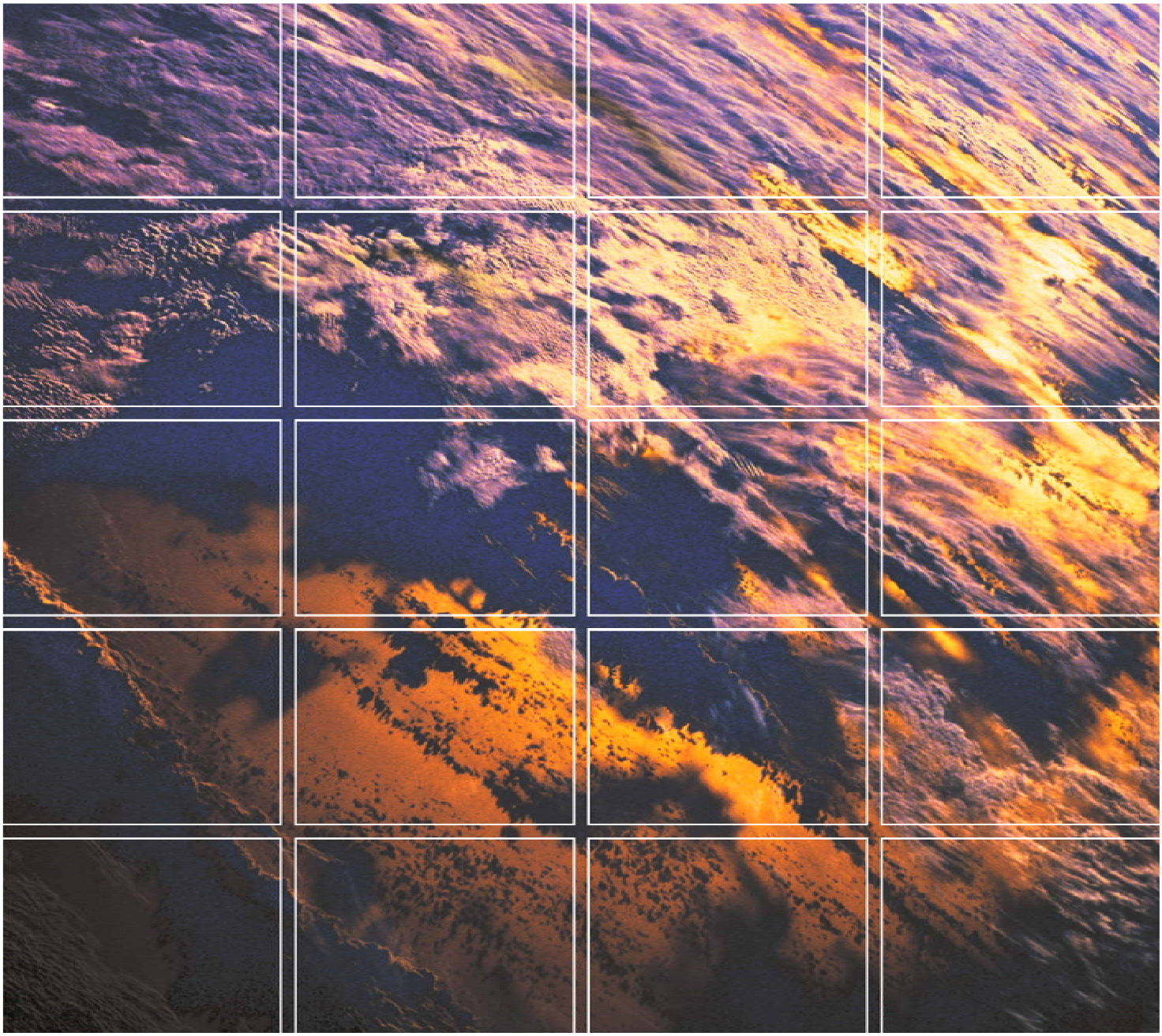

Nam Ngiep 1 Hydropower Project

Biodiversity Cumulative Impact Assessment

For Nam Ngiep Power Company Ltd.

January 2014

0200749

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ERM

Nam Ngiep 1 Hydropower Project

Biodiversity Cumulative Impact Assessment

Nam Ngiep Power Company Ltd.

January 2014

Approved by:	David Nicholson
Position:	*Project Manager*
Signed:	
Date:	17 January, 2014
Approved by:	Cristina Pellegrino
Position:	*Partner Director*
Signed:	
Date:	17 January, 2014

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FINAL REPORT

Nam Ngiep Power Company Ltd.

Nam Ngiep 1 Hydropower Project
Cumulative Impact Assessment

January 2014

Reference: 0200749

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NNP1 CUMULATIVE IMPACT ASSESSMENT

EXECUTIVE SUMMARY

ERM has prepared this Cumulative Impact Assessment (CIA) for the Nam Ngiep 1 Power Company (NN1PC) following a request by the Asian Development Bank to prepare this assessment. The purpose of the assessment is to better understand the impacts of past and future actions on the Nam Ngiep River and watershed.

This current CIA document is based on the principles outlined in the following documents:

- *the U.S. Council on Environmental Quality (CEQ) implementing the National Environmental Policy Act (NEPA) (US EPA 1999);*
- *International Finance Corporation Performance Standards 1 and 6 (IFC 2012);*
- *IFC's Draft (External Peer Review) – Cumulative Impact Assessment Guidance Note for Private Sector in Emerging Markets (ESSA & IFC 2012); and*
- *ADB Safeguard Policy Statement (2009).*

There is currently very little quantitative data available for other projects upon which to make an informed CIA for the Nam Ngiep watershed. Nonetheless, some other RFFAs for which impact assessments have been completed contain qualitative discussion of impacts.

An analysis of available information on seven other proposed hydro-electric power (HEP) projects in the area and various other reasonably foreseeable future actions (RFFA) was undertaken for this CIA. Impacts from this project and each of the RFFAs were considered on the VECs identified for the project:

- *VEC 1: Terrestrial biodiversity and habitats*
- *VEC 2: Aquatic biodiversity and habitats (including river flows)*
- *VEC 3: Ecosystem services*

The analysis was mostly qualitative as little quantitative data was available for the other projects.

The creation of reservoirs will inundate some terrestrial environments across the watershed however as the nature of the existing impacts is such that the valley floors are already exploited for agriculture and have been largely cleared, the impacts on these environments through inundation along will not be as large as the increased pressure on available resources from increased human populations.

The creation of reservoirs and barriers (i.e. dam walls) along water courses such as will occur for this project and the potential six other HEPs 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.

1 INTRODUCTION

1.1 THE CUMULATIVE IMPACT ASSESSMENT CONCEPT

Assessment of cumulative impacts builds from the assessment of the direct/indirect impacts of the Project undertaken during the Environmental Impact Assessment (EIA: ERI 2012) process and within the Initial Report (ERM 2013a). The results of the direct/indirect assessment are considered in combination with other past, present, and reasonably foreseeable future actions potentially affecting resources and receptors.

The ultimate goal of this analysis is to capture the total effects of many actions over time that may be inadvertently missed by evaluating each action individually. To encourage informed decision making we assess the relative contribution of the Project to the overall cumulative effects. The Cumulative Impact Assessment (CIA) describes the additive or combined result of the alternatives as they potentially interact with actions external to the Project. It is critical to focus the CIA on meaningful cumulative impact issues, rather than on all conceivable impact relationships.

1.2 LIMITATIONS

In order to deliver a comprehensive CIA, quantitative data is required on the Project and the other reasonably foreseeable future actions (RFFAs). Currently there is very little quantitative data available for other (RFFAs) upon which to make an informed CIA for the Nam Ngiep watershed. Nonetheless, some other RFFAs for which impact assessments have been completed contain qualitative discussion of impacts. For this reason, the CIA process for the Nam Ngiep watershed is somewhat constrained.

2 METHODOLOGY

2.1 APPROACH

An Initial Report containing a CIA was prepared by ERM in 2013 and submitted to the Asian Development Bank (ADB) for review. This current CIA document is a revision based on the ADB review of the draft Initial Report (24 May 2013) and the subsequent ADB review of the Environmental Impact Assessment Report (16 December 2013) with some reliance on guidance from the principles outlined in the following documents:

- the U.S. Council on Environmental Quality (CEQ) implementing the National Environmental Policy Act (NEPA) (US EPA 1999);
- International Finance Corporation Performance Standards 1 and 6 (IFC 2012);
- IFC's Draft (External Peer Review) – Cumulative Impact Assessment Guidance Note for Private Sector in Emerging Markets (ESSA & IFC 2012); and
- ADB Safeguard Policy Statement (2009).

Consistent with the IFC's Draft (External Peer Review) – *Cumulative Impact Assessment Guidance Note for Private Sector in Emerging Markets,* this CIA report focusses on the identified Valued Environmental and Social Components (VECs) (ESSA & IFC 2012). VECs are environmental and social attributes that are considered important in assessing risk (ESSA & IFC 2012). The VECs identified as a result of the literature review described in *Section 3.1* are:

- VEC 1: Terrestrial biodiversity and habitats
- VEC 2: Aquatic biodiversity and habitats (including river flows)
- VEC 3: Ecosystem services

Discussion of these VECs is provided in *Section 6.1* framed in terms of the parameters (consistent with the ADB review of the draft Initial Report):

- Known or suspected impacts by the project and RFFAs;

  Known cumulative impact issues in the region; and
- Concerns generally recognized as important on the basis of scientific concerns.

2.2 *INVESTIGATION AREAS*

In order to satisfy the assessment requirements, a number of locations were assessed for baseline biodiversity values. Within this report the following terminology applies:

- Study area – the area encompassing all areas assessed for biodiversity values. This includes the Project area and candidate offset sites (*Figure 4.1*).
- Project area – the area potentially directly and indirectly affected by the Project. This includes the footprint of disturbance of the various components.
- Candidate offset sites – the areas investigated to provide potential offset sites. This included consideration of the biodiversity values at four locations the Upper Nam Ngiep River, Nam Xan River, Huay Ngua Provincial Protected Area and the Phou Khao Kouay (PKK) National Protected Area (NPA).

