Kuala Bertam should be maintained to ensure aquatic life is not adversely affected.	
1.5 Aquatic Weed	<u>*Stream Ecology*</u> - Aquatic weeds may appear in large quantities causing reduction in surface aeration of reservoir water - Use of herbicide to control aquatic weed might affect aquatic life	L, Si L, Si	- Lake needs to be monitored for any algal blooms and invasion of the aquatic plants. Removal can be carried out by physical and mechanical means. - Control dosage of herbicide and use herbicide not toxic to fish	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	- Improper disposal of aquatic weed causes solid waste problem	L, Si	- Provide a proper sanitary disposal site	
1.6 Water discharge	*Surface Water Quality* - Water from the depth of the lake in the hypolimnion layer, if released to the lower stream is not suitable for aquatic life (plant and animal) including fishes but also for human. Areas few kilometres from the dam may not be suitable for human settlement due to the odour caused by the released of hydrogen sulphide making water unsuitable for human usage	L, Si	- Minimise the practice of hypolimnion water discharge - Carry out mechanical aeration before release into the river - Remove vegetation before reservoir inundation to reduce hydrogen sulphide formation - The impact of hydrogen sulphide in Sg. Bertam and Sg. Telom is expected to be acceptable due to the presence of riffles and rapids that will increase the dissolved oxygen level and at the same time diluting hydrogen sulphide from feeder tributaries along the main river	
	Stream Ecology - Water from Susu Dam will be discharge via a tunnel at Sg. Telom about 6.4 downstream. The section of Sg. Bertam after Susu Dam will be dried up resulting in the loss of aquatic habitat and fish population.	L, Si, P	- The project proponent will compensate for the loss of habitat and fisheries by releasing fish fingerlings at Sg. Telom and Sg. Lemoi.	- Fish community at downstream of discharge point will change according to new habitat formed
1.7 Sediment flushing	*Surface Water Quality* - Increase suspended solids in the downstream rivers	L, Si	- Schedule sediment flushing during natural high flow	
1.8 Usage and Maintenance of	*Noise and Vibration* - The expected continuous noise level of	S, N	- The noise due to vehicles using access roads is not significant if	

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
Access Roads	not more than 75 dB(A) at 7.5 m from the road		the residences are at least 100 m from the road.	
	Habitat and Fauna - Increase access to forested areas, encroachment and illegal hunting activities	P, Si	- Controlled access at entry/exit points of access roads for use of operational and maintenance staff - Periodical checks and ground surveillance of access roads	
1.9 Outfall from Power Tunnel	*Surface Water Hydrology* - Sudden and large increase of discharge from power tunnel is dangerous to villagers - Increase bank erosion	P, Si	- Construct detention pond to regulate the flow - Provide warning system and inform the villagers on the system	
2.0 DAM SAFETY				
2.1 Dam Safety	*Socio-Economy* - Due to unforeseen circumstances, dam break may occur and will affect *Orang Asli* villagers downstream such as Kg. Teji, Kg. Senangkar/Abu, Pos Telanuk and Kg. Renglas.	P, Si	- Implementation of Emergency Response Plan (ERP)	
	QRA Due to unforeseen circumstances, dam break may occur. Based on the worst case scenario, the affected villages in the case of dam break are Kg. Teji, Kg. Senangkar/Abu, Pos Telanuk and Kg. Renglas	P, Si	- Installation of early warning system - Procedures of evacuation process - Implementation of Emergency Response Plan (ERP) - Educating people surrounding the dam on the danger associated with dam failure and step to be	

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ACTIVITY		POTENTIAL IMPACTS	[+]SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
				taken. - Installation of safety post in the village to help people in case failure occur	
IV.	**DECOMMISSIONING/ABANDONMENT**				
1.1	Dewatering of reservoir	*Surface Water Hydrology* - Sudden increase in flow rate especially between Kg. Susu and Kuala Bertam may cause bed and bank erosion *Public Health* - Water overflow if the release of water is not regulated. This could flush out the old mosquitoes breeding sites but new breeding sites are eventually created (so mosquito abundance may initially fall before rising to new levels)	S, Si S, Si	- Slow dewatering to minimise turbulence - Prevent formation of stagnant water bodies	-
1.2	Removal of sediment	*Noise and Vibration* - The work will involve excavation and this will be done by heavy machineries such as bulldozers. - The expected continuous noise level of not more than 100 dB(A) at point of operation area	S, Si	- Limit hours of operation to only Daylight - The operation is at least 300 m from the residential areas	-
1.3	Dam demolition	*Air Quality* - Dust generation	S, Si	- Workers exposed to dust to wear masks - Use water spray when necessary	-

