Draft Environmental Impact Assessment

Project Number: 41924
January 2014

LAO: Nam Ngiep 1 Hydropower Project

Prepared by Nam Ngiep Power Company Ltd. with assistance from ERM-Siam Co., Ltd. and Environmental Research Institute, Chulalongkorn University for the Asian Development Bank. This is an updated version of the draft originally posted in January 2012 available on http://www.adb.org/projects/documents/nam-ngiep-1-hydropower-project-results-eia

Environmental Impact Assessment for Nam Ngiep 1 Hydropower Project

Updated Version, January 2014

Executive Summary

NAM NGIEP 1
POWER COMPANY

Introduction

This is the Executive Summary of the Environmental Impact Assessment (EIA) Report for the Nam Ngiep 1 Hydropower Project, a 290-megawatt (MW) hydropower plant to be built on the Ngiep River (Nam Ngiep) in Bolikhamxay and Xaysomboun provinces of the Lao PDR. The Nam Ngiep 1 Power Company (NN1PC) is to begin construction of the plant in 2014, with production of electricity scheduled to start at the beginning of 2019. Through this EIA the Company aims to avoid creating adverse impacts through the Project, and where avoidance is not possible, to minimize, mitigate or compensate for any adverse impacts on the environment and affected people.

The Project objective is to provide electricity to the Lao national grid and for export to earn foreign exchange needed for national development. The development of hydropower facilities will allow the Lao PDR to enhance its economic prosperity and improve the lives of its people. Over a 27-year concession agreement the Project will provide an estimated US$665 million in revenues to the Lao government. After this the Project will be transferred to Lao public ownership. As a build-operate-transfer project with annual power generation of around 1,620 GWh, Nam Ngiep 1 will sell its output to the Electricity Generating Authority of Thailand (EGAT) and Electricité du Laos (EdL) under power purchase agreements and the concession agreement with the Lao government.

The Project was identified in the early 1990s and a preliminary feasibility study conducted in 1991. At the request of the Lao government, the Japan International Cooperation Agency (JICA) later conducted a full feasibility study into environmental impacts and technical and commercial aspects. The study confirmed the Project's feasibility on a build-operate-transfer basis and recommended optimal development based on physical, economic and environmental and social safeguard considerations. Japan's Kansai Electric Power Company joined partners on further studies in May 2003, and in April 2006 Kansai and EGAT entered an agreement to jointly develop the Project. A revised tariff MOU was concluded in July 2011 and a Power Purchase Agreement signed in 2013.

This EIA was prepared for NN1PC by the Environmental Research Institute of Chulalongkorn University (ERIC) in March 2012 and revised by ERM Siam in January 2014. In line with national standards and the Safeguard Policy Statement (2009) of the Asian Development Bank (ADB), the assessment gauges the Project's potential impacts on the physical, biological, and socio-economic and cultural environments, and describes measures to prevent, mitigate and/or offset any adverse environmental impacts expected through its design, construction and operation. Impacts and risks are analyzed in the context of the project's area of influence, which encompasses the main dam site and reservoir, resettlement site, re-regulation dam, lower Nam Ngiep (downstream of the dams), access roads and transmission line. The study area covers the project's influence area and candidate biodiversity offset sites. Included in the EIA are the environmental assessments for the Project access road and transmission lines.

Data contained in the EIA was obtained through field surveys, village interviews, consultations with people likely to be affected by the project, species specialists and biodiversity experts, and reviews of literature on the environmental characteristics of the Study area and reports on comparable hydropower projects. Extensive surveys of the area and its terrestrial and aquatic biodiversity were conducted during wet and dry seasons. More detailed data on these broad and various aspects is presented in Appendices A-I of the report.

This revised EIA takes into account suggestions received from stakeholders, including people likely to be affected by the Project, the ADB and the Project Lenders' Technical Advisor, a four-member panel with expertise on biodiversity, social development, resettlement and the implementation of hydropower project environmental management plans. The report is based on a proposed dam with full supply level (FSL) at EL 320 m. This was selected as the most promising Project design in terms of economic viability and minimizing environmental and social impacts. In addition to being guided by ADB Safeguard Policy Statement (2009), and by International Treaties that Laos is signatory to, the Project and this EIA are bound by the laws and decrees of the Lao PDR.

Description of the Project

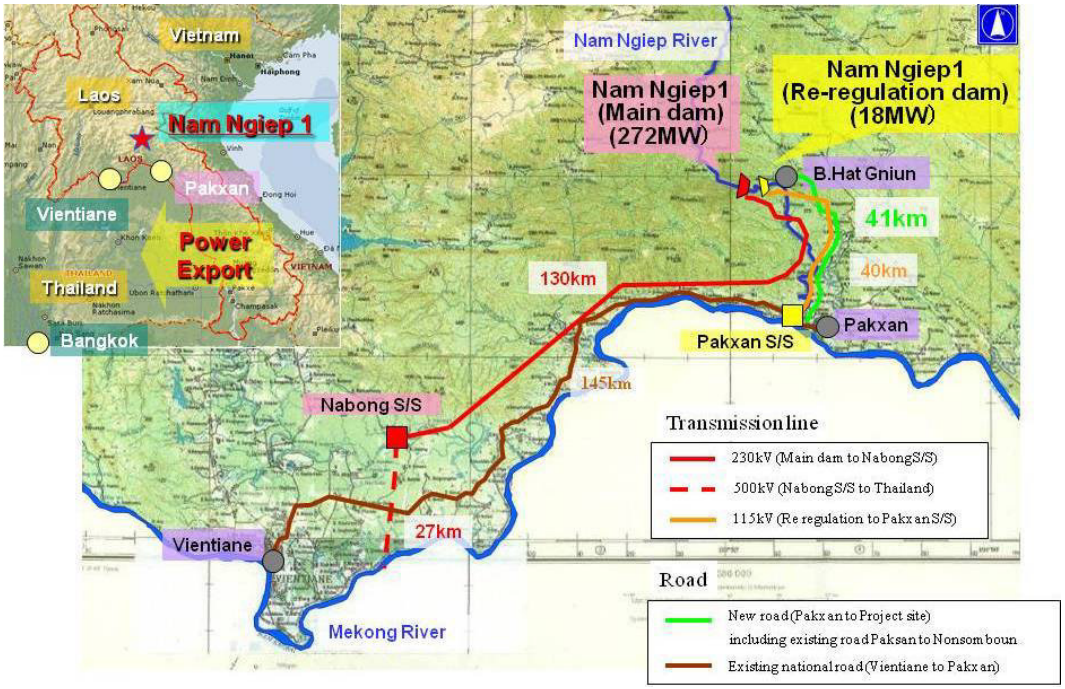
Background

The Lao PDR's hydropower resources will be a primary income source for the future, mainly through selling electricity to neighbouring countries. For the Nam Ngiep 1 Hydropower Project (NNP1), several pre-feasibility studies have been carried out. The JICA Feasibility Study of 2000 - 2002 stated that the Project would help networks cope with peaks or intermediate peaks in the load curve, and that it would be able to maintain price competitiveness among other power sources.

The Nam Ngiep 1 Power Company was established by Kansai Electric Power from Japan, EGAT International from Thailand, and Lao Holding State Enterprise (LHSE) from the Lao PDR. At the end of the concession period, the facilities are to be transferred to GOL at no charge. Current Project cost is estimated to be approximately US$0.9 billion. According to the results of more detailed studies on the environmental and social impacts, environmental and social costs recommended for the various mitigation and other measures would be around US$52.5 million.

Location

The main dam site will be on the Ngiep River, approximately 145 km north-east of Vientiane, and about 40 km north of Pakxan. The main Project facilities will be located in Bolikhamxay Province, although the reservoir will also cover part of the newly-established Xaysomboun Province.



Project Design

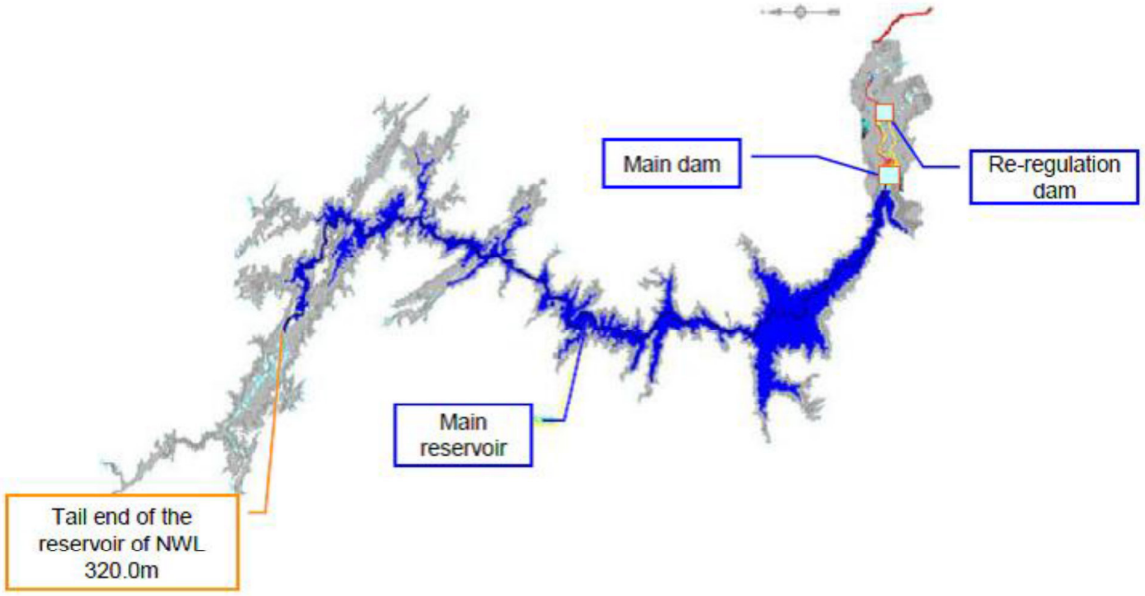
Nam Ngiep 1 will construct a 148-m high concrete gravity dam on the Nam Ngiep and a 272 MW Main Power Station that can generate annual power of 1,546 GWh. A Re-Regulation Power Station further downstream will have a capacity of 18 MW and annual power generation of 105 GWh.

Table: Main Project Features

Facility	Items	Specifications
Main Reservoir	Flood water level	320 EL. M
	Normal water level	320 EL. M
	Rated water level	312 EL. M
	Minimum operating level	296 EL. M
	Reservoir surface area	66.9 km^2
	Effective storage capacity	1,192 10^6 m^3
	Catchment area	3,700 km2
	Average annual inflow	148.4 m^3/s (4.68 billion m^3)
Main Dam Roller-Compacted Concrete gravity dam	Dam height	148 m
	Crest length	530 m
	Dam volume	2,034 10^3 m^3
	Crest level	322 EL. M
Spillway (4 x radial gates)	Design flood	5,210 m^3/s (1,000-year)
Intake (2 x bell-mouth)	Discharge capacity	230 m^3/s
Penstock (2 x exposed and embedded	Length	185 m
	Diameter	5.2 m
Powerhouse (Semi-underground)	Dimensions	25 m long, 62.5 m wide, 47.2 m high
Turbine and generator (2 x Francis Units)	Max. plant discharge	230 m^3/s
	Gross head	132.7 m
	Effective head	130.9 m
	Rated output	272 MW
	Annual power generation	1,546 GWh
230 kV Transmission Line	Distance	125 km to Nabong Substation
Re-Regulation Reservoir	Flood water level	185.9 EL. M
	Normal water level	179 EL. M
	Minimum operating level	174 EL. M
	Reservoir surface area	1.27 km^2 at NWL
	Effective storage capacity	4.6 $10^6 m^3$
	Catchment area	3,725 km^2
Re- Regulation Dam (Concrete Gravity dam)	Dam height	20.6 m
	Crest length	90 m
	Dam volume	23.9 10^3 m^3
	Crest level	187 EL. M (non-overflow section)
Re-regulation Gate (fixed wheel)	Discharge capacity	5,210 m^3/s (1,000-year)
Saddle dam (RCC associate with rockfill)	Crest length	507 m
	Dam height	14.6 m
Intake (open)	Discharge capacity	160 m^3/s
Powerhouse (Semi-underground)	Dimensions	46 m long, 22 m wide, 49 m high
Turbine and Generator (Bulb Unit)	Max. plant discharge	160 m^3/s
	Gross head	13.1 m
	Effective head	12.7 m
	Rated output	18 MW (at Substation)
	Annual power generation	105 GWh (Substation)
115 kV Transmission Line	Distance	40 km to Pakxan Substation

Main Reservoir

The main dam location will be 1.7 km upstream from the end of a narrow gorge, and 11.2 km from Ban Hat Gniun. The resulting reservoir will inundate the main river (length 72 km) and its tributaries. The main dam reservoir is illustrated below.