The location of the investigation areas is shown in *Figure 4.1*.

3 INFORMATION SOURCES

3.1 LITERATURE REVIEW

Key documents used to inform this CIA include:

- *Nam Ngiep 1 Hydropower Project Environmental Impact Assessment (EIA) Draft Report*, Prepared by Environmental Research Institute (ERI), Chulalongkorn University, 2012.
- *Nam Ngiep 1 Hydropower Project Social Impact Assessment Report*, prepared by Sriburi *et al.* for the Kansai Electric Power Company Inc., May 2012.
- *Nam Ngiep 1 Hydropower Project Biodiversity Baseline Report,* prepared by ERM for KANSAI Electric Power Co., INC., September 2013.
- *Nam Ngiep 1 Hydropower Project Resettlement Technical Review Final Report*, prepared by ERM-Siam, Co Ltd. for the Kansai Electric Power Company Inc., May 2013.
- *Lao: Nam Ngiep 1 Hydropower Project, Draft Initial Environmental Examination (IEE),* Prepared by The Kansai Electric Power Company, Inc., EGAT International Company, Ltd. And Lao Holding State Enterprise for the Asian Development Bank, January 2012.
- *Power System Development Plan for Lao PDR: Final Report, Volume C: Project Catalogue*, Prepared for Lao People's Democratic Republic, Ministry of Industry & Handicrafts, Department of Electricity and World Bank by Maunsell Limited 2004.
- *Nam Phouan Hydropower Project: Environmental and Social Impact Assessment*, Prepared by Velcan Energy, and Lem Consultants, September 2012.
- *Nam Ngiep 2 Hydropower Project Final Environmental Impact Assessment Report,* Prepared by NCC Environmental Assessment Team, February 2010.
- *National Statistics Centre of the Lao PDR*. Lao Department of Statistics NSC (2007).

3.2 BIODIVERSITY SURVEY (THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR))

In order to supplement the available information (above), field investigations were undertaken in March and July 2013 by the Thailand Institute of Scientific and Technological Research (TISTR) to collect data representative of wet and dry season biodiversity conditions.

The surveys incorporated detailed assessments that included forest and vegetation cover survey and assessment, wildlife survey and assessment, and aquatic ecology survey and assessment.

Survey was undertaken at four of the investigation areas that include:

- The Project area (main dam site and reservoir, re-regulation dam site, resettlement site/lower Nam Ngiep);
- Upper Nam Ngiep River;
- Upper and lower Nam Xan River; and
- Huay Ngua provincial protected area.

3.3 VILLAGE AND MARKET SURVEYS

Two field visits were conducted. The first visit was undertaken in February and March 2013. The visit included engagement with key government and non-government officials to understand current land use and tenure as well as use and threats to biodiversity in the Nam Ngiep River watershed and potential offset site. In addition, village and market surveys were undertaken. These were used to gather data on the utilisation of ecosystem services by project affected people (PAP), including the use of threatened flora and fauna. The village surveys included focus group discussions and in-depth interviews with relevant community representatives (e.g. hunters, gatherers); while the market surveys involved visual review and informal discussions with stall operators.

The second field visit was conducted in July 2013. The focus was on understanding and assessing the ecosystem services in the potential offset sites as well as community acceptance of the proposed offset measures. The survey approach was similar to that conducted in the first field visit – e.g. focus group discussions, in-depth interviews and visual surveys.

In total, 18 villages and four markets were surveyed. The outcome was an understanding of stakeholder opinions and concerns as they relate to the potential offset sites and proposed offset measures and an understanding of ecosystem services utilised by local community members.

3.4 GOVERNMENT AGENCY AND NON-GOVERNMENTAL ORGANISATION (NGO) CONSULTATION

During early September, ERM consulted with relevant agencies and NGOs to discuss aspects of the NNP1 project. This consultation included discussion and information requests regarding other hydro-electric power projects (HEPs) and other current and proposed developments, including mines and forestry. The consultation occurred as shown in *Table 3.1*.

Table 3.1 ERM Consultation with Government Agencies and NGOs

Agency	Person
March 2013	
Independent Advisory Panel	• Ms Kathy MacKinnon & Dr Charly Mehl
Non-Government Organisations	• Mr Alex McWilliam Mr Troy Hansel Wildlife Conservation Society (WCS) (Lao PDR Program) • Mr Vene Vongphet, International Union for the Conservation of Nature (IUCN) (Vientiane Office)
Regional Administrative Agencies	• Mr Amphavanh Sisouvanh, Mr Simon Krohn, Mr Piseth Chea, and Mr Henrik Larsen Mekong River Commission (Vientiane Office)
Lao PDR Government Departments	• Mr Viengkeo Souksavadty, Deputy Director General, Ministry of Information, Culture and Tourism (MICT) • Outakeo Keoduangsing, Director of Legal Division, Investment Promotion Department, Ministry of Planning and Investment (MPI) • Mr Saysomone Phothisat Deputy Director General and Mr Lampanh Kommadam Director of Conservation Forest Management, Department of Forest Resource Management (DFRM) • Mr Aengphone Phaengsuwan, Director of Centre – EIA Review of Hydropower Projects, DESIA and Peter G. Jensen, Chief Technical Advisor, Ministry of Natural Resources and Environment (MoNRE)
Local Officials	• Phou Khao Kouay NPA, Lieutenant Colonel That Keoathone
Others	• Mr Robert Allen, Theun-Hinboun Power Company Ltd • Mr Martin Hollands, Conservation Policy and Practice Ltd. (Former Lao PDR Program Manager, WWF) • Ms Marion Ravenscroft, Lao National Museum (see MICT section)
August 2013	
Lao PDR Government Departments	• Mr Lamphanh Kommadam, Ministry of Natural Resources and Environment, Department of Forestry Resource Management Director of Conservation Forest Management Division • Mr Khamphoui Sivongxay Water Resource Data & Information Centre, Department of Water Resources, Ministry of Agriculture and Forestry, Department of Forestry • Mr Bounpone Sengthong Director of Production Forest and Timber Harvest Management Division • Mr Keodokmay Phouipaseuth Ministry of Natural Resources and Environment, Department of Water Resources Division of Water Surface and Groundwater Quality Management • Mr Saysamone Phothisat Deputy Director General Ministry of Natural Resources and Environment, Department of Forestry Resource Management • Mr Kingkham Manivong Head of Law Division Water Resource Data & Information Centre, Department of Water Resources
International Aid agencies	• Rachel Jolly Aus AIDManager - Mekong Water Resources Unit • John Dore Aus AIDSenior Regional Water Sector Specialist

4 PROJECT IMPACTS BASELINE

Project impacts are discussed in detail in ERI (2012), ERM (2012) and ERM (2013a). This section provides some regional context of the Project Area.

4.1 REGIONAL SETTING

The overall Study area consists of two adjacent catchments in Lao PDR. The Nam Ngiep and Nam Xan catchments which are in the Bolikhamxay Province, 145 kilometres (km) northeast from Vientiane or 50 km north from Pakxan District. The study area is shown in *Figure 4.1*.

The Nam Ngiep watershed (where the Project area is located) is approximately 340,000 ha in size. The inundation area proposed for this project will consist of two reservoirs: the main reservoir (main dam) being 6798 ha in size; and a smaller subsidiary reservoir (re-regulation dam) being 699 ha in size. The total length of the proposed inundation area from Ban Piengta to the proposed main dam is around 73 km and from main dam to the proposed re-regulating dam is around 5 km.

The Nam Xan watershed is 210,000 ha in size. The study area encompasses a 140 km reach of the Nam Xan River and the surrounding forested areas and villages.

The population density in the Nam Ngiep catchment is not high. Settlements are nearly all limited to the river valleys, with the main exceptions being the large expanse of fairly flat land towards the Mekong River and larger valleys toward the north and northeast of the watershed. These are also some of the most populated areas in the watershed. The major settlements relative to the Nam Ngiep catchment are: Phonsavan, the capital of Xieng Khouang Province is just outside the catchment boundary to the north and Pakxan, the capital of Bolikhamxay Province downstream of the proposed dam near the Nam Ngiep confluence with the Mekong River. Other settlements in the north of the Nam Ngiep catchment include Muang Khoun and Phaxai.

The main road through the watershed is National Road 1D, which was until recently a dirt road with some sections covered in gravel. It connects Phonsavan (the capital of Xieng Khouang Province) with Pakxan (the capital of Bolikhamxay Province). It runs north from Pakxan through the Nam Xan watershed and then turns west to go through the northern part of the Nam Ngiep watershed. Urban development and consolidation occurs along this road. No major thoroughfare roads are in the lower part of the Nam Ngiep watershed.

250000
300000
350000
400000
2150000
2100000
2050000

Legend

- Nam Ngiep Catchment Boundary
- Waterbody
- Road
- City or Town
- Lao PDR Boundary
- National Park Boundary

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

N
0 10 20 30Km
1:600,000

Basemap: Bing Maps
Datum: WGS84

Phoukout
Phonsavan
Nonghet
Muang Khoun
Phaxai
Nam Ngum
Nam Ngiep
Thathom
Vang Vieng
Nam Song Diversion
Nam Ngum 2 Reservoir
Nam Xan
Nam Ngum Reservoir
Hinheup
Ba. Donkha
Nam Ngum Reservoir
Longxan
Huay Ngua Provincial Protected Area
Phou Ngou Provincial Protected Area
Thinkeo
Phonhong
Nam Ngum Reservoir
Nam Leuk reservoir
Phou Khao Khouay National Protected Area
Nam Kading National Protected Area
Mekong River
Nam Mang 3 Reservoir
Ban Keun
Pakxan
Phou Pha Nang National Protected Area
Hai
Tha Ngon

bing

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_CIA_G001_R0.mxd	
Date:	10/01/2014	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 4.1 - Regional Setting

Nam Ngiep 1 Hydropower Project
Biodiversity Cumulative Impact Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

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4.1.1 Terrestrial Environments

Lao PDR is highly bio diverse, when compared with many other countries, including its immediate neighbours. According to the UNDP (2009), as cited in ERI (2012), at least 166 species of reptile and amphibian, 700 bird species, and 100 mammal species are found in Lao PDR.