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ACTIVITY	POTENTIAL IMPACTS	+SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS
	Noise and Vibration - The work will involve blasting on the structure for demolition. - The expected continuous noise level of not more than 100 dB(A) at point of operation area	S, Si	- Limit hours of operation to only Daylight - The operation is at least 300 m from the residential areas	
	Public Health - Wild rodent population will be displaced and may be brought into closer contact with human community.	S, Si	- Prevent accumulation of biodegradable wastes which are food sources to these rodents	
1.4 Restoration of reservoir area	*Surface Water Hydrology* Bring back the natural flow pattern which can gradually rejuvenate the aquatic habitat	B	- Not required	
	Flora - Revegetation of the affected area	B	None required	- Restoration of natural habitat
1.5 Transportation of demolition debris	*Air Quality* - Dust generation and gaseous emissions from vehicular movements	S, N S, N	- Water spray on unpaved roads and wheel wash trough facilities - Good maintenance of heavy vehicles to prevent generation of excessive dark smokes - Drivers to observe speed limits	-
	Noise and Vibration - The expected continuous noise level of not more than 75 dB(A) at 7.5 m from the road		- The noise due to vehicles to transport the macninery and goods using access roads is not significant provided that the residences are at least 100 m from the road.	

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ACTIVITY	POTENTIAL IMPACTS	[+]SIGNIFI-CANCE OF IMPACTS	PROPOSED MITIGATION MEASURES	RESIDUAL IMPACTS

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Table ES-3: Potential Impacts and Mitigation on Public Health

Potential Impacts	Mitigation
1. General health of the local communities	
• The general health is fairly good. Their current health problems are closely related to sanitary and personal hygiene.	• The general health of the community and their attitude and hygiene need to be improved in order to control the water-borne diseases as well as in preventing the water source from being contaminated. Health education programs on the importance of environmental sanitation and personal hygiene should be carried out regularly to reduce the transmission of communicable diseases.
• Their risks to water and vector-borne disease are high especially to dengue and dengue haemorrhagic fever, giardiasis and *Ascaris lumbricoides.*infection.	• The supply of treated water needs to be improved in these communities in order to prevent dependence on untreated water, including the GFS system. Other health-related amenities such as proper sewage system and garbage disposal would greatly contribute to better environmental cleanliness.
• Regulated streamflow with the poor sanitation and personal hygiene of the local communities could increase risk to waterborne disease During construction, sediment pollution and stream siltation could pollute the water supply for the local communities	• Environmental flow regulation to reduce the impacts of changed streamflow regimes on aquatic, floodplain and ecosystem downstream.
•	
• Downstream affected population particularly those reliant on water source and fisheries could suffer serious harm to their livelihoods and the future productivity of their resources could be put at risk.	• Erosion and sediment control technique to minimise water pollution. .
2. Parasitic Intestinal Infections	
• Increased risk to intestinal parasitic infections could be due to consumption of GFS and river water supply.Risk to these infections also could be due to the improper sewage system.	• The supply of treated water need to be improved in these communities in order to prevent dependence on untreated water
•	
• Regulated streamflow could result in higher chances of concentrating faecal contamination.	• Environmental flow regulation must be followed and provision of basic amenities must be improved. Health education programs on the importance of environmental sanitation and personal hygiene must be carried out to reduce the transmission of these parasitic intestinal infections.
	•
3. Vectorborne diseases	

• Malaria is still a threat in this area. Once a malaria case and any vector-borne case introduced or imported to this area could trigger an outbreak due to availability of vectors and suitable habitats in this area. • The vectors of dengue breed in container. A change of the lifestyle of the local people could resulted in an increase in the number of breeding habitats • During construction, deforestation will give rise to larger numbers of vectors, as the streams are exposed to sunlight. • Changes to the environment will give rise to different vector species and may also increase the number of the current vectors by providing more suitable habitats.	• Health screening is mandatory for all workers especially migrants who came from endemic area. The recruitment of the migrant workers must follow legal procedure. • All workers at the construction site to be examined for malaria following the malaria surveillance program from the Ministry of Health and for the other vector-borne diseases. • To prevent breeding of vectors of DF/DHF, unwanted containers, which may collect rainwater should be disposed properly. • People have to make sure that they cut the both ends of the tins before they discard them so that they would not collect water. • Constant periodic surveillance of the mosquito fauna is also needed.
5. Schistosomiasis • No snail host and no parasite of schistosomiasis could be found in this area. Risk to schistosomiasis transmission is low.	• Post impoundments survey could be carried out to reconfirm the absence of schistosomiasis in the area.
6. Zoonotic disease • The parasites for zoonotic diseases found during the survey could lead to the risk for zoonotic disease transmission. In addition small mammals especially rodents are potential transmitters of diseases caused by microbes such as parasites, viruses and bacteria.	• Altered environment can become a potential source of emerging disease. There must be a constant surveillance of the vectors population for the early detection of emerging and other communicable diseases.
7. Tuberculosis and other communicable diseases • Tuberculosis is still a public health threat in this area. Any case that comes to this area could be a potential source of tuberculosis and other communicable diseases transmissions.	• Health screening is mandatory for all workers especially migrants who came from endemic area. The recruitment of the migrant workers must follow legal procedure. There must be a constant surveillance for the early detection of emerging and other communicable diseases.