Source: Kansai and EGAT, Technical Report, 2011

The reservoir is narrow along most of its length. Most of the inundation (36.8 km^2, or 5 %) would be within 20 km upstream from the main dam. During the minimum operation level (water level EL 296 m), the reservoir will cover an area of 37.4 km^2.

Main Dam

The main dam will consist of the main dam body, a diversion tunnel, cofferdams upstream and downstream, the main power station, and a tailrace. Intakes, penstocks, a spillway, a riparian release conduit, and valve are to be located in the main dam body.

The main dam facilities will be located on the left bank (when facing downstream) to avoid a folded zone on the right bank and to minimize the impact caused by locating the facilities on the slopes. The main dam will be located in the gorge, 1.2 km downstream from the junction where the Nam Katha joins the Nam Ngiep. The main structure will be formed by a Roller Compacted Concrete (RCC) gravity dam, with a crest length of approximately 530 m and a height of 148 m. Dam crest elevation will be EL 322 m.

The reservoir water level has been set at EL 320 m. Although higher water levels would be more economical, the EL 320 water level was selected in order to reduce the impacts on the environment and on residents around the reservoir.

A spillway with four gates will be mounted in the middle of the RCC dam. A ski jump type spillway was selected to mitigate the effects of discharged water around the powerhouse downstream.

Main Power Station
The main power station, a four-storey building, is approximately 25 m long, 62.5 m wide, and 47.2 m high. The tailrace is 48.5 m long. Two Francis turbine units will be installed at the main power station, which will generate energy for delivery to EGAT. All generating units will be isolated and protected from the pressurized water supply by inlet valves within the main power station.

Re-Regulation Dam
The re-regulation dam is located 6.2 km downstream from the main dam (1.3 km downstream from Ban Hatsaykham, and 3.2 km upstream from Ban Hat Gniun). Its function is to store discharged water from the main dam during power peaks, re-using it for power generation and releasing it downstream evenly on a 24-hour basis on weekdays. This will regulate downstream flows to mitigate environmental impacts caused by fluctuations in water level.

Re-Regulation Power Station
The proposed re-regulation powerhouse has a length of 46.4 m, a width of 22.1 m and a height of 49.1 m. One bulb type turbine will generate energy for delivery to EDL, the re-regulation power station, the administration office and the operator's village.

Saddle Dam
To secure an effective storage capacity and prevent leakage, a saddle dam will be built on the right bank, and the area behind it will be utilized for the resettlement area. The crest elevation is designed to be higher than the maximum water level, at EL 187.0 m, which is lower than the paddy fields at Houay Soup Area. Paddy fields and resettlement areas behind the dyke will be located higher than the saddle dam, and will be secure during the wet season. However, paddy fields and community in the re-regulating reservoir area will be resettled in agreement with affected people.

Transmission Lines
There are two transmission lines for the Project, a 230 kV line from the main power station and a 115 kV line from the re-regulation power station. The 230 kV line will run for 125 km to Nabong substation, from where an export line will run to Thailand. The 115 kV line will run 40 km to Pakxan substation. While considered associated Project facilities, the 115kV line and substation will be constructed by and are the responsibility of EDL and are outside the scope of this assessment.

Construction Plan
Construction of the main plant, scheduled for completion over a period of 64 months, is to be in the following order:

1. Construction of a new road to reach the diversion tunnel outlet, rehabilitation/expansion of existing access road, construction of labour camp, administration facilities and lay-down area.
2. Excavation of the diversion tunnel from the outlet toward inlet.
3. Filling of gravel and soil to construct the primary cofferdam.
4. Construction of inlet structure of diversion tunnel and river flow diversion.
5. Construction of cofferdam by placing CVC concrete with appropriate foundation treatment.
6. Excavation of dam foundation and abutment. Construction of temporary roads, batching plant and crushing plant.
7. Placing consolidation/curtain grouting for dam foundation.

8. Placing dam concrete. Clearing major trees in proposed reservoir area.
9. Installation of turbines, generators, penstock, riparian release system, intake structure, spillway gates and other related facilities.
10. Construction of transmission line.
11. Installation of transformer and switching facility.
12. Impoundment by closing the inlet gate of diversion tunnel.
13. Placement of concrete in diversion tunnel at the dam axis.
14. Performance test.

Four major construction contracts will be used to accomplish Project works:

- Civil Works Contract
- Electrical and Mechanical Works Contract
- Hydraulic Metal Works Contract
- Transmission Line Works Contract

The maximum number of workers expected on site is 1,800 workers, working from a main camp between the main dam and the re-regulation dam (for the Owner and the main contractors) and one near the main dam (for sub contractor). Three work camps are also anticipated along the access road during its construction and another may be required for erection of the transmission lines.

Operation and Maintenance
The maximum water discharge through the turbines of the main power station will be 230 m^3/s. The re-regulation power station maximum discharge will normally be 160 m^3/s.

The maximum reservoir elevation of the main dam will be EL 320 m, with a minimum operating level of EL 296 m. Reservoir drawdown occurs during the dry season, with filling taking place during the wet season. Discharge from the main dam will be stored in the re-regulation reservoir. Normal operation of the main power station is designed around 16-hour peak generation on weekdays and Saturdays. There is to be no operation on Sundays except during the rainy season. The re-regulation reservoir will store water discharged from the main dam, re-use it for additional power generation, and then release it downstream evenly on a 24-hour basis on weekdays and Saturdays. This will regulate the downstream flow by smoothing out the peak discharge.

Operation of both the main dam and re-regulation dam will decrease discharge in the rainy season and augment flow in the dry season. The operation of the re-regulation reservoir is based on a maximum reservoir elevation of EL179 m and a minimum operating level of EL 174 m. The main dam will intentionally release water downstream during emergency events such as drought or flooding. Spillway gates would be operated during flooding in accordance with the operational rules, to minimize downstream impacts. Before operating the spillway gates, information on expected water level increases would be disseminated to those living downstream in accordance with the spillway gates operation rules and the emergency action plan.

Post-Operation and Decommissioning
There is no planned decommissioning for this project. After the concession period of 27 years, the project facilities will be transferred to the government for continuous hydropower generation. Any potential decommissioning activities taking place after the transfer would be the responsibility of

the new owner and would be outside the scope of the currently defined project. However, there will be required decommissioning/rehabilitation activities for temporary and ancillary sites/facilities. Further information is provided in the Concession Agreement's Annex C on Environmental and Social Obligations.

Study of Alternatives

No-Project Alternative

The No-Project alternative does not comply with the Greater Mekong Subregion energy strategy, with Lao national development priorities, with GOL policies for the power sector or the MOU between Laos and Thailand on energy supply.

The EGAT 2010 Power Development Plan for least-cost system expansion proposes a total capacity increase of more than 21,500 MW from 2010 through 2020 to cover forecasted power consumption and planned retirements. Up to 25% of overall power requirements will be sourced by 2030 from neighbouring countries. If the Project was to be replaced by another power plant of equivalent operational characteristics, a CCGT or another import hydropower project would be the most appropriate alternative.

Without the Project, existing trends of forest, land, and water use can be expected to continue and it is likely that these resources would be exploited at unsustainable levels. If the Project goes ahead, with its environmental monitoring system in place and effectively implemented and the recommended mitigation measures implemented, it is likely there would be lesser overall environmental degradation than if the Project were not implemented.

Energy Alternatives

A wide range of fuels and power-generating technologies are currently available. Petroleum, lignite, coal, and natural gas are non-renewable resources. While lignite and natural gas are both found in the region and used for electricity generation, further expansion of their use for additional electricity production is not recommended because of the high volume of greenhouse gas emissions from these sources. Among renewable energy sources, hydropower is at present the most viable both technically and economically for exploitation in the Lao PDR.

Project Design Alternatives

Small-Scale Hydropower Alternatives

An alternative would be many small-scale hydropower generators along the river, rather than one large dam. This would not be feasible for both economic and environmental reasons. River flow fluctuations between wet and dry seasons are too great for a small-scale hydroelectric system to work. The electricity produced would be appropriate for local communities, but not for cities or for export, unless all the small systems were linked in a grid. If a large number of small-scale systems were linked thus, the cost of infrastructure to transmit the electricity would be prohibitive. Operation and maintenance costs would also be massive, since each small-scale system would require its own personnel.

Alternative Dam Sites
For dam site selection, three sites were compared in terms of their economic, topographical and geological, and technical aspects. While the environmental impact of these three alternatives did not differ significantly, the technical and economic viability of the chosen site was clearly superior.

Access Road Route Alternatives
Alternatives for the access road, including alternative routes and levels of rehabilitation/upgrades, have been considered to identify the various scenarios that are financially and technically feasible, with the minimum environmental and social impact. In particular, alternatives were considered to minimize the length of road within protected areas.

Assessment of an alternative route from Ban Nonsomboun to Ban Hat Gniun indicated that each scenario would have impacts on the affected area inside the PPA, on the environment, on land acquisition, and on construction cost. However, the alternative road would be very close to the Phou Ngou protected area and would necessitate additional time for various surveys and re-approval processes.

From Ban Hat Gniun to the Dam Site, due to the need to access multiple locations, the geographic constraints, the requirement for access via each side of Nam Ngiep, and the desire to minimize watercourse crossings (which would have environmental impacts), there are few available alternatives. The use of only the JICA road was considered, but due to the steep and complex topography, its long-term use would entail substantial maintenance and repair costs. Therefore, it was determined that additional new roads were required.

Transmission Line Alignment Alternatives (230 kV Line)
A number of alternative route alignment scenarios were considered with criteria including:

- Reliability of power transmission;
- Avoidance of areas with significant environmental value;
- Avoidance of significant socio-economic features;
- Cost effectiveness.

The original route alignment was designed prior to the creation of the Huay Ngua Provincial Protected Area (PPA). Following creation of the PPA, it became clear that the alignment traverses this area. The following alternative routes were then considered:

- Option 1: running along the east bank of the Nam Ngiep, then parallel to the EDL transmission line route.
- Option 2: running along the west bank of the Nam Ngiep, passing the eastern side of the PPA and joining the original alignment south of the PPA.

Based on assessment of the cost, constructability, reliability and environmental and social impacts, Option 2 was considered the preferred option.

Description of the Physical, Biological, and Social and Cultural Environments

Physical

The Nam Ngiep catchment covers about 4,533 km^2. The Ngiep River runs 160 kilometres in a generally south to southwest direction to the Mekong River. The river source lies 2,819 meters above mean sea level (MSL). For most of its flow, the river passes through steep valleys down to a level of 150-160 MSL, where it enters a low plain before joining the Mekong River. Upstream of the dams the terrain is mountainous with intermittent narrow plains, all inhabited.

High mountains can be found on both sides of the Nam Ngiep, notably Phu Xao at 2,590 meters and Phu Khe at 2,125 meters MSL. These provide large amounts of water to the Nam Ngiep throughout the year. Most of the river downstream from the dams has an elevation of less than 180 meters.

The re-regulation dam is located about 6 kilometers downstream from the main dam in a part of the river that runs from west to east. The area is still characterized by valleys, but the slopes are not as steep as upstream. The terrain on both sides of the river widens, forming flatter plains.

The terrain downstream of the re-regulation dam is rather flat and tilts gradually towards the Mekong River. Tributaries from Phu Keng, Phu Ngou to Phu Pha Mela merge in this section of Nam Ngiep. The major tributaries are Nam Pha and Nam Tek. The flat area from Ban Nam Ngiep towards the Mekong River has an average relief of 150-160 meters. In this area, the Nam Ngiep runs parallel to the Nam Xan before it merges with the Mekong at Pakxan. Both rivers help create a fertile plain which is one of the most important agricultural areas of the country.

Biological

As detailed in the Baseline Biodiversity Assessment Report (Appendix A), the vegetation within the Project Area is dominated by forest (natural habitat) and fallow land vegetation (modified habitat). The original forests of the Project area were predominantly dry evergreen and mixed deciduous forests. However, shifting cultivation has removed much of the original forest and large areas of grassland, bamboo and other secondary vegetation are now present.

Deciduous forest covers approximately 35% of the Project footprint. Young and old fallow land is also highly represented with 16 and 21% respectively. In the main reservoir area, approximately 50% of the area is mapped as natural habitat with deciduous forest the dominant land cover type. Patches of natural habitat are dispersed throughout this main inundation area with the majority of the deciduous forest and evergreen forest within the reservoir's narrower stretches. Fallow land and rice paddy areas dominate the lower third of the inundation area.