The Project is proposed to occur in central Lao PDR within the Mekong River basin within the Luang Prabang Montane Rainforest Ecoregion (IM0121) defined by the Worldwide Fund for Nature (WWF) (WWF 2003a).

The Luang Prabang Montane Rainforests Ecoregion comprises areas largely above 800 m in north-central Lao PDR and is globally recognized for its diversity in bird species (some 540 different species of birds have been recorded here) despite more than 70% of the original forest cover being lost as a result of shifting cultivation. The remaining forests contain a rich mix of tree and non-timber species including hardwoods, conifers, rhododendron, ferns, orchids and lichens (WWF 2003b). No endemic species have been recorded in this ecoregion but this is thought to be due to the lack of biological surveys rather than a true lack of endemics.

The ecoregions is characterised by a variety of forest associations including montane hardwoods, mixed conifer-hardwood forests, open montane forests, and open conifer forests (Wikramanayake *et al* 2002). These forests have been subject to heavy logging pressure and much of the forest cover of central Lao PDR is subject to existing forestry operations, or occurs within approved forest leases. Humid evergreen forest occurs at lower elevations around 800 m with *Dipterocarpus turbinatus* and *Toxicodendron succedaneum* as the dominant over storey species. The low stature of trees in this community and open understory with an abundance of broad-leaved monocots and grasses suggest severe past impacts from burning and clearance (Wikramanayake *et al* 2002). Slash and burn agriculture is a land use that is still practiced widely in central Lao PDR, including the Project Area (ERM 2013a).

Large tracts of remnant and intact forest are known to occur in less accessible parts of the ecoregion housing several large mammals such as Northern White-cheeked Gibbon (*Nomascus leucogenys*), Tiger (*Panthera tigris corbetti*), Asian Elephant (*Elephas maximus*) and Asiatic Black Bears (*Ursus thibetanus*); all of which are considered to be under continued threat due to habitat loss and hunting/ poaching (WWF 2003b).

The forest types within the Nam Ngiep watershed were classified according to the classifications and definitions from Forest Inventory and Planning Division, Department of Forestry (DoF). In ERM (2013a) it is noted that the forest and land use data used by ERI (2012) for the EIA was based upon superceded imagery; the Assessment of Forest Cover and Land Use during 1992-2002 (Department of Forestry 2005) has been superseded by land cover mapping data prepared by the Department of Forest and Resource

Management (DFRM) in 2010 (DRFM 2010). *Figure 4.2* and *Table 4.1* show the land cover mapping of the Project Area region.

Table 4.1 Land Cover of the Nam Ngiep Catchment Above the Proposed NNP1 Project

Land Cover	IFC Habitat Class	Area (ha)	% of Total
Decidous Forest	N	62017	46
Evergreen Forest	N	38492	29
Bamboo	N	6018	4
Old Fallow Land	M	16559	12
Young Fallow Land	M	4582	3
Slash and Burn	M	1837	1
Rice Paddy	M	276	0
Grassland	M	4028	3
Urban Area	M	45	0
Water	-	491	0
Rock	-	167	0
Cloud	-	34	0
Shadow	-	167	0
Total		134713	
* N=Natural; M=Modified.			

300000 310000 320000 330000 340000 350000 360000

2120000 2110000 2100000 2090000 2080000 2070000 2060000 2050000 2040000 2030000

Legend

- Evergreen Forest (Current Forest)
- Deciduous Forest (Current Forest)
- Deciduous Forest Plantation (Current Forest)
- Bamboo (Potential Forest)
- Old Fallow Land (Potential Forest)
- Young Fallow Land (Potential Forest)
- Slash and Burn Land (Potential Forest)
- Rice Paddy
- Grassland
- Swamp
- Rock
- Barren Land
- Urban Area
- Water
- Other Land
- Cloud
- Shadow
- Nam Ngiep Inundation Area
- Re-regulation Dam
- Proposed Access Road
- Nam Ngiep Sub-catchment Boundary

N

0 2.5 5 7.5Km

1:250,000

Land Cover: DFRM
Datum: WGS84

Mekong River

Client:	Nam Ngiep Power Company Ltd.		**Figure 4.2 - Land Cover Mapping of the Project Area Region**
Drawing No:	0185065b_CIA_G002_R0.mxd		Nam Ngiep 1 Hydropower Project Biodiversity Cumulative Impact Assessment
Date:	17/01/2014	Drawing Size: A3	
Drawn By:	TC	Reviewed By: DN	Environmental Resources Management ANZ

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Protected Areas and National Biodiversity Conservation Areas (NBCAs)

National Biodiversity Conservation Areas (NBCAs) were established in Lao PDR in 1993 under a Prime Ministerial Decree. At 2012, the total land area of Lao protected under these NBCAs was 3.4 million hectares or 14.3% of the country's total area (ERI 2012). Other conservation areas and protection forests are designated at provincial and district level bringing the total national protection and conservation forest area to 11.76 million hectares or 49.6% of the total land area (ERI 2012). *Figure 4.1*shows the NBCAs relative to the regional setting of the Project Area. There are no NBCAs in the NNP1 project catchment. Two NBCAs occur near the Nam Ngiep River channel downstream from the NNP1 project area: Huay Ngua Provincial Protected Area (PPA) and Phou Ngou PPA.

- Huay Ngua PPA: Located approximately 8 km downstream of the NNP1 project and is 5435 ha in area.

- Phou Ngou PPA: Located approximately 11 km downstream of the NNP1 project and is 6610 ha in area. Phou Ngou PPA is a narrow, elongated shape that follows a ridge line running north-west to south-east and contains no major watercourses or lakes

Neither of these PPAs include aquatic environments that will be impacted by the NNP1 project.

Flora and Fauna of the Project Area

Flora

The diversity of vascular plants recorded in the inundation area (upper Nam Ngiep) was greater in comparison to all other areas sampled, with at least 509 species recorded. The primary vegetation types at each of the components of the Project is summarised in *Table 4.2*.

Table 4.2 Primary Forest Type at Project Area

Survey Location	Forest Type Description
Main Dam Site	**Mixed deciduous forest** located in the steep valley. Nearby the forest is mixed with some species of dry evergreen forest. Canopy cover is approximately 60-70%. Top canopy height is 20-40 m.
Resettlement Site	**Secondary growth of mixed deciduous forest**. Canopy cover is approximately 40%. The average height of the upper canopy is approximately 15 m.
Re-regulation Dam Site	**Lower mixed deciduous forest** and **mixed deciduous forest** on one river bank. Canopy cover is approximately 50-60%. Top canopy height is 10 m. On other river bank is Eucalyptus plantation. Canopy height is 15 m under which is densely covered by seedlings of the original mixed deciduous forest type.
Lower Nam Ngiep	Dominated by **disturbed mixed deciduous forest**. Canopy cover is approximately 60-70%. Top canopy height is 20-30 m.

Survey Location	Forest Type Description
Transmission Line	**Secondary growth of mixed deciduous forest** with canopy cover of 40%. Forest condition and species diversity is similar to the Resettlement site. The average height of the upper canopy is approximately 15 m.

For the forest types the forest canopies are divided in 3 classes. The dominant species for each survey locations are summarised in *Table 4.3*.

Table 4.3 Dominant Flora Species in Project Area

Canopy class	Dominant species
Main Dam Site Mixed Deciduous Forest	
Top canopy (20-35m)	*Pometia pinnata* Forst, *Duabanga grandiflora* (Roxb. ex DC.) Walp., *Lagerstroemia calyculata* Kurz, *Toona ciliata* M.Roem., *Pterospermum diversifolium* Blume
Middle canopy (10-15m)	*Nephelium hypoleucum* Kurz, *Mitrephora tomentosa* Hook.f. & Thomson, *Baccaurea ramiflora* Lour., *Saracia indica* L., and *Arenga weaterhoutii* Griff.
Lower canopy (<10m)	saplings and seedling of the higher canopies
Resettlement Site Secondary Growth of Mixed Deciduous Forest	
Top canopy (~15m)	*Taliparitimacrophyllum* (Roxb. ex Hornem.) Fryxell, *Peltophorum dasyrachis* (Miq.) Kurz, *Macaanga denticulata* (Blume) Müll.Arg., *Lepisanthes rubiginosa* (Roxb.) Leenh., *Cratoxylum formosum* (Jack) Dyer., *Aporosa villosa* (Wall. ex Lindl.) Baill., *Chaetocarpus castanocarpus* (Roxb.) Thwaites, *Maesa ramentacea* (Roxb.) A.DC., *Irvingia malayana* Oliv. ex A.W.Benn. and *Lagerstoemia calyculata* Kurz.
Lower canopy (<10m)	Densely covered by seedlings of original forest type, shrubs, climbers and herbs such as *Cleistanthus papyraceus* Airy Shaw, *Ardisia helferiana* Kurz, *Chionanthus velutinus* (Kerr) P.S.Green, *Connarus semidecandrus* Jack and *Amomum biflorum* Jack. The typical species of bamboo found in the area is *Gigantochloa albociliata* (Munro) Kurz.
Re-regulation Dam Lower Mixed Deciduous Forest	
Top canopy (~10m)	*Macaanga denticulata* (Blume) Müll.Arg., *Maesa ramentacea* (Roxb.) A.DC., *Milletia acutiflora* Gagnep. and *Lagerstoemia calyculata* Kurz. The common species of bamboo found in the area, which are *Gigantochloa albociliata* (Munro) Kurz, *Pseudostachyum polymorphum* Munro and *Bambusa bambos* (L.) Voss.
Lower Nam Ngiep Disturbed Mixed Deciduous Forest	
Top canopy (20-30m)	*Gironniera nervosa* Planch., *Ficus racemosa* L., Morus alba L., *Xanthophyllum lanceatum* (Miq.) J.J.Sm, etc. In a particular area, a cemetery forest, contains a very large tree, and dominated with *Lagerstroemia calyculata* Kurz. The forest is highly respected by local people, and very well preserved
Middle canopy (10-18m)	*Callicarpa arborea* Roxb., *Litsea glutinosa* (Lour.) C.B.Rob., *Crudia chrysantha* (Pierre) K.Schum., *Cratoxylum formosum* (Jack) Dyer, etc.
Lower canopy (<10m)	Saplings and seedling of the trees in the higher such as *Trewia nudiflora* L., *Baccaurea ramiflora* Lour., *Pseuduvaria rugosa* (Blume) Merr, *Mallotus philippinensis* Müll.Arg., etc.
Transmission Line Secondary Growth of Mixed Deciduous Forest	
Top canopy (~15m)	*Taliparitimacrophyllum* (Roxb. ex Hornem.) Fryxell, *Peltophorum dasyrachis* (Miq.) Kurz, *Macaanga denticulata* (Blume) Müll.Arg., *Lepisanthes rubiginosa* (Roxb.) Leenh., *Cratoxylum formosum* (Jack) Dyer., *Aporosa villosa* (Wall. ex Lindl.) Baill., *Chaetocarpus castanocarpus* (Roxb.) Thwaites, *Maesa ramentacea* (Roxb.) A.DC., *Irvingia malayana* Oliv. ex A.W.Benn. and *Lagerstoemia calyculata* Kurz.

Canopy class	Dominant species
Lower canopy	Densely covered by seedlings of original forest type, shrubs, climbers and herbs such as *Cleistanthus papyraceus* Airy Shaw, *Ardisia helferiana* Kurz, *Chionanthus velutinus* (Kerr) P.S.Green, *Connarus semidecandrus* Jack and *Amomum biflorum* Jack. The typical species of bamboo found in the area is *Gigantochloa albociliata* (Munro) Kurz.

Fauna

The main dam area was surveyed for fauna during the 2007 survey with additional data collected in 2013. The diversity of fauna in the main dam inundation area (upper Nam Ngiep) was high in comparison to other areas sampled in 2013 (the candidate offset sites). Habitats varied in condition with human disturbance evident in areas downstream of the main dam location. The habitats of the main surveyed areas include:

- The main dam area - The upper area of the Nam Ngiep River is dominated by primary forest. The habitat in this area if in good condition for wildlife in comparison to other areas surveyed. Site surveys detected (through interviews with villagers or direct observation) at least 46 mammals species, 50 bird species, 28 reptiles species and 10 amphibian species.

- The resettlement area - The resettlement area is mostly and heavily disturbed as a result of slash and burn activities. There is evidence of some regeneration and secondary growth. Site surveys detected (through interviews with villagers or direct observation) at least 9 mammals species, 24 birds species, 19 reptiles species and 8 amphibian species.

- Downstream of the Project (lower Nam Ngiep River) - This area is mostly disturbed and dominated by agricultural landuse. There is high human activity in this area. Site surveys detected (through interviews with villagers or direct observation) at least 12 mammals species, 27 birds species, 21 reptiles species and 7 amphibian species.

4.1.2 Hydrology

The Mekong River discharges approximately 475 km^3 of water annually and its basin covers an area of 795,000 km^2 (Mekong River Commission 2011). The Nam Ngiep River originates near Phonsavan and travels south-southeast through the mountain regions of Hom district in the Vientiane Province and Bolikhan district in the Bolikhamxay Province. The river emerges from a ravine around 7.7 km upstream of the village of Hat Gnium, where the NNP1 dam will be constructed. The river then flows downstream through to the confluence with the Mekong River at Pakxan.

The Nam Ngiep River is the eleventh longest tributary of the Mekong River in the Lao PDR (Phanthaba et al. 2005, as cited in ERI 2012). The Nam Ngiep watershed area at the dam site is estimated to be 3700 km^2 with the annual mean inflow of 148.4m^3/s or 4.68 km^3 per annum. The Nam Ngiep River accounts for 1.5% of the flow of the Mekong River (Hori 2000, as cited in ERI 2012). The Nam Ngiep watershed accounts for 0.5% of the Mekong River watershed area, and the NNP1 dam site captures approximately 1% of the total annual discharge of the Mekong River.

The estimated hydropower potential of the lower Mekong is 30,000 MW, approximately 10 per cent of this has been developed along Mekong tributaries (Mekong River Commission 2011). More than 70% of the 124 existing and potential tributary projects identified in the MRC hydropower database in 2009 are located in Lao PDR and 10% are located in Cambodia.

Because the Nam Ngiep River passes different habitats with elevations ranging from 1,300 m at the source to 200 m above the mean sea level (MSL) at its convergence with the Mekong, it supports a large variety of aquatic biota.

The proposed Project lies on the Nam Ngiep River which flows in a south-southeast direction through a mountainous region to the gorge at Hat Gniun village where the topography changes to a hilly landscape before entering the Mekong River at Pakxan. The gorge is the location for the proposed dam construction.

The flow regime of an aquatic ecosystem plays a role in the health and productivity of the system and for some species, flows can trigger movement during some periods. The Nam Ngiep River has a watershed area of 4320 km^2 with the river approximately 160 km in length (Kansai 2012). Flows of the river are influenced by the monsoon dominated weather which divides the year into clearly defined wet and dry periods. Peak discharges (200-325 m^3/s) occur between June and September with lowest discharge volumes (50-75 m^3/s) in February to April.

Aquatic Biota

Fish

The fish community of the Mekong River is large, with most of the production based on migratory river species (Poulsen *et al.,* 2004). Fish migration is an important component for many fish species life cycle. In the Mekong, fish migration can be generally described in terms of (EIA citing Poulsen *et al.*, 2004):

- annual movement between inundated floodplains (where most fish production originates) and dry season refuges;
- movement into spawning areas within the river system (usually upstream) from dry season refuges, generally upon start of flooding; and

- passive migration of fish fry downstream from spawning areas.

During the 2007 survey of the main dam site, 42 species were detected. The species detected included relatively similar proportion of surface feeder, column feeder and bottom feeder species. The survey within the main dam area during 2013 detected 75 species.

The EIA noted that the fish community detected 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 2013 survey. The EIA assessment also noted that of the larger species detected many are migratory species of the lower Mekong basin that move upstream during the wet season spawning activities (EIA citing Poulsen *et.al.* 2004). These larger species, such as mud carp (*Cirrhinus molitorella*) and Asian red tailed catfish *(Hemibagrus wyckioides*) were detected in 2007 and 2013 surveys. The surveys noted a number of juvenile individuals of the migratory species suggesting that the Nam Ngiep River plays a role in providing habitat for the reproductive cycle (EIA citing Lowe-McConnell 1995).

Other Biota

Benthic fauna and plankton samples were collected from the Project area with species richness varying at each sampling site. No specific trends in richness across sampling areas were identified. Complete results are provided in the Baseline Biodiversity Report.

4.2 SOCIAL PROFILE OF THE REGION

The Nam Ngiep watershed covers parts of seven districts in three provinces: two districts in Bolikhamxay (Bolikhan and Pakxan Districts), two in Vientiane Province (Hom and Xaisomboun Districts), and three in Xieng Khoung Province (Thathom, Phaxai and Khoun Districts).***Error! Reference source not found.*** *Table 4.4* presents the area of the provinces, and the number of villages, households, and population (male and female) in the entire province and in each of the districts that are part of the Nam Ngiep watershed.

Table 4.4 Districts, Villages, and Population in the Provinces in the Nam Ngiep Watershed Area (2008)

Province and Districts in Nam Ngiep Watershed Area	Area (km2)	Village	# Households	Population		
				Total	Female	Male
Vientiane(12 districts)	22,554	528	77,069	433,567	216,595	216,972
- Hom		41	4,044	28,153	13,540	14,613
- Xaisomboun		56	4,513	28,236	14,030	14,206
Bolikhamxay (6 districts)	14,863	326	39,827	231,544	114,509	117,035
- Bolikhan		45	5,592	35,964	17,549	18,415
- Pakxan		59	8,088	42,261	21,445	20,816
Xieng Khouang (8 districts)	17,506	502	39,029	249,817	123,865	125,952
- Thathom		23	2,163	13,106	6,355	6,751
- Phaxai		32	2,018	12,031	5,975	6,056
- Khoun		52	4,777	33,490	16,748	16,742

Source: Calculated from population census (NSC 2007).

Demographic characteristics of the provinces that share parts of the Nam Ngiep watershed are shown in *Table 4.5*. It can be seen that some public health conditions have changed dramatically for the better. It should be noted that at the time this information was collected, the portion of the project area now in Vientiane Province was then in the Xaysomboon Special Region (SR). In all, the crude birth rate has declined, as has the infant mortality rate. There has also been a drastic reduction in the crude death rates as basic health care, cleaner water, and other improvements have reached more communities. Yet the natural rate of population growth is still higher than the natural average in all but Vientiane Province. In all the poor and high priority poor areas of the watershed, it is likely that growing population is causing more pressure on the natural resources, with over-fishing, over-hunting, unsustainable use of lands, and over-extraction of non-timber forest products. As the resources are over-exploited and degrade, it is then the poorest who suffer the most (USAID 2006).