The resettlement site is mapped with approximately 40% natural habitat, which is primarily bamboo with a small area of deciduous forest. The access road mapping identifies the dominant land types to be deciduous forest, with smaller portions of old fallow land. Approximately 60% is mapped as natural habitat - primarily deciduous forest with a small area of bamboo. The transmission line mapping identifies the dominant land types to be deciduous forest and old fallow land, with smaller portions of young fallow land and rice paddies. Approximately 40% is mapped as natural habitat, primarily deciduous forest with a small area of bamboo.

None of the Project components are proposed within conservation forest or protected areas. While two National Protected Areas, Phou Khao Khoay and Nam Ka Ding, lie in areas adjacent to the Project Area, the Project does not pose any direct threat. The Project area does contain some important forests which are generally located on steep terrains inaccessible to humans, allowing the vegetation to remain relatively intact and keeping the areas viable for a number of native flora and fauna species. These forests are located at elevations above the flood level of the reservoir.

The area is under pressure from logging and hunting and from continuing shifting cultivation. In the more remote and steep areas there are also patches of pristine forest. These are located, however, outside of the immediate Project and reservoir area, in places difficult to access by boat or by foot. Because of the relatively difficult access, there is also less hunting pressure in these areas.

Flora Species
A total of thirteen species of plants listed as critically endangered, endangered or vulnerable under the IUCN Red List of Threatened Species were recorded within the Project Area during surveys. These include one species listed as critically endangered, seven as endangered and five as vulnerable.

Other Plants and Non-Timber Forest Products (NTFPs)
Forest products, especially NTFPs, play an important role in the rural economy, with villagers in the Project area collecting them for food and household use, rarely for sale. The main NTFPs found in the Project Area are: bamboo, rattan, mushrooms and agarwood or *ketsana* (*Aquilaria crassna*).

Terrestrial Ecology/ Wildlife
Most of the Project components are located on the lower slopes of mountains or in the valleys. Although these used to be among the most important wildlife habitats, human activities have forced the wildlife into the higher and less accessible slopes, so that the proposed Project activities are now located well below the remaining habitats.

A number of fauna species listed on the IUCN Red List have been recorded within the Project area, including the Northern white-cheeked gibbon, listed as critically endangered. A number of other species were reported through indirect records. Species listed as critically endangered or endangered are considered candidates for critical habitat and these species records have been investigated further. Direct and indirect records have identified:

- 21 mammal species (1 critically endangered, 7 endangered, 13 vulnerable);
- 5 bird species (1 critically endangered, 2 endangered, 2 vulnerable);
- 9 reptile species (2 endangered, 7 vulnerable);
- No endangered amphibian species.

Aquatic Biodiversity Values
Various aquatic habitats are represented in the Project area, with seasonal variation in terms of water depth, clarity, flow and wetted width. In general, river habitats are fast flowing with greater water depth and flows during the wet season. Dry-season river habitats exhibit riffle zones which are flooded during the wet season. The river beds are generally dominated by sand and gravel. Villagers use the river environment for fishing and other activities and cattle can be observed in the

water body. Tributary habitats in the Upper Nam Ngiep and resettlement area are generally shallower and slower flowing, with some areas drying to isolated pools in the dry season.

The fish community surveyed in 2007 contains species common to the Mekong tributaries and was dominated by Cyprinidae species. Cyprinidae family species were reported to adapt to different environmental in various sections of the river, and this family was also the dominant group detected during a 2013 survey. Of the larger species detected many are migratory species of the lower Mekong basin that move upstream during the wet season spawning activities.

Aquatic surveys across the Project area detected nine species listed as critically endangered, endangered or vulnerable on the IUCN Red List. Species listed as critically endangered or endangered are considered candidates for critical habitat and these species' records have been surveyed further. Species listed as nationally restricted are also considered candidates for critical habitat and as such *Wallago leeri* has been included as a candidate species. A full species list is provided in the Biodiversity Baseline Assessment Report (Appendix A). An additional field survey will be used to update this report and to provide inputs to the critical habitat assessment.

Wetlands

According to survey and analysis of forest and vegetation cover and land use maps, only 97 ha or about 0.02% of the watershed is swampy. Most of these swamps are already disturbed by the expansion of residential and agricultural areas, so have lost their ecological function as wetlands. They are not Ramsar sites and have no potential in their disturbed states to become Ramsar sites.

Conservation Significant Values Summary

The outcomes of the assessment, which benefited from consultations with species specialists, did not identify any area of critical habitat for terrestrial flora or fauna species. Ongoing assessment is currently underway to clarify the values of the Project area and the potentially impacted downstream area for fish species, including migratory species. In the meantime, while no areas of critical habitat have been identified within the Project Area, an assessment of potential impacts on the habitats and species and the application of mitigation measures with specific reference to biodiversity values, including priority habitat values, have been considered. The impact assessment has identified an unavoidable loss of approximately 3944 ha of natural habitat and 3549 ha of modified habitat. The biodiversity values of the Project disturbance area were compared with those of the candidate offset sites. In pursuit of a no net loss or a net gain on biodiversity, an appropriate offset site or a combination of these sites are discussed in the Biodiversity Offset Design Report.

Social

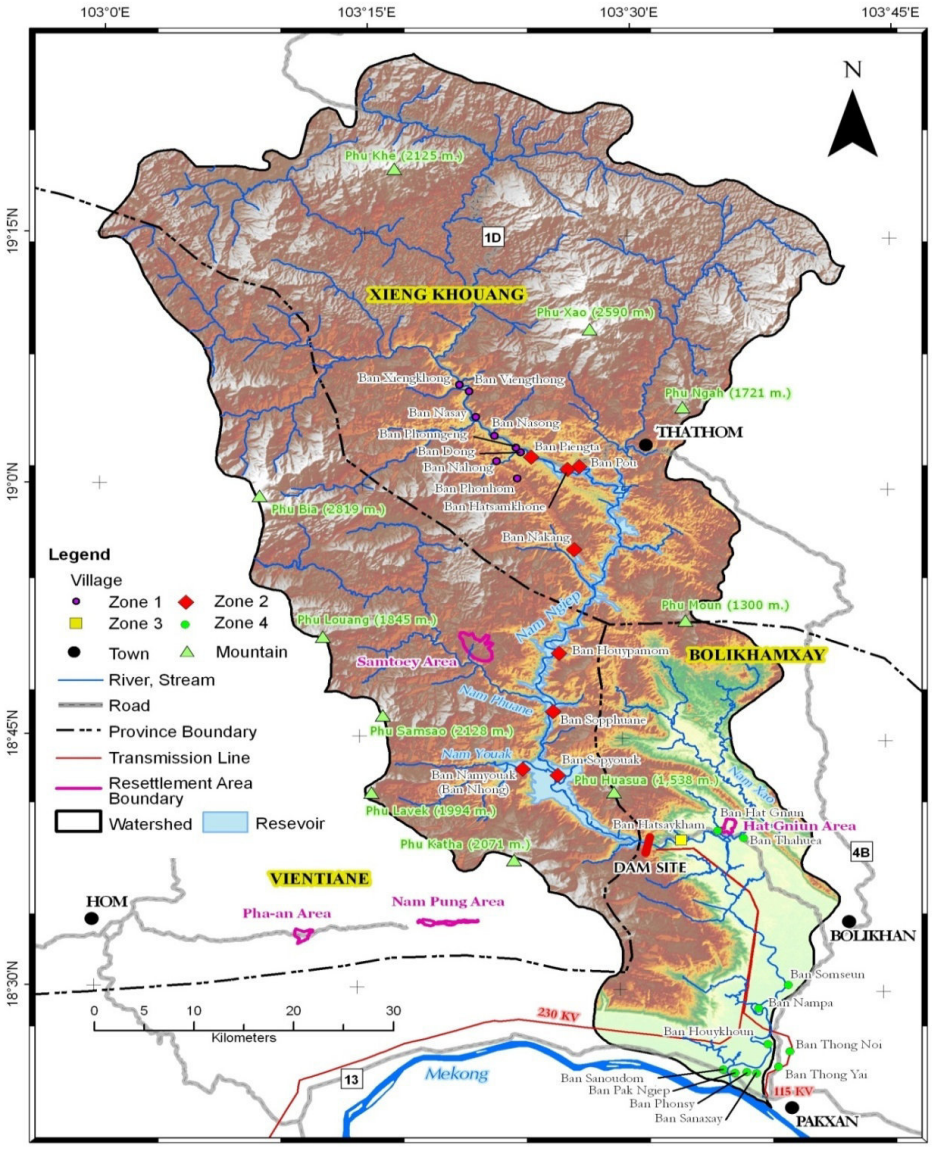
The Project Area has been divided into five zones for social programming purposes.

Zone 1

In Zone 1, which covers the area upstream from Main Dam, eight villages along the banks of the Nam Ngiep will be indirectly affected by the Project. Watershed management policies may affect the use of forest and water resources by people in these communities. However, these same watershed management programs could yield long-term benefits to the villagers by promoting more sustainable agricultural and forest management practices. The eight villages are:

- Ban Thaviengxay
- Ban Nahong
- Ban Phonhom
- Ban Phonngeng
- Ban Nasong
- Ban Nasay
- Ban Viengthong
- Ban Xiengkhong

Six of the villages lie along National Road 1D, which runs beside the Nam Ngiep. The two exceptions are Ban Nahong, which is 6 km up the Nam Thong, and Ban Phonhom, which is further uphill from Ban Nahong. The predominant settlement patterns are clusters, with nearly all the houses located near one another, stretching along the road.



Zone 2

Zone 2 covers the area affected by the main reservoir and is divided into two sub-zones. The communities in the upper section of the reservoir, Zone 2UR, will only be partly inundated by the reservoir. The communities in the lower section of the reservoir, designated as Zone 2LR, will be completely inundated by the reservoir and so the residents will need to be resettled.

Sub-Zone 2UR – Upper Reservoir Area

Three villages alongside the Nam Ngiep will be directly affected. All are part of Thathom District, now in Xaysomboun Province. At the time of a survey in 2007, a fourth village, Ban Nakang, was part of this zone, but it has since moved to Ban Phonhom in Zone 1. The three villages are:

- Ban Pou
- Ban Hatsamkhone
- Ban Piengta

It is expected that ten households in Ban Pou and five households in Hatsamkhone will need to be relocated to a higher elevation because their residential land will be flooded, and about 54% of households will lose some of their productive land to the reservoir and require compensation for their losses. Residents of these communities will also receive livelihoods training and resources and have access to improved social services and infrastructure provided by the Project.

All three communities lie along national road 1D, in a combined linear and cluster form. Ban Pou has two main parts: one is a cluster, mainly populated by Hmong households, and the second is a linear settlement along both sides of the village from national road 1D towards the Nam Ngiep, mainly populated by Lao Loum households. Ban Hatsamkhone tends to be more linear, with houses along both sides of 1D and a second line along a village road towards the river. Ban Piengta has a main cluster and extending from that a stretch of houses along both sides of road 1D.

Sub-Zone 2LR – Lower Reservoir Area

This sub-zone covers the lower section of reservoir, where four villages will be completely inundated. All are part of Hom District, now in Xaysomboun. All 384 households (according to the 2011 survey) in these villages will be resettled and compensated for loss of housing, land and other assets. They will gain infrastructure, social services, and economic and social development programs, to ensure that their standard of living is at the same level, if not better, than it was before the project. All households will be brought above the poverty level. The four villages are:

- Ban Houaypamom
- Ban Sopphuane
- Ban Namyouak
- Ban Sopyouak

The settlement patterns of these four villages are similar. Each has a main cluster of houses, very dense in Ban Sopyouak and Ban Namyouak, with the rest of the households scattered near the villages, some in more linear pattern along the river or its tributaries, others spread out in the fields.

Zone 3 – Construction Area

This zone covers the area where the main Project components will be built: the main dam, re-regulating dam, powerhouses, camp site, storage areas, access roads, and re-regulating reservoir. There is one directly affected village in this zone:

- Hatsaykham, an administrative sub-village of Ban Hat Gniun

Because of construction activities and inundation of the re-regulation reservoir, all 33 households of Hatsaykham will be resettled and compensated for their loss of housing, residential and production land, and other assets. People will also be provided with infrastructure, social services and

economic and social development programs to ensure their standard of living is at the same level, if not better, than it was before the project. All households will be brought above the poverty level. The settlement pattern of this village is linear, along the left bank of the Nam Ngiep River.