Table 4.5 ***Birth and Death Rates, Fertility and Infant Mortality in the Provinces of the Nam Ngiep Watershed: 1995 and 2000***

Name of Provinces	Crude Birth Rate		Crude Death Rate		Natural Increase Rate		Total fertility Rate		Infant Mortality Rate	
	1995	2000	1995	2000	1995	2000	1995	2000	1995	2000
Xieng Khouang	41.9	38.3	15	7.5	2.6	3.08	6.3	5.8	121	69.6
Vientiane	36.3	32.6	13.9	5.6	2.4	2.7	5.9	3.9	102	34.9
Bolikhamxay	39.3	36.9	16.5	3.6	2.5	3.33	5.8	5.2	136	26
Xaysomboon SR	40.4	44.6	16.9	6.7	3	3.79	7.2	6.8	138	58.7
Whole Country	41.3	34	15.1	6.3	2.5	2.77	5.4	4.9	104	82.2

Source: Calculated from population census 1995 (NSC 2007).

As part of the Social Impact Assessment for this project, the area covered by the dams (and power generation infrastructure) was been divided into five zones. The five zones are as follows:

- Zone 1 – Upstream Area: This zone covers the area upstream from the reservoir and is located in the Thathom District, Xieng Khouang Province. Within the zone, there are eight villages along the Nam Ngiep River. It is anticipated that these villages will be indirectly affected by the Project.

- Zone 2 – Reservoir Area: This zone covers the area affected by the reservoir. The zone has been split into two sub-zones. The three communities located in the upper section of the reservoir (in the Vientiane Province) will be partly inundated. These communities have been designated as Zone 2UR. The four communities in the lower section of the reservoir (in the Xieng Khouang Province) will be completely inundated. This area has been designated as Zone 2LR.

- Zone 3 – Construction Area: This zone covers the area where the main Project infrastructure will be established. There is one village that will likely be directly affected as a result of the inundation and construction activities.

- Zone 4 – Downstream Area: This zone covers much of the Nam Ngiep River watershed downstream of the re-regulation dam. There are nine villages located within this zone: three are located in the Bolikhan District and six are located in the Pakxan District.

- Zone 5 – Resettlement Area: This zone covers the host communities.

4.2.1 *Population*

Table 4.6 provides a summary of the villages located in the Project area, including the number of households and population. There are approximately 25 villages and 20,337 people (this excludes the host communities in Zone 5).

Table 4.6 Households and Population in the Project Area

Zone	Province	District	Village	No of Households	Population
1	Xieng Khouang	Thathom	Thaviengxay (Dong)	267	1,646
			Phonngeng	95	771
			Nasong	111	681
			Viengthong	107	617
			Nasay	51	270
			Xiengkhong	102	546
			Nahong	92	543
			Phonhom	180	1,200
2	Xieng	Thathom	Pou	172	1,129
			Piengta	82	454
			Hatsamkhone	74	453
	Vientiane	Hom	Houpamom	37	254
			Sopphuane	58	416
			Sopyouak	126	916
			Namyouak	163	1,149
3	Bolikhamxay	Bolikhan	Hatsaykam	33	218
4	Bolikhamxay	Bolikhan	Nampa	84	584
			Somseun	221	1,207
			Houykoun	358	2,180
	Bolikhamxay	Pakxan	Thong Noi	165	839
			Thong Yai	86	437
			Sanaxay	274	1,156
			Phonsy	137	719
			Pak Ngiep	173	859
			Sanoudom	94	457
5	Bolikhamxay	Bolikhan	Hat Gniun	67	371
			Thahuea	50	265

Source: SDP of the Nam Ngiep 1 Hydropower Project

The villages are home to three main ethnic groups – lowland Lao, Hmong and Khmu. The distribution of the groups tends to vary by zone.

Despite traditional ways of living, conditions are changing in Lao PDR. This in part is being driven by government policy, which is consolidating smaller villages into larger ones to improve access to infrastructure, such as roads and communication technology. This has meant considerable population increases, particularly over the past four to five years, in a number of the villages in the Project area (refer *Table 4.7*) (Sriburi *et al.* 2012).

Table 4.7 Population Changes

Zone	Village	2007 Population	2011 Population	2007 to 2011 Population Change	2007 to 2011 % Change
1	Thaviengxay (Dong)	756	1,646	890	117.7%
	Phonngeng	589	771	182	30.9%
	Nasong	668	681	13	1.9%
	Viengthong	385	617	232	60.3%
	Nasay	246	270	24	9.8%
	Xiengkhong	376	546	170	45.2%
	Nahong	563	543	-20	-3.6%
	Phonhom	628	1200	572	91.1%
2	Pou	842	1,129	287	34.1%
	Piengta	452	454	2	0.4%
	Hatsamkhone	419	453	34	8.1%
	Nakang	316	0	-316	-100.0%
	Houypamom	225	254	29	12.9%
	Sopphuane	304	416	112	36.8%
	Sopyouak	759	916	157	20.7%
	Namyouak	956	1,149	193	20.2%
3	Hatsaykham	165	218	53	32.1%
4	Nampa	479	584	105	21.9%
	Somseun	1,182	1,207	25	2.1%
	Houykhoun	2,089	2,180	91	4.4%
	Tong Noi	720	839	119	16.5%
	Thong Yai	379	437	58	15.3%
	Sanaxay	1,066	1,156	90	8.4%
	Phonsy	660	719	59	8.9%
	Pak Ngiep	826	659	-167	-20.2%
	Sanoudom	449	457	8	1.8%
5	Hat Gniun	395	371	-24	-6.1%
	Thahuea	273	265	-8	-2.9%

Source: Social Impact Assessment Draft Report – Nam Ngiep 1 Hydropower Project (Sriburi *et al.* 2012)

4.2.2 Economic

The average annual household income ranges from 8,200,000 to 17,700,000 Kip per household (or 1,000 – 2,200 USD per household) (Sriburi *et al.* 2012). Agriculture is the primary economic activity for all villagers in the Project area. Crops are often grown along the river just above the flood zone, in small fenced plots. This ensures that water is readily available for irrigation. However, a small number of villagers also have plots adjacent to their house.

Crops include rice, which is a staple in the local diet, maize, sugar cane, cassava, banana, and pineapple. Much of what is generated is consumed within the household.

In addition to crops, most villagers raise small animals (e.g. pigs, chickens, duck), which provide a source of protein. Larger livestock (e.g. cows, water buffalo) is raised for sale or inclusion in festivals and/ or celebrations.

In terms of food sources, villagers also fish in nearby waterways. Most of the fish caught is consumed within the household. Nearby forests also provide food. This includes edible plants and fruit, including bamboo shoots and leafy plants.

4.2.3 Infrastructure

The villages can be divided into two main groups in terms of the available infrastructure. First group has reasonably good quality infrastructure and services (e.g. year round road access, electricity, schools, health centres) in or in close proximity to the village. This includes the villages of Houykhoun, Thong Noi, Sanoudon, Sanaxay, Phonsy, Phonngeng, and Dong Thaviengxay.

The second group has relatively little and/ or poor quality infrastructure and services. The majority of villages fall into this group. For example, roads are only passable during the dry season or the villages are accessible only by river.

In addition, many of the houses are made primarily of bamboo. In instances, where the homes are made of wood, quality of the construction is often not good. This means that villagers are not well protected from rain, strong sun or cold conditions.

5 IDENTIFICATION OF PAST, PRESENT AND REASONABLY FORESEEABLE FUTURE ACTIONS

Past and present actions that have influenced the current condition of the resources or receptors within the region and Study Area were investigated. Reasonably foreseeable future actions (RFFAs) were identified based upon stakeholder consultation, review of agency planning documents and a literature review.

5.1 PAST AND PRESENT ACTIONS

In general terms, the current status of resources and receptors within any Study Area are determined in large part by both human-controlled events, such as subsistence harvest or commercial fisheries, and natural events, such as species predation or climate change.

The baseline biodiversity condition of the Project Area has been described in the Project EIA and other sections of the Initial Report. The baseline includes the consideration of historical trends that have contributed to the current state of the environment, including historic clearing for agriculture such as slash and burn practices, as well as timber harvesting (both legal and illegal) and hunting pressure from the local populations and illegal poaching. These impacts are discussed in specific relation to the relevant VECs in *Section 6.1*.

HEPs

No major HEPs currently exist in the Nam Ngiep watershed.

Forestry

Consultation with DFRM (refer *Section 3.4*) identified that currently, the Provincial government auctions timber allocations to companies on a rotational basis. These allocations are located in two types of areas: 1) in designated production forest, and 2) from land in proposed development footprints (e.g. new dams, roads or other infrastructure) prior to that development, essentially making use of the timber that is to be cleared for that development. This process is unlikely to change with changes in land use or development of NNP1, other HEPs or other RFFAs. Currently the middle reaches of the Nam Ngiep catchment are designated as production forest (*Figure 5.1*).

Mining

Figure 5.1 shows no active mining leases in the Nam Ngiep watershed. Three mining leases under survey coincide with the Nam Ngiep watershed. One is near the centre of the watershed with two others partly within the upper reaches of the watershed near the headwaters in the north. Two leases where survey is proposed are located in the lower parts of the watershed near the

Project Area with four more partly within the upper reaches of the watershed in the north and east.

Agriculture

Agriculture is widespread with agricultural land cover types accounting for the majority of land cover types in the Project Area (discussed further in *Section 6.1.1*). Rubber plantations occur in the Project Area and continue to be established (ERM-Siam, Co Ltd. 2013).

Villages and Settlements

The population density in the Nam Ngiep catchment is not high. Settlements are nearly all limited to the river valleys, with the main exceptions being the large expanse of fairly flat land towards the Mekong River and larger valleys toward the north and northeast of the watershed. These are also some of the most populated areas in the watershed. The major settlements relative to the Nam Ngiep catchment are: Phonsavan, the capital of Xieng Khouang Province is just outside the catchment boundary to the north and Pakxan, the capital of Bolikhamxay Province downstream of the proposed dam near the Nam Ngiep confluence with the Mekong River. Other settlements in the north of the Nam Ngiep catchment include Muang Khoun and Phaxai.

The Lao PDR Government currently has a policy of village consolidation. This has meant considerable population increases, particularly over the past four to five years, in a number of the villages in the Project area (*refer Table 4.7*) (Sriburi *et al.* 2012). It is expected that this will have both positive and negative impacts on the natural environment. It is expected that the natural environments surrounding abandoned villages would experience less resource use and the ecology could potentially benefit from this diminution of local resource use. Conversely, it is expected that the natural environments surrounding the consolidated villages would experience more resource use and the ecology could potentially be negatively impacted from this potential increase in local resource use.

Infrastructure

Roads

The main road through the watershed is National Road 1D, which was until recently a dirt road with some sections covered in gravel. It connects Phonsavan (the capital of Xieng Khouang Province) with Pakxan (the capital of Bolikhamxay Province). It runs north from Pakxan through the Nam Xan watershed and then turns west to go through the northern part of the Nam Ngiep watershed. Urban development and consolidation occurs along this road. No major thoroughfare roads are in the lower part of the Nam Ngiep watershed.

A rudimentary road network exists throughout the catchment with few major, all-weather roads. During consultation with the MPI, they identified that road upgrades/development has recently occurred. A new road was built in the Nam Xan catchment from Paksan to Khonsana in 2012 and another road was resurfaced to bitumen to service the Nam Ngiep 2 project in the upper Nam Ngiep in 2010. However, the new road in the Nam Xan catchment was severely damaged in the 2013 wet season and has yet to be reconstructed. Both of these roads have been used to transport construction materials for the NNP2 project and it would appear that the heavy construction traffic has compounded the damage. It should be noted that the terrain of both catchments make road construction difficult and expensive. This is compounded by poor road construction techniques, traffic and the wet season. It is envisaged that these factors will continue to hamper overland transport in the short to medium term.

Electricity

A major development in the catchment has been transmission line construction for HEPs and domestic supply. It was observed by ERM in the field that a transmission line was constructed without appropriate environmental controls, causing landslips and erosion. It was also observed that multiple transmission lines have been constructed along similar routes to service both HEPs and Electricite du Laos (EDL) supply lines.

5.2 *REASONABLY FORESEEABLE FUTURE ACTIONS*

Temporal Scope

The timeframe for the analysis was determined based upon the Project timeframe and the reasonably foreseeable actions that could be predicted. A timeframe of 15 years has been established for the analysis, which includes the construction process, which is planned at a total of 70 months (ERI 2012), and 9-10 years of operation. Predictions beyond this timeframe are considered to be unreliable.

Proposed Hydroelectric Power Projects

There is a noticeable lack of available quantitative information on the foreseeable future hydropower projects, providing a limitation for the CIA, however some projects have impact assessment documents that provide qualitative discussions of potential impacts to biodiversity. The analysis has been limited to those for which public information was available or those for which impact assessments were provided during ERM's consultation phase.

The RFFAs considered within this CIA include (refer *Figure 5.1*)

- NNP1 (the current Project).
- Nam Ngiep 2 Hydropower Project (NNP2).

- Nam Ngiep 3 Hydropower Project (NNP3).
- Nam Pot Hydropower Project.
- Nam Phouan Hydropower Project.
- Nam Chain Hydropower Project.
- Nam Ngiep (Mouang Mai) Hydropower Project.

Interviews as part of the Resettlement Report (ERM-Siam, Co Ltd. 2013) indicated that villagers in the Project Area were aware of a number of proposed developments in the local area, including Nam Ngiep 1, Nam Ngiep 2 and the Nam Xan project. The Nam Xan project is a proposed weir, which will provide electricity generation for village consumption. Villagers at Ban Kanyong mentioned construction of Keang Tong and Keang Dao dam, which be used for electricity generation.

Table 5.1 below describes the RFFAs (specifically other Hydropower Projects) that occur, or a predicted to occur, within the watershed (Study Area). RFFAs listed in the table below are limited to those activities that are formally listed in agency planning documents, those for which permit applications have been completed, or activities that have received funding. The listed RFFAs are ranked according to their potential impact on the proposed Project or the resources that may be affected by the proposed Project. Although many local, regional and national plans may list dozens of Projects, this is not always a strong indication that a Project will be constructed. For this reason, the probability ranking below is also based on professional judgment and discussions with Project proponents.

Seven hydropower projects are proposed within the Nam Ngiep watershed (refer *Table 5.1*). The total installed capacity known from proposed HEPs 585 MW. NNP1 will have a capacity of 290 MW, the four other projects for which the total installed capacity is known have a combined total installed capacity of 295 MW. In this regard, NNP1 is the largest development on the Nam Ngiep River, accounting for 49.6% of the 585 MW of development that is reasonably foreseeable within the next 25 years. Four projects other than NNP1 have data available on size of the reservoirs. The two dams for NNP1 will be approximately 7497 ha in size with the sum of the other three where data are available being 1313 ha. In that regard, the reservoirs of NNP1 will be approximately 85.1 per cent of the known size of proposed HEP reservoirs in the catchment.

Table 5.1 Reasonably foreseeable future actions

RFFA	Province	Electricity Generating Capacity	Status	Description	Project Catchment Size (km²)/ Total River Catchment Size (km²)	Project Footprint Size	Type (Storage or Run-of-River)	Likely Changes to Daily/ Seasonal River Flows	New Road and Electricity Infrastructure Required	Probability	Resources/Receptors affected
Nam Ngiep 1 (this project)	Vientiane/ Bolikhamxay	290 MW	Planning and Approvals Stage	NNP1 consists of two reservoirs each impounded by a separate dam serving two separate power stations. The Project will operate a main power station and a re-regulation power station. The main power station is designed to re-regulate and stabilise the Nam Ngiep Rriver discharge from the main power station for the safety to the downstream area of the re-regulation dam.	3700 (main dam) & 3725 (re-regulation dam includes main dam area)/ 4320	6798 ha proposed maximum main dam reservoir size; 699 ha proposed maximum re-regulation dam reservoir size; 467 ha resettlement area	Storage	Current average annual inflows 148.4 m^3/s; Re-regulation dam will release a minimum dry season flow of 27 m^3/s during the dry season and wet season inflows will equal outflows after dam is at capacity (expected to take one year). Note that a maximum flow of 5.5 m^3/s will be allowed during the reservoir filling period (expected to take one year).	Upgrade 30.45 km of existing roads; New 11.16 km road (linking Ban Hat Gniun to dam site); New temporary roads (16.81 km) (linking Ban Hat Gniun to dam site); 170 km transmission lines	Unknown	Wildlife, Wildlife Habitat, Forests/Vegetation, Aquatic habitat, Communities
Nam Ngiep 2	Xiengkhouang	180 MW	Under construction	This project involves a main dam and a tributary dam located 15 km away linked by a tunnel which are both linked to a powerhouse. The proponent is the China International Water and Electric Corporation. The concession agreement was signed 18/8/11 and commercial operation is expected in 2015. The Project has commenced construction and is located upstream of the NNP1 project, in the north western section of the Nam Ngiep watershed on a tributary of the Nam Ngiep, the Nam Sen.	Unknown catchment area of proposed reservoir/ 2440 (total Nam Sen catchment area – project located approximately 5 km upstream from confluence with Nam Ngiep)/ 4320 (Nam Ngiep)	754 ha main reservoir size; 19 ha tributary dam	Storage	Unknown	Unknown	High	Wildlife, Wildlife Habitat, Forests/Vegetation, Aquatic habitat
Nam Ngiep 3A	Xiengkhouang	Unknown	Unknown	Unknown project details. The location is close to the Nam Ngiep 2 HEP dam.	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Nam Pot	Xiengkhouang/ Vientiane	20-25 MW	Approved – construction planned 2015	A small project to be built in Phatay Village, Phatay District approximately 27 km south-southeast of the Xieng Khuang Provincial Capital. The project will be built on the Pot River, a 22 km long tributary of the Seum River. The power generated will be used domestically for nine-ten villages (Vientiane Times 2012).	Unknown/ Unknown	490 ha reservoir (estimated maximum)	Storage	Unknown	22 km new access roads; 6 km new transmission line	Unknown	Unknown
Nam Chain	Xiengkhouang	Unknown	Unknown	Unknown project details. The location is close to the north eastern extent of the Nam Ngiep watershed.	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

RFFA	Province	Electricity Generating Capacity	Status	Description	Project Catchment Size (km²)/ Total River Catchment Size (km²)	Project Footprint Size	Type (Storage or Run-of-River)	Likely Changes to Daily/ Seasonal River Flows	New Road and Electricity Infrastructure Required	Probability	Resources/Receptors affected
Nam Phouan	Vientiane	52 MW	Approved – construction date unknown	Project Environmental and Social Impact Studies were prepared in 2012 and has been accepted and approved by Lao PDR Government (Velcan 2013). The proposed location of the Project is on the Nam Phouan river which is a tributary of the Nam Ngiep river located approximately 30 km (in a direct line) upstream of the NNP1 proposed project area. The project includes a reservoir on the Nam Phouan and a 3.7 km long tunnel that diverts this water into powerhouse in a different catchment: the Nam Om River (intermittent river with a small catchment size of 4km²). Two dam site options were considered. The downstream option sized at 50 ha and the upstream option at 30 ha.	Unknown/ 480	50 ha downstream reservoir option; 30 ha upstream reservoir option	Run-of-river	Calculated flow of the Nam Phouan River is 29m³/s. Proposed flow released from the reservoir into the Nam Phouan will be 0.5m³/s to maintain the natural flow of the river during dry season with overflows anticipated during the wet season. Discharge from powerstation into Nam Om River capacity is 35m³/s.	Unknown length of access roads; 44 km of transmission lines.	High	Wildlife, Wildlife Habitat, Forests/Vegetation, Aquatic habitat
Nam Ngiep (Mouang Mai)	Bolikhamxay	38 MW	Feasibility Stage	Information on this project is scarce. A memorandum of understanding signed 25/2/10. The Feasibility Study is ongoing, but the location of the dam site is not publically available. It is reported to be proposed for the main stream of the Nam Ngiep river, downstream of NNP1 between the Project site and Pakxan.	Unknown	Unknown	Unknown	Unknown	Unknown	Moderate	Wildlife, Wildlife Habitat, Forests/Vegetation, Aquatic habitat

Information in this table is sourced from Kansai (2011), NCC EAT (2010), Ministry of Energy and Mines (2012), China International Water and Electric Corp (2012), Maunsell (2004) and Velcan and Lem (2012).