Zone 4 - Downstream Area

This zone covers the catchment area of the Nam Ngiep River downstream from the re-regulating dam, except from Ban Hat Gniun and Ban Thahuea, which are host villages and form an extra Zone 5. There are nine villages downstream from the dam, aside from the two host villages:

- Ban Somseun
- Ban Nampa
- Ban Houykhoun

These three villages lie around 30 km downstream from the main dam site and form part of Bolikhan District, Bolikhamxay Province.

- Ban Thong Noi
- Ban Thong Yai
- Ban Sanaxay
- Ban Phonsy
- Ban Pak Ngiep
- Ban Sanoudom

These six villages are in Pakxan District, Bolikhamxay Province and are 30-40 km from the Dam Site. Possible impacts to these villages are from changes of water level, quality and temperature in the Nam Ngiep and possible erosion of the riverbank. Because of mitigation measures included in the project design (i.e. water flow control via the re-regulation dam) and their distance from the dam, any such impacts are expected to be minimal. Even so, these villages will be involved in monitoring of the water quality and flow, as well as in supplemental fisheries programs.

Zone 5 - Prospective Resettlement Areas and Host Villages

After various stages of consultation and negotiations, the Houay Soup area in Bolikhan District, Bolikhamxay Province, on the opposite bank of the Nam Ngiep from Ban Hat Gniun, was suggested as a resettlement area for the four villages from Zone 2LR. Consequently, the province allocated an area of 6,000 ha right of the Nam Ngiep. The flatter lands along both banks of the Houay Soup stream can be used for approximately 400 ha of irrigated paddy fields and further upland rice fields, grassing areas, cash crops, and commercial tree plantations. Villagers from 2LR expressed concern over soil quality, which the company will address with special soil improvement programs.

Although the people of Hatsaykham had initially agreed to resettle near the main village of Ban Hat Gniun, close to their current site, they reconsidered when the new resettlement site was selected across the Nam Ngiep. The residents of Hatsaykham, who mostly belong to the Hmong ethnic group, also asked to move to the new resettlement area, preferring to be with their fellow Hmong from the villages of Zone 2LR.

As the nearest villages to the resettlement site, Ban Hat Gniun and Ban Thahuea are considered host villages to the resettled communities. They will be connected an access road and people from the resettlement site will pass the host villages on the road towards the provincial capital. Furthermore, the new school building in the resettlement area will be available for students from Hat Gniun. As host communities, Hat Gniun and Thahuea will be provided with improved social services and

with livelihood development programs under the Project. As the villages closest downstream from the two dams, water quality near these two villages will also be closely monitored and supplemental fisheries programs provided.

Cultural

The main ethnic groups present in the project area are Hmong and Lao Loum. Both groups display individual cultural characteristics as well as shared customs.

Community Profiles

Communities in the project area, above all in Zone 2, have been shaped by movements during and after the revolutionary war that ended in 1975. While communities have a long history, the villages in Zone 2 tend to be 20-40 years old. The villages generally show some characteristics particular to the ethnicity of the community; this influences the village layout, with houses either in clusters or spread apart. A main road can further influence this layout: in Zones 1 and 2UR, houses tend to align along the D1 road.

Villages and their paddy fields, tend to be located close to rivers or tributaries. Agriculture forms the main income source with paddy fields considered the most valuable land asset. Rice is also grown in upland fields (*hai*), though yields are lower. A number of other upland crops are grown in *hai*, including cash crops such as maize. Most households also raise small livestock like chickens, pigs, and large livestock like cattle.

Typical settlement

Houses tend to follow traditional ethnic patterns: Lao Loum houses are two storey buildings with the ground level open. The second level sits on wood poles, and is divided into a bedroom or bedrooms, a sitting area, and a kitchen in a corner of the house.

Upland ethnic groups like the Hmong traditionally build single-story houses directly on the ground, with walls and roofs of bamboo. Households with more wealth and higher status have walls and roofs made of wood. The houses have a single room with the kitchen in the middle. Sleeping places are located around the fire place. Typically the house may accommodate several family clusters. Households in the impacted communities do not strictly follow this pattern. Some of the Hmong who have lived for years in Sopyouak and Namyouak have adopted the lowland style of two-storey houses, while wealthier households in all communities have started building one- and two-storey houses with brick walls. Furthermore, detached kitchen buildings can be seen.

Other structures and land uses in the house plots are typically granaries, animal pens, vegetable gardens, mortars to mill rice, and storage sheds for firewood. House plots are usually fenced, either individually or as clusters of households belonging to the same wider family.

Cultural Practices and Interaction

Cultural practices directly follow ethnicity, and are evident in daily life as well as in formal rituals and annual festivals. Inter- marriage between the ethnic groups does occur within the Project area but is not common. In general, the different ethnic groups are able to live well together and share public spaces and resources, as well as public facilities and services. At the same time, each ethnic group maintains its identity, even when sharing a village. Each group will build their own houses

with their own particular characteristics. For example, Hmong houses may shelter several family units, sometimes resulting from the practice of polygamy, though this custom is in decline.

While the Lao Loum typically follow a matrilinear inheritance system, the Hmong follow patrilineal inheritance: Property is passed from father to son, newly-wed couples move in with the husband's family and will often remain there as part of an extended family, even after their own children are born. Men own the land and make decisions concerning it. Few women inherit land.

Environmental Impacts, Mitigation and Offset Measures

The EIA identifies and assesses Project impacts that are likely to affect the environment and provides recommendations to avoid, minimize, mitigate and or compensate for adverse impacts on the environment and affected people. Impacts are assessed over the following phases:

(i) Pre-construction and construction of facilities (1 year for preconstruction, 5 for construction)
(ii) The initial inundation period (including the time when the reservoir is first filled, 1–3 years);
(iii) Operation of the two reservoirs and power plants (up to 27 years).

The environmental impacts are analyzed for three major aspects, (1) the physical environment, (2) the biological environment, and (3) socio-economic and cultural environment.

Construction Phase

Diversion of Water around Cofferdams
Probable temporary flow regime fluctuations in the river during river diversion period, plus release of sediment associated with diversion tunnel construction.

Movement of Materials and Equipment to Site
Residents living alongside access roads may experience impacts from increased traffic resulting in noise, dust, vibration and reduced safety.

Ordnance Clearance
Possible inappropriate removal of UXO could result in injuries or fatalities.

Earth Moving
Potential impacts include increased erosion of exposed surfaces, increase sediment loads in drainage lines, release of chemical contaminants into water, and emissions of dust and noise.

Spoil Disposal
Surplus spoil will need to be safely disposed of to avoid erosion, sedimentation of water courses and release of chemicals in runoff.

Quarrying
Potential impacts on people and wildlife from noise and vibration, blasting and dust. There is also a risk of release of sediment and chemicals into watercourse from washing activities.

Vehicle and Machinery Maintenance
Vehicles and machines on construction sites will produce quantities of used oil, parts etc. which will need to be disposed of safely and securely to prevent environmental damage.

Materials Storage
Some construction materials can be dangerous and will need to be properly identified, stored and handled to minimize risks of accident and pollution.

Waste Management – Worker Camps
Worker camps will produce solid and liquid wastes, which will require treatment and safe disposal to prevent soil and water pollution.

Worker Health and Worker's Impacts on Wildlife
Programs will be run to minimize conflict with local communities and spread of diseases. Workers will be made aware of prohibition of hunting and entry into protected areas.

Reservoir Clearance
Vegetation in the reservoir area will be cleared to minimize the development of anoxic conditions, which could impact water quality downstream.

Impoundment
Management of downstream river flows will be a key task at this stage.

Decommissioning of Construction Facilities
When construction ends, all construction facilities, equipment and camps will be safely removed and the areas stabilized to minimize pollution risks. All sites will be rehabilitated and re-vegetated.

Impacts and Mitigation Measures: Physical Environment

Topography
No mitigation measures are required that relate solely to changes in topography. Possible impacts related to changes in topography, such as erosion or sedimentation, are considered separately.

Meteorology
The potential impact of the Project on climate is not expected to be significant. Local monitoring of meteorological and climate data will be carried out during preconstruction, construction and operation, so that work plans can be adjusted to fit meteorological conditions.

Climate Change
Nam Ngiep 1, like all hydroelectric facilities, is potentially vulnerable to the impacts of climate change. Based on a rapid climate risk assessment, potential risks associated with climate change include alterations in basin discharge that might compromise the ability of the Project to meet design power output, and increases in the frequency or intensity of flooding within the Nam Ngiep basin with implications for dam safety.

Regarding flood risks, the Project design is based on conservative assumptions and should be robust to a range of uncertainty in future flood magnitudes. Recent efforts to project the climate and hydrology of the Lower Mekong Basin do not depict generally unfavourable alterations in climatic and hydrologic regimes for hydropower generation, and no strong cautions are raised with respect to the performance of Nam Ngiep 1 under an altered climate, at least through mid-century. Although some studies indicate reduced flows, the majority of studies suggest moderate increases in flow. Most studies indicate that any changes in annual basin discharge would not substantially

impair hydropower generation. To properly understand the magnitude of the climate change vulnerability of the Project, detailed hydrological and reservoir simulations will be undertaken focusing on modelling of catchment processes and hydropower operations using downscaled climate projections. The simulation results related to flooding and dam safety will be reviewed by a Dam Safety Review Panel (DSRP) to ensure the structural integrity of the design of dams.

Geology, Landforms and Seismology
Based on regional geology and local geological data, the potential for earthquakes in the Project area is determined to be low. Landslides and rock movements are possible during construction. To prevent these, the following mitigation measures will be implemented:

- Data from geological tests is used in design and to prepare a construction safety plan.
- Any landslides and rock movements around the site will be investigated during construction.
- Grouting is recommended as reported in the Technical Reports.

The DSRP will review all aspects of dam safety, including as cited above the results of climate risk assessment studies, and to review construction supervision and quality assurance, the instrumentation plan, the operation and maintenance plan, and the emergency preparedness plan.

Erosion and Sedimentation
During construction, the potential for adverse impacts from erosion is significant: sediment control measures are required. Whenever feasible, construction, particularly land clearing activities, will be conducted during dry periods to help minimize erosion impacts. Erosion and sedimentation control plans will be included in site-specific plans that will contain:

- Conceptual design of erosion and sediment controls
- Water quality monitoring plan
- All vegetation on slopes above full supply level shall be retained.

Wherever possible, land clearing and vegetation removal will be conducted with as small a footprint as possible to ensure a maximum amount of original ground cover is maintained in existing condition. Suitable measures to control sedimentation and erosion include:

- Soil erosion and sediment control practices installed prior to any major soil disturbance.
- All areas disturbed by construction activities will be, as far as reasonably possible, landscaped to reflect natural contours and restore suitable drainage paths.
- Soil and spoil removed during the construction process will be stockpiled separately and stabilization measures implemented.
- Stockpiles will be stored appropriately and not on drainage lines or in floodway zones.
- Potential erosion problems along the base of waste or soil surplus will be considered in planning the location of such sites.
- Waste or surplus materials shall not be placed in areas subject to flooding, or in watercourses.

The Project will focus on management of erosion of excavated surfaces, especially during the wet season. A Site Specific Management Plan with an Erosion and Sediment Control sub-plan will be prepared for all sites and will include environmental management and pollution control techniques. It will also include a Water Quality Monitoring Plan. The Plan will meet appropriate standards, and

include development of drainage works, sediment traps, diversions, culverts and other structures to treat water to an acceptable quality before discharge.

Reservoir and River Water Quality
Assessment of impacts to water quality is considered with reference to national standards and water quality models developed by NEWJEC, an international engineering firm based in Japan. The impact assessment considers three phases: (1) pre-construction and construction (one year for pre-construction five for construction), (2) the initial inundation period and (3) long-term operations.

During the construction phase wastewater will be treated to meet the appropriate standards and then discharged to the Nam Ngiep. Given the average annual flow of the river, the release will not have a significant impact on water quality.

Based on the geological characteristics at the main dam site, leakage of impoundment water is expected to be very limited. Therefore underground water is not expected to be significantly affected in terms of quantity. No hazardous minerals are found in the area, so the underground water quality is also not expected to be significantly impacted.

The primary potential cause of deterioration on downstream water quality requiring mitigation measures is surface water runoff from the erosion of the soil surface. To minimize the impact of wastewater from the worker camp sites, settling ponds for sediment settling and for nutrient treatment will be constructed, and workers will be trained on hygiene.