250000
300000
350000
400000
2150000
2100000
2050000

Legend

- Catchment Boundary
- Waterbody
- Road
- City or Town
- Lao PDR Boundary
- Surrounding Hydroelectric Power Projects
- Nam Ngiep 2 Tunnel

Mining Tenements:

- Mining Lease Under Survey (mining not yet approved)
- Mining Lease with Survey Proposed (mining not yet approved)
- Mining Lease with Concessions

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Proposed Access Road

Candidate Offset Sites:

- Nam Ngiep Offset Area
- Huay Ngua Provincial Protected Area
- Phou Khao Khouay National Protected Area
- Nam Xan Offset - River Centreline

Forest Zone:

- National Protection Forest
- Production Forest

N

0 10 20 30Km

1:600,000

Basemap: Bing Maps

Note: Known extent of mining tenements displayed, with some tenements partially shown.

Phoukout
NKL Co., Ltd
Nam Ngum 4A
Phonsavan
Vinacomin
COECCO
State Enterprises for Agriculture - Industry Development (DAI)
Nonghet
Daosavan Investment and Construction., Ltd
Phongsabthavy Construction., Ltd
Muang Khoun
Phou Bia Mining Limited
Nam Ngiep 3A
Phongsabthavy Construction., Ltd
PPC Consultant., Ltd
Phaxai
Nam Ngiep 2 Tributary Dam
Nam Ngiep 2 Main Reservoir
Nam Chain
Nilandon Development Mining., Ltd
Nam Pot
Nam Ngiep 2 Powerhouse
Nam San 3A
Nam Ngum
Nam Ngiep
Namchong-Namgneup
Nam San 3B
GnotNamxan NamPeuak
Thathom
Nammo
Lao-Muang-om Mining., Ltd
Nam Ngiep Catchment
China Base Ningbo Foreign Trade Co., Ltd
Neyland Lao Mining., Ltd
Phoupasang-Punghok
Phak Beak
Nam Phouan
CAVICO Vietnam & Laoyongchaluen Trading Import-Export
Nam Xan Catchment
Nam Xan
Nam Ngum 2 Reservoir
Nam Bak 2
PT Construction Company., Ltd
Hinheup
Nam Ngum Reservoir
Ba. Donkha
Agriculture Development
Phoutume
Longxan
Thinkeo
Phonhong
Nam Mang 1
Nam Leuk reservoir
Lao Thong Her Development., Ltd
Mekong River
Pakxan
BanKeun
Nam Mang 3 Reservoir
Qinghai Xingoi Co., Ltd
Schuan Above Advantage Lomon Mining (Lao) Co., Ltd
Hai
Tha Ngon

bing™

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_OFFSETDES_G002_R0.mxd	
Date:	13/09/2013	Drawing Size: A3
Drawn By:	TC	Reviewed By: DN

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 5.1 - Past & Current Actions & RFFAs

Nam Ngiep 1 Hydropower Project
Biodiversity Cumulative Impact

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

Other RFFAs

Forestry

Forestry will presumably continue as scheduled in the production forests present in the middle reaches of the Nam Ngiep catchment (refer *Figure 5.1*). From consultation with DFRM (refer *Section 3.4*), forestry operations will increase in two ways:

- Development in the road network creating a denser and more extensive road network as has occurred for previously constructed projects and will occur for NNP1 and other RFFAs will provide greater access to previously unobtainable timber resources. This could potentially increase the allocations of timber allowed by the Provincial government in newly designated forestry areas; and

- An increase in development will increase the amount of timber taken from those development footprints.

It is also reasonable to assume that increases in population increase the pressure on timber harvesting by locals for housing, boats and other domestic uses.

Mining

Interviews as part of the Resettlement Report (ERM-Siam, Co Ltd. 2013) indicated that although villagers in the Project Area were aware of a number of proposed HEP developments in the local area, the villagers did not identify any proposed mining projects.

It is unclear how mining leases currently under survey will operationally interact with the Project Area (refer *Figure 5.1*), however it is assumed that potential mining will be many years in the future. Areas currently under survey may be at a feasibility stage with potential mining operation many years away and it will take even more years than that for mining activity to manifest in areas where survey is currently proposed.

Agriculture

Agriculture is very important to the communities in the Project Area. It is difficult to predict how agriculture will change over time. A broad assumption is that as population increases in the future, so too will the demand for agricultural products and therefore arable land. Interviews and observations as part of the Resettlement Report (ERM-Siam, Co Ltd. 2013) indicate that rubber plantations continue to be established.

Villages and Settlements

It is anticipated that there will be an influx of people to the area to work on the construction of NNP1 and this will potentially have a legacy if those people decide to remain after the construction is complete. Overall, as the road network and electricity availability are improved, there will likely be an increase of settlement. The patterns of that potential settlement however are unpredictable.

Village consolidation will have both positive and negative impacts on the natural environment. It is expected that the natural environments surrounding abandoned villages would experience less resource use and the ecology could potentially benefit from this diminution of local resource use. Conversely, it is expected that the natural environments surrounding the consolidated villages would experience more resource use and the ecology could potentially be negatively impacted from this potential increase in local resource use.

Infrastructure

Roads

Very little detailed information is available regarding specific proposed road upgrades in the area. During consultation, the MPI (refer *Section 3.4*) indicated that increases in the road network are in response to development pressures. The development of NNP1 and the other HEPs will provide an improved road network in the catchment. The consequences of this improved road network will be to allow people greater transport around the catchment during more parts of the year due to upgrades of dry season roads to all-weather roads and likely into new areas where roads were not previously present or where access was difficult. New roads in the Nam Xan and Nam Ngiep catchments will increase the ability to transport minerals and thus may increase the economic/logistical viability of mineral extraction projects. It should be noted that the terrain of both catchments make road construction difficult and expensive. This is compounded by poor road construction techniques, traffic and the wet season. It is envisaged that these factors will continue to hamper overland transport in the short to medium term.

Electricity

Past and present electricity infrastructure developments discussed above (refer *Section 5.1*) have resulted in various impacts. Although it is not clear the exact location of any future powerline construction for other HEPs or RFFAs, it is reasonable to assume that there is the potential for both positive and negative impacts from powerline development. The positive impacts include an enhanced quality of life for people who are the beneficiaries of the available power and potentially negative impacts to the environment if development is poorly planned or controlled as has been described in *Section 5.1*.

6 CUMULATIVE IMPACT ASSESSMENT

ERM has identified the following VECs according to the methods outlined in *Section 2* of this report, the Project baseline and impacts presented in the EIA, supporting literature, peer reviewed journals and other investigations undertaken during the Initial Report. The three VECs of importance to the Project and that are the foci of this CIA are:

- VEC 1: Terrestrial biodiversity and habitats
- VEC 2: Aquatic biodiversity and habitats (including river flows)

VEC 3: Ecosystem services Discussion of these VECs is provided in this Section framed in terms of the parameters (consistent with the ADB review of the draft Initial Report):

- Known or suspected impacts by the project and RFFAs;
- Known cumulative impact issues in the region;and
- Concerns generally recognized as important on the basis of scientific concerns.

6.1 VEC DISCUSSION

6.1.1 VEC 1: Terrestrial Biodiversity and Habitats

Known or Suspected Impacts by the Project and RFFAs

The Project (those lands covered by the proposed reservoir, the dam sites and powerhouse) will cover parts of three provinces, and so will affect forest and other vegetative cover in those areas. The largest area will be affected by the reservoir, most of which is located in Hom district in the Vientiane Province, and the Bolikhan district in the Bolikhamxay Province (ERI 2012).

The Project will cause flooding of areas along the Nam Ngiep upstream of the main dam and into some tributaries, as well as in some of the sections between the main dam and the reregulation dam. The dam inundation area is 70 km in length, and includes total surface areas of 67.98 km^2 (main dam) and 6.99 km^2 (re-regulation dam). In addition, the Project will change the land features of the sites where project facilities are located (ERI 2012).

The scoping of project impacts identified a number of potential impacts to biodiversity values, including:

- Permanent and temporary loss of habitat;
- Disturbance and displacement of resident species due to noise, light, dust or vibration;

- Creation of a barrier to fauna movement, including terrestrial and aquatic;
- Permanent or temporary fragmentation of habitat;
- Edge effects;
- Downstream impacts due to changes in the flow regime;
- Degradation of habitat as a result of introduction of, and competition with, alien species;
- Degradation of habitat in the event of release of hazardous substances or pollution; and
- Mortality as a result of vehicle strike.

The Project footprint and adjacent areas contains biodiversity and conservation values. Baseline studies undertaken for the Biodiversity Impact Assessment identified a diversity of terrestrial flora and fauna species, and ecosystems, including some species listed on the IUCN Red List of threatened species.