Noise and Vibration
Assessment of noise and vibration impacts is made only for the Project construction phase; the impacts during normal operation of the dam are expected to be negligible. Following surveys conducted to identify sensitive areas, only Ban Hat Gniun, located about 3 km from the construction site, was considered at risk of being affected by noise and vibrations during construction. The following measures will be implemented to mitigate the noise impacts:

- Appropriate Personal Protective Equipment for noise shall be provided to all workers.
- All noise generating construction equipment shall have effective sound control devices.
- Loud construction activities limited to day time.
- People shall be warned in advance of any blasting work.
- All machinery and vehicles will be properly maintained and serviced.
- Noise barriers installed if levels exceed standards during monitoring.

The contractor shall retain a qualified blasting specialist to develop a sites-specific blasting program report to assess, control, and monitor air blasts and ground vibrations from blasting. This shall include, at a minimum, the following measures:

- Blast vibrations will not be allowed to exceed the specified frequency-dependent limits.
- Air blasts shall not to exceed 0.013-psi (133 dB) at residence or other occupied structure.

Air Quality
All potential impacts on air quality at the Project site can be limited through good construction management practices. Three principles: prevention, suppression and containment, are adopted to

control the creation of dust and other emissions, and to decrease airborne hazards to health. Any impacts on air quality from construction activities will likely be temporary and controllable.

The contractor shall implement an emission and dust control plan within the environmental protection and mitigation framework. Measures will be applied through site planning and careful control of construction traffic, demolition works, and other activities. Air monitoring will be routinely conducted in areas that generate dust, and sampling locations and parameters specified in applicable standards will be identified in the Site-Specific Environmental Management Plans.

Potential Contaminated Sites

Chemical Use and Storage

Activities that may cause contamination are chemical storage, drum reconditioning or recycling, electric transformers, explosive products and storage, landfill, pest control, petroleum products and oil storage, and scrap yards. Stringent management of hazardous materials to prevent spills will be implemented in all construction sites.

Quarry Site and Waste Disposal

To minimize potential contamination from the proposed quarry site and solid waste landfill, the following measures will be adopted:

1) Use of construction chemicals

- All chemicals and waste considered potentially hazardous will be registered and its movement and use tracked. Emergency response procedures will be developed and displayed. Safety procedures and training for handling of hazardous materials will be established for workers.
- Hazardous materials shall only be handled by trained personnel.
- General waste at the construction site will be stored and transported out of the camp. Wastewater treatment systems will be installed at camps.

2) Spillage prevention

- Vehicles carrying hazardous materials, including pesticides and fertilizers, must be covered during transport.
- Chemicals must be sealed well before use.

3) Storage of hazardous materials

- A hazardous waste storage area will be prepared.
- All workers will be informed of the stringent controls.
- Warning signs and rules must be located in appropriate places.

4) Leachate of quarry site and landfill

Appropriate measures to prevent contaminated runoff from discharging to the river shall be taken.

Hydrology

To reach the operational reservoir level, water impoundment will last for one rainy season, or one year. A diversion tunnel (10 m inner diameter, 660 m in length) will be constructed beforehand and will be in service for three years.

At the dam site, a procedure is in place to handle flooding during construction. The diversion tunnel will handle flooding during the first wet season after RCC placement. During this period, floods higher than the 1.5-year return period would be allowed to overtop the main dam. Both the coffer dam and main dam are designed to withstand the overflow conditions. Therefore, construction materials would not be a potential cause of flood damages downstream. Upstream, there will be no people living lower than the elevation of normal water level (EL.320 m). However, a warning system will be provided to alert all workers during potential overflow conditions.

After the second wet season of RCC placement, the dam and its storage, together with the diversion tunnel, can handle a 50-year return period flood.

Riparian Release and Environmental Flows

During construction the Project will maintain minimum flows downstream to mitigate potential environmental impacts and to help maintain ecosystem services. A riparian release conduit will discharge water when the reservoir is at EL 245 m, but prior to this the water level will be below the sill elevation of the bottom outlet. During this period, downstream releases will come from the re-regulation reservoir, which stores natural inflow from its side catchment (25 km^2). The release flow from the re-regulation dam will gradually be increased from 5.5 m^3/s (the minimum riparian release required by the CA) to 27 m^3/s during impoundment of the main dam to ensure continuity of the Nam Ngiep ecological system and of river uses by downstream residents.

Required minimum water depth for navigation and fish has been considered. Village information suggests the minimum required water depth for navigation is 0.5 m (Hb) and the required depth for fish is usually double the fish's height. Required minimum water depth is therefore set at 0.5 m.

Compliance with flow and depth thresholds will be monitored during impoundment. Recommended mitigation measures to minimize the impacts on hydrology from the Project are summarised as follows:

- During construction, flow in the river must not be significantly changed. The suitable period for construction is during low-flow season.
- The possibility of flash floods during the rainy season shall be included in safety plans for the construction sites. Construction materials must be carefully stored during the flood season.
- Water levels, especially from the dam site to Pakxan, shall be monitored continuously.
- During dam construction the developer must resettle all households in the flooded area and compensate them according to national regulations and international standards.
- During construction, public consultation with local residents must be conducted frequently.
- Training will be given to downstream residents to help them prepare for potential emergency situations.
- During construction, the minimum downstream flow rate released from the re-regulation dam will be 5.5 m^3/s, and the minimum downstream water depth will be maintained at 0.5 m.

Impacts to Occupational Health and Safety

Given the relative scarcity of industrial projects in the Lao PDR, many of the construction workforce can be expected to have never worked in an industrial setting before. Such workers are vulnerable to workplace accidents and danger. Contractors will be required to provide workers with a safe and healthy working environment and to take steps to prevent accidents, injury, and disease arising from, associated with, or occurring during the course of work by (i) identifying and minimizing, as far as practicable, the causes of potential hazards to workers; (ii) providing preventive and protective measures; (iii) providing appropriate equipment to minimize risk and requiring and enforcing its use; (iv) training workers; (v) documenting and reporting accidents, incidents and diseases; and (vi) having emergency prevention, preparedness, and response arrangements in place.

Impacts to Community Health and Safety

The potential impacts on the health and safety of Project area residents are closely related to those for construction workers. The temporary migration of around 1,800 workers to the area may bring higher rates of exposure to already common ailments among villagers, and to less common diseases, including those spread through sexual contact. The primary method of minimizing this risk will be through the Occupational Health and Safety measures mentioned above.

In general it is anticipated that the improved health infrastructure the Project will bring to the area, allied with improvements in road access and education, will lead to better overall health levels among the local population. Nevertheless, the Project has committed to regular monitoring of health indicators among resettled villagers and other affected people so that any dangerous trends can be identified and arrested at their early stages of development. At the same time, a rigorous safety and security policy is to be applied to all construction sites and surrounding areas to ensure that local people do not access dangerous areas and that they are not exposed to any potentially hazardous machinery, equipment, supplies or activities associated with Project construction.

Impacts and Mitigation Measures: Biological Environment

Construction activities with potential impacts on biodiversity include:

- UXO clearance for any footprint;
- Land clearing for roads, camps and offices, resettlement area, industrial facilities;
- Excavation including blasting and land levelling required for infrastructure footprints;
- Transport of materials along existing and new transport corridors and transmission line;
- Operation of large machinery;
- In-stream construction activities for waterway crossings;
- Interruption of river and tributary flows for infrastructure construction and reservoir filling;
- Storage of hazardous materials and refuelling;
- Tunnelling;
- Operation of accommodation camps during the construction period.

Table: Significance for natural and modified habitats within the Project area

Impact	Description	Sensitivity	Magnitude	Significance
Temporary loss of habitat	Temporary disturbance of terrestrial and aquatic habitat for access roads, laydown areas, camps, bridges	Low	Small	Negligible
Permanent loss of habitat	Permanent loss of 8,359 ha of habitat including 4,050 ha of natural habitat.	Medium	Medium	Moderate
Change in habitat characteristics	Transition of flowing water habitat to still water habitat: inundation of 73 km of the Nam Ngiep plus tributary reaches: 7,497 ha of reservoir footprint	Medium	Large	Major
Temporary disturbance to fauna behaviour	Disturbance to fauna behaviour due to noise, light and/or vibration as a result of construction activities	Low	Small	Negligible
Movement barrier, habitat fragmentation	Barrier to terrestrial fauna movement and habitat fragmentation	Medium	Medium	Moderate
	Barrier to aquatic fauna movement and habitat fragmentation	Medium	Large	Major
Edge effects degrading habitat	Construction and inundation will generate newly disturbed forest edges around the reservoir, access roads, transmission line and infrastructure.	Low	Small	Negligible
Alteration of flows	During reservoir impoundment, storage requirements limit the flow to downstream aquatic habitats	Medium	Medium	Moderate
Degradation of habitat	Introduction of alien species and competition with native communities	Medium	Small	Minor
	Accidental release of hazardous substances during construction	Medium	Small	Minor
	Erosion and runoff at waterway crossings leading to downstream degradation of water quality and aquatic habitats	Medium	Small	Minor
Fauna mortality	Fauna mortality during vegetation clearing if animals are struck by machinery or falling debris	Low	Small	Negligible

Table: Significance for identified biodiversity conservation values within the Project area.

Impact	Description	Sensitivity	Magnitude	Significance
Permanent national forest loss	National Protected Forest and Production Forest that will be permanently lost as the dam fills	High	Small	Moderate
Permanent habitat loss	IUCN Listed Critically Endangered and Endangered Species Habitat (terrestrial)	High	Small	Moderate
	IUCN Listed Vulnerable Species Habitat (terrestrial)	Medium	Small	Minor
	IUCN Listed Critically Endangered and Endangered Species Habitat (aquatic)	High	Small	Moderate
	IUCN Listed Vulnerable Species Habitat (aquatic)	Medium	Small	Minor
	Migratory species	High		

Habitat Sensitivity/Value		Magnitude of Effect			
		Negligible	Small	Medium	Large
Low	Habitats with no or local designation/recognition; habitats of significance for species of Least Concern; habitats which are common and widespread within the region.	Negligible	Negligible	Minor	Moderate
Medium	Habitats within nationally designated or recognised areas; habitats of significant importance to globally Vulnerable, Near Threatened or Data Deficient species; habitats of significant importance for nationally restricted range species; habitats supporting nationally significant concentrations of migratory species and/or congregatory species; nationally threatened or unique ecosystems.	Negligible	Minor	Moderate	Major
High	Habitats within internationally designated or recognised areas; habitats of importance to globally Critically Endangered or Endangered species; habitats of importance to endemic and/or globally restricted-range species; habitats supporting globally significant concentrations of migratory species and/ or congregatory species; highly threatened and/or unique ecosystems, areas associated with key evolutionary species (In accordance with IFC Critical Habitat Criteria)	Negligible	Moderate	Major	Critical
Magnitude of Effect Definition					
Negligible	*Effect is within the normal range of variation*				
Small	*Affects a small area of habitat, but without the loss of viability/function of the habitat*				
Medium	*Affects a sufficient proportion of the habitat that the viability/function of part of the habitat or the entire habitat is reduced, but does not threaten the long-term viability of the habitat or species dependent on it.*				
Large	*Affects the entire habitat or a significant proportion of the habitat to the extent that the viability/function of the entire habitat is reduced and the long-term viability of the habitat and the species dependent on it are threatened.*				

Avoidance, Mitigation and Management Measures

Mitigation measures can be implemented to manage disturbance during construction so that biodiversity values are not significantly impacted or impacts are reduced by the application of the mitigation hierarchy (avoid, minimise, mitigate and compensate through offsets).

Avoidance measures were initially investigated with a number of route options assessed for both the access road and transmission line. For the access road an alternative alignment was rejected due to greater probable disturbance of natural habitat and engineering considerations. For the transmission line an alternative route was preferred due to lower disturbance to natural habitat and avoidance of disturbance within the PPA.

To further mitigate potential impacts to biodiversity values, the remainder of the mitigation hierarchy principle was applied. The table below describes some of the environmental measures that will be incorporated into construction plans to reduce the potential for degradation of habitat, behaviour disturbance, fauna mortality and habitat fragmentation for native species.

Table: Construction Phase Mitigation and Management Measures

Nature of Impact	Overview of Measures
Loss of habitat	• Strict rules against logging and against wildlife hunting and poaching will be imposed on all staff, contractors and personnel associated with the Project, with penalties for anyone caught carrying and using firearms, animal snares and traps • The design and layout plan will be prepared to minimise tree cutting and protected area disturbance. The Project owner shall be responsible for dissemination of all rules, information concerning these restrictions, and punishment for violation. • The planned clearance area for the construction works shall be clearly identified and marked to avoid accidental clearing

	• Construction Contractor, in association with the Forest Guard, will schedule and implement routine inspection throughout construction to monitor clearing • Contractor will establish biological resource management program to manage activities and monitor compliance with permits and environmental regulations • Use or upgrade of existing roads where possible to minimise clearing requirements • In natural habitat areas to be cleared, microhabitat features such as hollow logs will be relocated to adjacent natural habitat rather than being destroyed
Disturbance to fauna behaviour	• Construction vehicles and machinery will be maintained in accordance with industry standard to minimise unnecessary noise generation • Transport schedules will avoid peak hours to minimise traffic through habitat areas • Speed limit signs will be installed on all roads throughout construction areas • Night lighting will be used only where necessary and will be directed toward the subject area and away from habitat areas where possible • Awareness of values of natural habitat areas will be raised among work force along with arrangements to restrict poaching
Barrier to movement and habitat fragmentation	• Landscaping and re-vegetation will occur after completion of construction, including at the reservoir margins to establish a suitable riparian corridor • In-stream works will be carried out in low-flow conditions where possible • The transmission line will not be fenced
Edge effects	• Dust suppression techniques will be utilised during construction • Landscaping and re-vegetation after construction, with native species where possible • Erosion control measures will be implemented and maintained e.g. using silt fence and temporary re-vegetation to minimize sediment release • Weed and pest management measures
Hydrology changes	• During construction, at least normal river flow will be maintained through diversion. Emergency programs prepared in case of floods • Wet season flash floods will be included in construction site safety plans • In-stream works for water crossings will be carried out in low-flow conditions where possible. Stabilisation measures will be used as appropriate • Local people informed of river changes that could affect transport and navigation • Water quality monitoring undertaken to inform adaptive management approaches such as altering the regulated release program
Degradation of habitat	• Construction and domestic waste will be appropriately stored and disposed of • For areas with direct runoff to a watercourse, sediment and erosion control devices will be installed and maintained until vegetation replanting can occur • Oil, chemical and solid waste will be stored, and handled and disposed of by appropriately licenced waste management contractors • Project weed and pest management plan to avoid introduction of weeds • Speed limit of maximum 40 km/h for construction vehicles will be enforced to limit noise and dust generation • Construction materials and chemicals appropriately secured and locked down during flood season • Engineering works will be designed to comply with agreed water quality standards • Water quality monitoring to begin as soon as possible • Emergency response plan and procedures will be implemented for construction activities. These will include emergency drills and education of workers

Fauna mortality	• Construction vehicle speed limit of 40 km/h enforced to minimise risk of fauna strike • Awareness of values of natural habitat areas will be raised among work force along with arrangements to restrict poaching • Ban on hunting wild animals will be strictly enforced for all staff • Fishing and using of illegal fishing gear anywhere along the river will be prohibited • UXO clearance and certification for the whole construction area • Construction activities will occur only within the UXO clearance boundary.

In addition to these general measures, specific measures for managing potential impacts to conservation-significant values are also considered. Throughout the baseline assessment, priority biodiversity values have been identified to assess possible critical habitat for species in line with IFC recommendations and the ADB safeguard requirement for Biodiversity Conservation and Sustainable Natural Resource Management.

Experts were commissioned to assess each candidate species against the critical habitat threshold criteria through field surveys. Through this analysis it was determined that no terrestrial species are likely to have critical habitat within the Project area. Ongoing investigation is being undertaken specific to aquatic species. It is acknowledged that some potential habitat within the area will be permanently lost and that indirect impacts to species may occur. As such, measures specific to these species will be included within the plans for management in biodiversity offset areas.

Table: Summary of Priority Biodiversity Values Management Measures

Species	Specific management measures
IUCN listed flora species	• IUCN-listed flora species presence within the disturbance corridor. These species need to be specifically managed within Biodiversity Offset Areas; replanting or propagation as appropriate • Project weed and pest management plan implemented to avoid introducing weeds to natural and modified habitat areas • Prohibit the use of IUCN-listed species for fire wood or construction
Asian small clawed otter, Smooth coated otter	• Raise awareness to discourage poaching; education of construction team and local villagers • Rehabilitation of any disturbed areas as soon as practical after clearing • Utilise appropriate sediment and erosion control measures to limit sedimentation of waterways
Asian elephant	• Raise awareness of the species to discourage poaching and contribute to management of human-elephant conflict through education of construction team members and local villagers • Restrict access to the elephant conservation area near Na village by construction teams and vehicles • Install appropriate elephant exclusion fencing near Na village • Rehabilitation of any disturbed areas as soon as practical after clearing
Leopard, Tiger, Asiatic golden cat, Leopard cat, Golden jackal, Sambar, Serow, Dhole	• Raise awareness to discourage poaching; education of construction team and local villagers • Rehabilitation of any disturbed areas as soon as practical after clearing

Fishing cat	• Rehabilitation of any disturbed areas as soon as practical after clearing • Establish watershed management to help maintain the quality of existing catchment habitats
Sun bear, Pangolin, Bengal slow loris, Pygmy slow loris, Himalayan black bear	• Raise awareness to discourage poaching; education of construction team and local villagers • Rehabilitation of any disturbed areas as soon as practical after clearing • Pre-clearing survey for presence of individuals prior to tree felling
Northern white-cheeked gibbon, Red-shanked douc langur, Phayre's leaf monkey	• Raise awareness to discourage poaching; education of construction team and local villagers • Rehabilitation of any disturbed areas as soon as practical after clearing • Establishment of artificial mineral licks near their habitats • Pre-clearing survey for presence of individuals prior to tree felling
Wreathed hornbill, Great hornbill, White winged duck, Greater coucal, Redbreasted parakeet, Darter	• Raise awareness to discourage poaching; education of construction team and local villagers • Rehabilitation of any disturbed areas as soon as practical after clearing
Green peafowl, Grey peacock, Silver pheasant, Siamese fireback pheasant, Lesser fish eagle	• Rehabilitation of any disturbed areas as soon as practical after clearing
Reticulated python, King cobra	• Raise awareness to discourage poaching; education of construction team and local villagers • Rehabilitation of any disturbed areas as soon as practical after clearing
Elongated tortoise	• Raise awareness to discourage poaching; education of construction team and local villagers • Rehabilitation of any disturbed areas as soon as practical after clearing
Big-headed turtle	• Rehabilitation of any disturbed areas as soon as practical after clearing • Raise awareness to discourage hunting by construction teams • Compensatory measures for unavoidable habitat loss including watershed management to help maintain the quality of existing catchment habitats
IUCN listed and migratory fish species	• Maintain appropriate downstream flows through suitable watercourse crossing structure design • Limit impacts to water quality through appropriate sediment and erosion control during construction • Raise awareness to discourage overfishing where possible • Establish watershed management to help maintain the quality of existing catchment habitats

In line with Concession Agreement requirements, an Environmental and Social Management and Monitoring Plan (ESMMP-CP) for the construction of the Project access road has already been prepared and submitted to the Ministry of Natural Resources and the Environment (MONRE), along with various sub-plans. An ESMMP-CP and subplans for the main dam are also under preparation.

Operations Phase

Impacts and Mitigation Measures: Physical Environment:
The creation of the reservoir could result in some minor microclimatic changes. The forested lands in the catchment and in the Project area will be important to help maintain and enhance climatic conditions.

Potential impacts to geohazards, such as landslides and rock falls, are not expected to be significant. During the operations phase, inspection of the dam structure and monitoring of water quality in the reservoirs and downstream are recommended.

Erosion and Sedimentation

Sedimentation
Flows from the dam site are expected to remove sandbars and finer sediment from beds, leaving a coarser substrate. This may result in the deposition of such materials further away from the Project, which could have adverse effects on aquatic habitat and species.

The creation of a large catchment area (3,700 km^2) is expected to ensure that sediment yield will remain at the current estimated low level. If steep slopes in the catchment area are subject to logging and slash-and-burn agriculture, this would reduce stability and lead to further erosion. It is important that prohibition of logging in the catchment area be enforced rigorously and that slash-and-burn activities be limited or reduced.

At Zone 4 (Downstream), mitigation measures will be essential to prevent or minimize adverse effects on aquatic habitat and associated species, particularly given the reliance of local people on fish and other aquatic or riparian wildlife species as food sources and for commerce.

Erosion
Areas downstream of the main dam site and re-regulation dam are expected to experience some erosion, particularly in areas of instability that are sensitive to erosion. The following measures are planned to control sensitive erosion:

- Location of works in sensitive erosion areas will be minimized.
- Where possible, works in sensitive erosion areas will be restricted to the dry season.
- Clearing of sites will be undertaken in the sequence that sites are required for construction.

Slope Stability
As the topography of the reservoir is mostly high mountainous range, rocks with shallow soil, sandstone, conglomerate and granites, are mostly found. These rocks have excellent draining capability, so their slope stability is relatively solid and able to cope with the fluctuation of the reservoir. Slope stability is therefore not found to be critical due to the fluctuation of the reservoir.

Reservoir and River Water Quality
Three major biophysical environmental issues have been found with dams in Southeast Asia:
- Large rates of sedimentation;
- Eutrophication and proliferation of exotic aquatic weeds; and
- Poor downstream water quality and changes in hydrological regime.

Nam Ngiep 1 operations are divided into two subphases: the Initial Operation Phase, from 5 to 10 years after start of operations and the Normal Operation Phase, after 10 years of operation.

Various changes of water quality (sediment, DO, phosphorous and nitrogen concentrations) during these periods can potentially have adverse effects downstream unless appropriate mitigation measures are taken.

While the dam structures have been designed to minimize changes in water flow, it is still likely that there will be changes in water quality during the first years of operation. The reservoir may also become stratified into thermocline and hypolimnion zones, and the water from these zones could be released downstream.

During the early phase of water impoundment, organic matter in the soil and remaining plants will degrade anaerobically, while some chemical components can be expected to leach from the concrete structures. This leaching and degradation can be expected to occur under anaerobic conditions for about seven years. After that, the rate of leaching and degradation will become much lower, depending on the amount of organic matter remaining in the reservoir, the depth of the impounded water and the effect of the thermocline. Regular monitoring of water quality will help indicate the ability of the water in the Project reservoir to recover.

The Project will conduct water quality data collection and monitoring before and during reservoir filling, and post-inundation. Samples will be collected at a minimum of four stations as follows:

- Upstream in the main reservoir
- In the middle of the main reservoir
- Downstream in the main reservoir
- Immediately downstream of the re-regulation pond

If monitoring results show dissolved oxygen of less than 2 mg/L or other serious impacts on water quality, the Project will investigate the causes of impact and consider installation of aeration equipment.

The most critical period of the Project in terms of downstream water quality will be when the impounded water is first discharged. Water pollutants from point sources as well as non-point sources of agricultural drainage and open defecation that have accumulated under anaerobic conditions would certainly affect the water quality downstream. Positive practices will include the installation of sanitary toilets and animal manure pits in communities near the reservoir, as well as educating local people on improved sanitary practices to prevent nitrogen build up.

Engineering works will comply with agreed water quality standards at various points in the purpose-built system. The Project owner and head contractor will mitigate direct and indirect impacts on people and aquatic/terrestrial species through alternative means if water quality standards are not met.

To prevent eutrophication and preserve the water quality of the reservoir and downstream water, an efficient biomass clearing program will be carried out before impounding. In addition, water quality monitoring of both the reservoir and downstream water will be routinely conducted,

specifically for phosphorus, nitrogen, and zooplankton and phytoplankton biomass, to evaluate the occurrence of eutrophication after reservoir impoundment.

When the water from the reservoir passes through the gates or flows over spillways, aeration will increase the dissolved oxygen content of the flowing water. Oxygenation will vary according to the water velocity and temperature.

Greenhouse Gas (GHG) Emissions

All dams and reservoirs release gases such as carbon dioxide and methane that can contribute to global warming. However, hydropower projects release less GHG per produced energy unit than thermal power plants. During operations, total GHG emissions from the Project reservoir are estimated to be approximately 152,000 t of CO_2 per year. Traditional power sources producing the same amount of power as the Project emit over 804,000 t of CO_2 per year.

Hydrology

Flows

The maximum monthly natural flow of the Nam Ngiep River was found to be about 483 m^3/s. A design flood with a 1,000-year probability is 5,210 m^3/s. After completion of dam construction, monthly outflow in the dry season will decrease, and in the rainy season will increase, because the main dam reservoir can regulate the discharge between seasons.

The spillway of the main dam is a gated type. Therefore the normal water level and flood surcharge level can be set at the same level of EL.320 m. At this water level the spillway can discharge flood flow of 5,210 m^3/s (1,000-year return period). This design flood period is relatively large and not likely to occur. Therefore the upstream area will be safe from flooding.

During operations the main dam will intentionally release water ("riparian release") downstream to maintain normal functions of the river. Cases of specific discharge of 0.15 $m^3/s/100\ km^2$ have been adopted for Nam Ngiep 1, and the minimum discharge after initial impounding shall not be less than 27 m^3/s during operation.

During flood periods, spillway gate operation rules will be followed to minimize downstream impacts. Before spilling, information regarding expected water level increase will be disseminated to downstream areas in accordance with operations rules and the emergency action plan.

Upstream and Reservoir

Nam Ngiep 1 is designed to avoid reservoir water levels of above EL 320 m, which would affect productive land or residential areas around the reservoir area.

Proper procedures for human and animal evacuation will be developed training of local residents and dam staff will be conducted, and grievances for incurred losses will be assessed and addressed in case backwater flooding in areas above EL 320 m should occur. An Emergency Action Plan (EAP) will be prepared to mitigate flood events that exceed the design flood. Impacts can be minimized by provision of adequate information and good communications between the Project and local residents.

Downstream

Possible impacts from Project discharge are changes in water level and velocity, and backwater effect at the confluence of Mekong River. During the wet season the dam and reservoir will control flow in the Nam Ngiep and is expected to reduce flooding at its confluence with the Mekong River.

Because of the lower water levels, sections of the river will be narrower. The biggest reduction of river width is expected at km 17.74, with a decrease in width of 16.35 m during June. Water velocity will have its maximum decrease in July and August, at about 0.2 m/s lower than the natural water velocity. These changes are considered minor, with the operating discharge planned to comply with natural conditions over 30 years.

During public consultations people living downstream of the project have expressed concern about backwater effect during peak floods. According to the hydrological study and water quality modelling results, it is clear that the Project will reduce the possibility of flooding at Pakxan. The irregular flooding of communities located along the Nam Ngiep near the Mekong, however, could be misunderstood to be caused by flows from the Nam Ngiep, when in fact they are almost entirely due to fluctuations in the Mekong. Effective information plans will be established to communicate with downstream communities, with information on water flow and river levels regularly disclosed to the public.

In the dry season, dam operations will mean the Nam Ngiep will be about 0.5-0.7 m higher than under natural conditions. The higher water levels will occur over almost the entire downstream segment of the river during March and April, with river width also expanding. At km 21.64 during May, river width could increase by over 31 m compared to the natural flow conditions. Downstream farmers may have concerns over lack of available water but problems with drawing water from the river are not anticipated. With the Project development, the downstream agricultural area will be safer from flooding in the wet season and will have more water in the river in the dry season.

Recommended mitigation measures to minimize the impacts on hydrology are provided as follows:

- Water levels, especially downstream of the dam site to Pakxan, to be monitored continuously.
- Water levels to be controlled to flow as close as possible to normal or natural levels at all times.
- Downstream residents will be informed how the river fluctuations will change because of the dam, and how they can then use the river as effectively as possible under the new conditions.
- Staff water level gauges installed along the river downstream of the dam for public information.
- The time delay for floods travelling along the river to be forecast, and residents to be informed.
- A flood warning system to be installed between the dam and the first main tributary.
- Information on water level analysis to be available to the public at all times. In extreme events, the Project shall inform people of the expected time and duration of extreme low or high flows.
- In case of flooding of downstream agricultural areas because of operations, the developer will compensate people for losses.
- The minimum guaranteed water release to be provided with further monitoring to enable suitable responses in management of releases.

Impacts and Mitigation Measures: Biological Environment

Water Quality

There is potential for impacts to water quality through the first year of inundation as a result of the decay of organic matter in the reservoir area. The water and sediment during this period will generate gases that may be toxic to fish and other aquatic species.

Water quality in the reservoir, especially in the years immediately after inundation, will be critical to maintaining productive fisheries. Water quality at first inundation will depend largely on the amount of biomass within the reservoir and the extent of stratification of the water column creating anoxic conditions. Adaptation to new conditions will be the main challenge for some species. A fisheries management program will introduce and maintain indigenous fish populations by finding new breeding and feeding habitats after construction, in the reservoir and other parts of the river.

Artificial circulation systems are usually considered economically unfeasible for a reservoir such as this. Mitigation measures are thus limited to biomass removal before inundation and the reservoir flow management policies until the first year. Appropriate countermeasures are needed if monitoring shows significant deterioration of water quality. These countermeasures will ensure maintenance of aquatic life downstream from the dam.

Downstream Habitats and Migratory Triggers

During operations, discharge from the main dam will be stored in the re-regulation reservoir and then discharged downstream. The normal release weekday release of water downstream will be 160m^3/s but on weekends the outflow will be gradually reduced to 48 m^3/s for a period of 17 hrs, and then to 27m^3/s for a period of 15 hours. During the dry season, a minimum water discharge of 27 m^3/sec will be released to ensure the health of the river downstream. Modelling shows that the dam operation could help preserve biodiversity in the river even during drought years, when in natural conditions flows can occasionally dwindle to levels far below the minimum release.

Aquatic biology in the newly formed reservoir and downstream will be monitored twice each year during the operations period, starting from year 2 until year 10. After this, fisheries resources are expected to be sufficiently stabilized and monitoring can be done once every three years.

Mitigation and management approaches have been considered to avoid, minimise and mitigate potential impacts to biodiversity. In general, many of the indirect impacts can be minimised, such as behavioural disturbance, degradation of habitats, edge effects and barriers to terrestrial fauna movement. The residual impacts identified relate to unavoidable loss of 4,050 ha of natural habitat and 3,549 ha of modified habitat. Direct disturbance to habitats will be minimised where possible. Some impact is unavoidable and as such compensatory measures have been considered.

Biodiversity Offset Design

A Biodiversity Offset Design Report has been developed (Appendix B) which outlines a biodiversity offset metric, developed to capture the type, amount and condition of biodiversity in the Project area and candidate offset sites. The application of the offset rules enables the most appropriate candidate offset sites to be chosen to achieve a no-net-loss of biodiversity values. The process has also included consultation with the government and NGOs to design governance, legal and institutional arrangements to administer projects designed to improve biodiversity values.

Cumulative Impacts Assessment

A Cumulative Impact Assessment has been prepared, based on US National Environmental Policy, International Finance Corporation Performance Standards and the 2009ADB Safeguard Policy Statement. Impacts from this Project and from foreseeable future actions were considered on the valued ecosystem components (VECs) identified for the Project which are: (i) terrestrial biodiversity and habitats, (ii) aquatic biodiversity and habitats (including river flows) and (iii) ecosystem services.

The analysis was mostly qualitative as little quantitative data is currently available. The assessment found that while the creation of the Project reservoirs will inundate some terrestrial environments, as the valley floors are already exploited for agriculture and have been largely cleared, the impacts on these environments will not be as large as that which will in any case occur through the increased pressure on available resources from increasing human population. The creation of the dam walls for this Project, in combination with the potential six other projects in the area, has the potential to greatly alter the aquatic ecology of the Nam Ngiep River as a whole with some impacts on the Mekong River. There could potentially be an increase in abundance of fish species adapted to lacustrine environments with those requiring migration and/or fast-flowing waters likely to decline.

An increase in construction activity and improvements to infrastructure in the region are both likely to lead to an increase in the human population in the area. This will likely negatively impact on terrestrial and aquatic resources as more people require agricultural and subsistence products from the arable land and forest areas.

The assessment shows that the Project's contribution to cumulative impacts could be minimized through implementation of the mitigation measures discussed above, with residual impacts compensated through the Biodiversity Offset Design.

Residual Impacts on Human use Values

Development of the project will likely impact the ability of villagers to access both tangible human use provisioning services and intangible cultural heritage values. This includes:

- Hunting, gathering and fishing.
- Collection and use of medicinal plants;
- Cultural heritage, such as cemeteries.
- Collection of timber products to be used as fuel or in construction.

Impacts to Occupational Health and Safety

During operations occupational health and safety will be guaranteed by professional working practices at the dams and powerhouses. Appropriate training will be given to all staff, depending on their roles, and access to potentially dangerous areas of the plant will be restricted to personnel with the appropriate skills, training and security clearance. Members of the public will be prohibited from entering areas containing moving machinery and live charge, and all staff and visitors will be required to wear suitable protective equipment when around the dams or powerhouses.

Impacts to Community Health and Safety

In general it is anticipated that the improved health infrastructure the Project will bring to the area, allied with improvements in road access and education, will lead to better overall health levels among the local population. Nevertheless, the Project has committed to regular monitoring of health indicators among resettled villagers and other affected people so that any dangerous trends can be identified and arrested at their early stages of development. At the same time, a rigorous safety and security policy is to be applied to all project facilities and surrounding areas to ensure that local people do not access dangerous areas and that they are not exposed to any potentially hazardous machinery, equipment, supplies or activities associated with Project operations.

A hydro safety plan and EAP will be drafted in line with national regulations and recognised international standards to govern the safety of all residents downstream of the plant should maximum water releases be required or should natural disasters threaten the structural integrity of the plant. To avoid or minimize the exacerbation of impacts caused by natural hazards, such as floods or landslides, or dam failure, the Dam Safety Review Panel will review all aspects of dam safety and the emergency preparedness plan. Affected communities will be informed of significant potential hazards and of key aspects of the emergency preparedness plan.

For the operations phase, an Environmental and Social Management and Monitoring Plan for the main dam is under preparation.

Public Consultation and Information Disclosure

Public consultation and disclosure began in 2007 and has continued to be a key component throughout the development of the Project. The objectives are to:

- Ensure that stakeholders concerns are incorporated in the Project design and implementation;
- Increase stakeholder awareness and familiarity with the Project;
- Ensure transparency in the decision-making process;
- Enhance the potential benefits by directly involving relevant stakeholders.

These objectives are being met through a comprehensive public consultation and disclosure process, which has been ongoing for a number of years. Information disclosure and consultation techniques include focus group discussions and village meetings, use of visual information such as pictures, diagrams, and 3D models. In selecting techniques, consideration was given to the following:

- Cultural norms and sensitivities to ensure that strategies align with cultural norms;
- Local community structures, including governance structures;
- Presence of women and vulnerable groups to ensure that these groups are not marginalised. The participation of women and other vulnerable groups has been encouraged, for example by organising women's or vulnerable group only focus group discussions;
- Potential language barriers: Consultation activities have largely been conducted in Lao. In villages with Hmong residents, the information presented was translated into Hmong;
- Literacy rates: Where possible consultation has been conducted using face-to-face communication and visual representation of information as well as participatory rural appraisal techniques to overcome issues in literacy;
- Steps were taken to ensure intimidation and coercion did not occur.

The feedback received during these meetings has been used to update and amend the Project design. Examples of changes that can be attributed to consultation include:

- Revisions to the transmission line route, in order to avoid an elephant conservation area;
- A change in planned reservoir height. The reservoir has been lowered from early plans – from 360 m above sea level to 320 m above sea level - to reduce the impact on the environment and villages in the upper reservoir. This will help reduce the number of villages that will need to be resettled;
- Increases in the minimum downstream flows to help sustain environmental values;
- Changes in the location and composition of the resettlement sites, including the community infrastructure and the process and materials to construct the housing.

Specific stakeholder engagement on environmental issues has been conducted with regional agencies, Lao government departments, local officials and NGOs from February–March 2013, and in November 2013. Consultations occurred in Vientiane as well as in villages within the Nam Ngiep (impacted area) and the Nam Xan catchment. The following individuals and organisations were involved in the stakeholder engagement:

- Independent Advisory Panel
- Wildlife Conservation Society (Lao PDR Program)
- International Union for the Conservation of Nature
- Mekong River Commission Secretariat
- Ministry of Information, Culture and Tourism
- Ministry of Planning and Investment
- Department of Forest Resource Management
- Ministry of Natural Resources and Environment
- Phou Khao Kouay NPA
- Theun-Hinboun Power Company
- Lao National Museum

Key discussion topics included

- Legal relevant international and Lao laws and regulations on environmental protection, biodiversity conservation, forestry, water resources, land use and planning, human rights, and legal arrangements for securing biodiversity conservation on public and private land.
- Financial mechanisms to support biodiversity conservation, including market mechanisms, monetary values of natural resources and ecosystem services, financial trusts for biodiversity conservation, funding arrangements for biodiversity conservation and NPAs, and NGO funding arrangements.
- Current management arrangements for land use planning and biodiversity conservation for mining concessions, private land, public land, conservation community partnerships, forestry, NPAs, existing biodiversity offsets, fisheries, and water resources.
- Current and future land uses including potential encumbrances to biodiversity offset establishment
- Threats to biodiversity offset establishment.

Grievance Redress Mechanism

The Project has the potential to affect the interests of thousands of people, which may result in differences in perception and expectations. These differences may lead to conflicts between potentially affected people (PAPs), including Project-area residents on the one hand, and the government, developer, and those hired to implement the Project on the other. A grievance redress mechanism (GRM) has therefore been established to achieve the following objectives:

- Promote productive relationships with local communities and identify community concerns through consultation, disclosures, participatory planning and decision making to prevent grievances wherever possible and maximize environmental and social benefits;
- Address and resolve differences or grievances associated with the Project through established GRM procedures, as outlined in the following sections.
- Address all grievances raised by PAPs, including those associated with land acquisition, compensation, resettlement and livelihood restoration, and environmental matters.

The GRM seeks to resolve disagreements or stakeholder concerns before they evolve into grievances. This is done through ongoing engagement with stakeholders. Informal negotiations and discussions will be conducted in a transparent manner and appropriately documented. Agreements that are reached will be voluntarily signed by all parties involved in the negotiation. In cases where concerns or conflicts cannot be resolved through consultation, the GRM has established a hierarchy of committees and procedures to receive and resolve grievances.

Stages and Timeframes

- Stage 1: PAPs can register grievances on any aspect of compensation, relocation or unaddressed losses with the Village Grievance Committee. This village committee organizes a meeting within 15 days to resolve the issue.

- Stage 2: If either the PAP or the Company is not satisfied with the decision of the Village Grievance Committee, an appeal can be made to the District Grievance Committee. The District Grievance Committee will then meet no more than 20 days from receipt of the grievance to make a decision on the matter.

- Stage 3: If the PAP or the Project is still not satisfied with the decision, an appeal can be made to the Provincial Grievance Redress Committee. The Provincial Committee will examine and consider the complaint or grievance in consultation with MONRE and the Company within 20 days.

- Stage 4: If the PAP is still not satisfied with the decision of the Provincial Grievance Redress Committee, or in the absence of any response within the stipulated time, the grievance can be submitted to the Court of Law by the PAPs or a representative of a non-profit organizations or the Village Grievance Committee on behalf of the PAPs or at the request of the Project. The Court of Law will follow up with the relevant authorities to make the final and binding decision.

- Stage 5: If the Project is found responsible for negligence, the Project will cover in full all administrative and legal fees incurred by PAPs in the GRM process at the district, provincial

and MONRE levels and in the Court of Law. Complaints and grievances concerning impacts during construction will be considered up to and no more than one year after the official date of completion of construction.

Establishment of Committees

Committee	Committee Members
Village Grievance Committee	• Village head (chairperson); • Representatives of local village authorities; • Village elders; • Representatives of community organizations, including LWU
District Grievance Committees	• Representative of the District Authority (chairperson); • Local village leaders/ heads; • Other PAP representatives • Local village elders and/or other local community organizations, including the LWU; • Representatives from local not-for-profit organizations; • Representatives from the Project team.
Provincial Grievance Redress Committee	• Representative of the provincial authority (chairperson); • Representatives from the provincial or district authority • Representatives from the PAP • Representatives from community organizations, e.g. LWU • Representatives from a local not-for-profit organization; • Representatives from the Project team.

The committees will be established at the beginning of the Project, particularly before resettlement. This will be done by making a formal request to the government for the relevant authorities in each province to establish the Provincial and District Grievance Committees. The District Committees will be given the authority to establish Village Grievance Committees.

ADB Accountability Mechanism

As partial funding for the Project is being sought from the ADB, the environmental and social safeguards of the ADB will also apply to the Project. This includes the ADB Accountability Mechanism (AM), a procedure through which a stakeholder can seek a solution or redress for their grievances.

The mechanism has two key components. The first, led by the Special Project Facilitator (SPF), is to respond to grievances raised by stakeholders affected by ADB-funded projects. The second component is led by the Compliance Review Panel (CRP), which consists of three members. The focus is on investigating issues of alleged noncompliance by ADB with its operations policies and procedures that has or is likely to cause direct and material harm to PAPs.

All grievances are received by the Complaint Receiving Officer (CRO). It is the CRO's responsibility to then direct the grievance to either the SPF or the CRP.

Project stakeholders will be informed of the AM process and provided with a Lao language brochure describing the process and their rights.

Monitoring and Reporting

Extensive monitoring of the Project will be carried out at various levels:

- Routine monitoring of activities and conditions during construction and operation by the Contractor and/or Subcontractors. To ensure mitigation measures are fully implemented, each compliance report will be made available and will be provided to the Project owner with a readily accessible record of construction progress, photographic documentation, and documentation of compliance with the Project environmental requirements.
- Periodic (sometimes unscheduled) monitoring of impacts and of compliance by two organizations established for this purpose: the Ministry of Natural Resources and the Environment, and the Environmental Management Office under the Owner's Environmental and Social Department.
- An Independent Monitoring Agency (IMA) is to be engaged by the government and funded by the owner to monitor and evaluate compliance with environmental safeguards and measures. The IMA will include well qualified experts in environmental and social monitoring to ensure compliance of the Company activities with its environmental and social contractual obligations. The monitors will focus on (i) improvement of the project monitoring activities, (ii) improvement of environmental and social measures to be implemented by ESD, (iii) improvement to be made in the grievance redress procedures to be implemented through the Project, and (iv) compliance with agreed entitlements and other obligations. The team will visit the different project sites during the construction and operation phase of the project on a bi-annual basis.
- Representatives of ADB and the lenders will be involved in regular field visits to monitor the project's progress in implementing environmental and social measures.
- Monitoring and Inspection by Independent Advisory Panel (IAP). The IAP's scope is comprehensive, extending to the setting, design, and plans for construction and operation. This includes review of all relevant environmental assessments, operational and construction plans, environmental management and monitoring plans, resettlement action plans, plan for indigenous peoples and associated reports on project progress and corrective actions.

Reporting

From the beginning of construction works through to the end of the concession period, the Owner shall prepare and submit monthly reports to MONRE covering the following items:

- Progress made on measures assessed against approved measures and monitoring programs;
- Difficulties encountered in implementing environmental measures, recommendations for remedying those difficulties, and steps to prevent or avoid similar difficulties;
- Number and type of non-compliances with the measures, and proposed corrective actions and timelines for completion of those actions;
- Relevant information from reports by construction contractors;
- Accidents or incidents relating to the environmental, social, and welfare of stakeholders; and
- Monitoring data of environmental parameters and conditions as committed in this EIA, the ESMMP-CP, and SSESMMP.

The Owner shall also prepare and submit an annual report to MONRE covering the following:

- A summary of the items covered by the Monthly Reports required above;
- Gantt diagram showing activities against what was planned for that period;
- Description and analysis of hydrology data and water quality
- Description and analysis of wildlife and fishery monitoring data;
- Description and analysis of hazardous substances waste data;
- Description and analysis of environmental incidents and accident data;
- Progress of planned outputs and performance objectives;
- Account of the environmental performance of all Project and related activities;
- Significant problems encountered and remedial measures taken; and
- Identification of any deviation from the ESMMP-CP, and EMP.

In the event of any accident, non-compliance, or other incident that may cause adverse environmental impact, the owner will report to MONRE and to the Department of Energy Business in writing, no more than seven days after becoming aware of such an incident. The owner will also inform the affected persons of any such adverse environmental impact.

The Owner will submit monitoring reports on quarterly basis to the lenders including ADB during the construction stage and semi-annually during the first two years of operation.

Institutional Arrangements and Implementation

While it is the responsibility of the Project owners and developers to mitigate any adverse environmental impacts and to assure environmental conditions will enhance the lives and livelihoods of the people in the Project area, it is the responsibility of the government to monitor the effectiveness of the mitigation measures, to facilitate public participation and involvement, and to assure the rights and the livelihoods of the people affected by the Project are protected. Environmental mitigation measures are thus to be carried out through or with the cooperation of the government at local, district, provincial and national levels.

At national level, government responsibilities will lie with the Joint Steering Committee (JSC) and MONRE as the primary supervisory and monitoring body. A JSC Secretariat will include the Department of Environmental and Social Impact Assessment (DESIA) of MONRE, the Department of Energy Promotion and Development (DEPD) of the Ministry of Energy and Mines, and the Resettlement Management Unit (RMU) established for this Project.

Environmental Management Unit

An Environmental Management Unit (EMU) will be established in MONRE to oversee implementation and monitoring of Project environmental components. These components will be carried out by agencies in MONRE and the Ministry of Agriculture and Forestry (MAF). Provincial and District EMUs will be established, consisting of the heads of the relevant government offices for the various environmental aspects of the Project. EMU staff will be engaged full time on this Project. They can be seconded from other offices or engaged on a contract basis.

Provincial EMUs will be established in each of the provinces affected by the Project, and District EMUs will be established in each of the districts affected by the Project, to assist the EMU in monitoring the environmental impacts and the mitigations measures of the Project.

The central Environmental Management Unit office will consist of an EMU Director (the Director-General of the DESIA, plus personnel from the Financial and Planning Division of MONRE and from other divisions of MONRE as required.

The primary tasks of the EMU are to:

- Review and make recommendations on the environmental management plans (EMPs);
- Monitor the implementation of the EMPs (both during construction and during operation), through independent and joint field monitoring and inspection;
- Monitor compliance with the safeguards and environmental obligations of the Project;
- Monitor all environmental and labour grievances;
- Inspect and identify measures to solve Project environmental and labour issues;
- Coordinate with central and local government agencies in the implementation of the EMPs;
- Review environmental reports produced by the Project; and
- Recommend the selection of the IMA for environmental matters, and coordinate work of the IMA on environmental matters.

In addition to the EMU, the Provincial Resettlement and Livelihood Restoration Committee (PRLRC) and the Resettlement Mangement Unit (RMU), while primarily involved with resettlement and other social issues, will also deal with environmental matters such as:

- Assuring GOL agencies assist with the proper use of land for agriculture and other uses by the resettled communities and by others in the Project area, so as to limit any detrimental impacts on the Project;
- Assuring GOL agencies provide adequate protection of the forests by the resettled communities and other communities in the Project area; and
- Assuring GOL agencies help monitor fish and other aquatic life in the Nam Ngiep and its tributaries, and provide assistance if the Project has any harmful impacts on fish or other aquatic life used by the local residents for food and/or their livelihoods.

Nam Ngiep 1 Power Environmental and Social Division

Within Nam Ngiep 1 Power, the Project owners will establish an Environmental and Social Division that will consist of both an Environmental Management Office (EMO) and a Social Management Office. Among the Division's responsibilities will be to:

- Manage the environmental, social, economic and resettlement components, using consultant inputs as required;
- Coordinate activities during construction and after construction with relevant government agencies, with the aim of improving the environmental performance of the Project during its operating phase; and
- Detect breaches of the standards during compliance monitoring and mitigation measures, resolve the problems and report on the outcomes.

The major tasks of the EMO are to:

- Collect baseline data and information and conduct subsequent monitoring of all aspects of the environment and labour that could be affected by the Project, such as fish and other marine resources, hydrology, water quality, river bank erosion, forest cover, etc.;
- Coordinate with the EMU and other GOL agencies to implement the mitigation measures in the EMP; and
- Assist the EMU in public consultations on environmental matters with stakeholders.

The EMO will include an environmental monitoring team and a construction monitoring team. The teams will continue to function throughout the first three years of the operation phase, but in gradually reduced numbers and roles, eventually with only the Environmental Compliance and Monitoring Team, which will then become included as part of the regular operations staff. The construction monitoring team will conclude its activities at the end of construction.

Budget

The figures below (in US$) are indicative of funds already set aside for environmental measures, but do not include various activities that will cover both environmental and social programs.

Item	Budget before COD	Budget after COD	Total Budget
ESD, EMU, PRLRC, RMU operation and working group	9,000,550	2,076,950	11,082,500
Environmental management cost	2,803,189	3,437,000	6,240,189
Watershed Management cost	367,076	1,809,844	2,176,920
Total	12,170,815	7,323,794	19,499,609

Budgets will be re-evaluated regularly to suit realignment of company organization, operation unit and updates to the environmental management plan. Any newly proposed budget shall be consistent at least with the budgets proposed in the Concession Agreement.