The baseline biodiversity assessment identified the land cover types within the Project footprint. The area of each land cover that will be disturbed for the Project is summarised in *Table 6.1**Error! Reference source not found.***. The IUCN listed critically endangered, endangered or vulnerable terrestrial species that have been recorded or have potential to occur (indirect records or interview results) within the Project area are summarised in *Table 6.2* along with the land cover code for the forest type that the species may inhabit (based on species profiles).

Table 6.1 Land Cover within the Project Area

Land Cover	IFC Habitat Class*	Area (ha)				Total (ha)	% of Total
		Main dam	Re-regulation dam	Resettle-ment	Access Road**		
Deciduous Forest	N	2690	131	56	19	**2896**	**36**
Evergreen Forest	N	488	24	0	2	**514**	**6**
Bamboo	N	236	127	132	7	**502**	**6**
Old Fallow Land	M	1321	194	163	12	**1678**	**21**
Young Fallow Land	M	1036	143	82	5	**1261**	**16**
Slash and Burn	M	328	27	19	1	**374**	**5**
Rice Paddy	M	107	5	15	1	**127**	**2**
Grassland	M	108	0	0	0	**108**	**1**

Land Cover	IFC Habitat Class*	Area (ha)				Total (ha)	% of Total
		Main dam	Re-regulation dam	Resettle-ment	Access Road**		
Urban Area	M	38	3	0	<1	**41**	**1**
Water	-	368	42	0	<1	**410**	**5**
Rock	-	1	0	0	0	**1**	**<1**
Cloud	-	4	0	0	<1	**4**	**<1**
Shadow	-	16	0	0	1	**16**	**<1**
Impacted Natural Habitat (NDVI)		*57*	*3*	*0*	***1***	***60***	***1***
	Total	**6798**	**699**	**467**	**49**		

* N=Natural; M=Modified.

**Access Road calculations based on 9.5 m wide road corridor

Table 6.2 IUCN Listed Terrestrial Flora and Fauna Species recorded in the Project Area

Scientific Names	Common Name	Land Cover Code	Area of habitat to be directly disturbed (ha)	Status
Flora				
Dipterocarpus turbinatus		DF, EF	3443	CR
Afzelia xylocarpa		DF, EF	3443	EN
Dalbergia oliveri		DF, EF	3443	EN
Dipterocarpus alatus		DF, EF	3443	EN
Hopea ferrea		DF, EF#	3443	EN
Shorea roxburghii	White meranti	B, DF, EF	3944	EN
Dalbergia cochinchinensis	Thailand rosewood	DF	2909	VU
Hopea odorata		DF, EF	3443	VU
Ternstroemia wallichiana		DF, EF	3443	VU
Mammals				
Nomascus leucogenys	Northern white-cheeked gibbon	EF	534	CR
Cuon alpinus	Asian wild dog, dhole	DF	2909	EN
Elephas maximus	Asiatic elephant	B, DF	3410	EN
Manis javanica	Sunda pangolin	DF	2909	EN
Panthera tigris	Tiger	DF	2909	EN
Prionailurus viverrinus	Fishing cat	EF	534	EN
Pygathrix nemaeus	Red-shanked douc langur	EF	534	EN
Trachypithecus phayrei	Phayre's leaf monkey	B, DF, EF	3944	EN
Aonyx cinerea	Asian small-clawed otter	W	410	VU
Arctictis binturong	Binturong	DF	2909	VU
Bos gaurus	Gaur	DF	2909	VU
Capricornis milneedwardsii	Chinese serow	B, DF, EF	3944	VU
Helarctos malayanus	Malayan sun bear	B, DF	3410	VU
Lutrogale perspicillata	Smooth-coated otter	RP, W	410	VU
Macaca arctoides	Stump-tailed macaque	DF, EF	3443	VU

Scientific Names	Common Name	Land Cover Code	Area of habitat to be directly disturbed (ha)	Status
Macaca leonina	Northern pig-tailed macaque	DF, EF	3433	VU
Nycticebus bengalensis	Bengal slow loris	DF, EF	3443	VU
Nycticebus pygmaeus	Pygmy slow loris	B, DF, EF	3944	VU
Pardofelis marmorata	Marbled cat	B, DF, EF	3944	VU
Rusa unicolor	Sambar deer	DF, EF	3443	VU
Ursus thibetanus	Himalayan black bear	B, DF, EF	3944	VU
Reptiles				
Platysternon megacephalum	Big-headed turtle	W	410	EN
Amyda cartilaginea	Southeast Asian softshell turtle	W	410	VU
Malayemys subtrijuga	Snail-eating turtle	W	410	VU
Naja siamensis	Indo-Chinese spitting cobra	DF, EF, G, OFL, YFL, RP, SB	6992	VU
Ophiophagus hannah	King cobra	DF, EF, G, OFL, YFL, SB	6820	VU
Siebenrockiella crassicollis	Siamese temple turtle	W	410	VU
Birds				
Gyps bengalensis	White backed vulture	SB, U	416	CR
Cairina scutulata	White winged duck	DF, EF	3443	EN
Aceros nipalensis	Rufous-necked hornbill	DF, EF	3443	VU
Aquila heliaca	Imperial eagle	DF, EF	3443	VU

#Little habitat information is available and an assumption has been made for suitability based on plant form.
*Represents the area of potentially suitable habitat within the Project area.

Most of the Project components are located on the lower slopes of mountains or in the valleys and although these used to be among the most important wildlife habitats, human activities (largely agriculture) have forced the wildlife into the higher and less accessible slopes, so that the proposed Project activities are now located well below their remaining habitats (ERI 2012). Generally, the clearance of vegetation within the dam site, powerhouse and reservoir can lead to fragmentation of already diminishing areas of natural forests and wildlife habitats. Although the Project EIA (ERI 2012) states that the areas of the reservoir, dam, and re-regulation dam are not significant for wildlife migration, breeding, or feeding, overall, the existence value, as well as the ecological research value of the ecosystem will be diminished. Rare and/or threatened tree and plant species may also be affected by flooding. The permanently maintained access roads to the dam site and powerhouse during and after construction will eliminate the ability of the land on which the roads are located to regenerate to the original species-rich secondary forest (ERI 2012).

Two of the country's 20 NBCAs, Phou Khao Khoauy and Nam Ka Ding, are in Vientiane and Bolikhamxay provinces. However, both NBCAs are located far from the Project area and the Project does not pose any direct threat to an NBCA or major protected forest (ERI 2012).

Subsequent potential impacts to biodiversity from the proposed Project include poaching of birds and illegal hunting of mammals by construction workers, other project staff and villagers during logging and biomass removal (ERI 2012).

NNP2 HEP

The EIA for the Nam Ngiep 2 Hydropower Project (NCC EAT 2010) identifies that the reservoir areas will be 754 ha for the main reservoir and 19 ha for the tributary dam. No detail is provided on the length of proposed new or upgraded access roads of transmission lines. The EIA states negative impacts from that project are:

- the loss of habitat and habitat destruction are a main threat to amphibians, reptiles and birds;
- the dam reduces the forest habitats of both resident and migratory birds where resident birds use forest habitats as feeding, resting and nesting sites;
- the creation of a large reservoir usually affects the movement of mammals and creates small fragmented habitats; and
- a main threat to amphibians and reptiles is illegal poaching and temporary and permanent human settlement in the forest at the main dam.

NCC EAT (2010) present no discussion of the cumulative impacts of the NNP2 HEP in their EIA.

Nam Phouan HEP

A review of Maunsell (2004) and Velcan and Lem (2012) identifies the following impacts from the proposed Nam Phouan HEP:

- Reservoir size: 50 ha (downstream reservoir option); 30 ha (upstream reservoir option);
- Calculated flow of the Nam Phouan River is 29m3/s. Proposed flow released from the reservoir into the Nam Phouan will be 0.5m3/s to maintain the natural flow of the river during dry season with overflows anticipated during the wet season.
- Unknown length of access roads; 44 km of transmission lines.

The Environmental and Social Impact Assessment (ESIA) (Velcan and Lem 2012) for the Nam Phouan HEP indicates the following impacts may occur from that development on terrestrial ecology:

- Vegetation

The terrestrial ecology/forest section of Velcan and Lem (2012) identifies forest types in the Nam Phouan Project Area as disturbed primary and secondary forest vegetation (secondary forests being those that have regenerated from shifting cultivation areas). Velcan and Lem (2012) claim that:

- The reservoir area to be inundated is covered with disturbed primary and secondary forests. Secondary forests have regenerated on abandoned areas of shifting cultivation. This is regenerating mixed deciduous forest with some areas of secondary shrubs, grasslands and bare lands with some grasses and scattered trees. There is some dry evergreen forest along the proposed transmission line that have been degraded due to selective logging. Velcan and Lem (2012) estimate that the project will result in the clearing of 50 ha of forest.

- The habitats of the study area are locally and regionally common.

- The proposed inundation area has been extensively and significantly disturbed from years of forest conversion for other uses such as slash and burn agriculture, burning as a hunting tool and illegal logging.

This section concludes that based on the field assessment, the proposed reservoir area contains virtually nothing of biodiversity conservation value and claims in support of this conclusion the fact that neither the proposed inundation area nor any surrounding area has been proposed as a NBCA. The impact assessment claims the impact on biodiversity from forest clearance will be insignificant and predicts a small change to the forest type from the increased presence of soil moisture adjacent to the lake which could favour the proliferation of evergreen species. The report claims that this could potentially be a positive impact as a greater diversity of forest types will be present.

- Wildlife Resources

The results of fauna surveys and inquiries (it is possible that inquiries means interviews however this is unknown) by Velcan and Lem (2012) identified no threatened species listed on the IUCN Red List present in the study area. The impact assessment document assesses the impact of the vegetation clearance for reservoir establishment at the regional scale as having 'medium' impacts on biodiversity. At the local scale, Velcan and Lem (2012) identify that the impact of habitat reduction and biodiversity loss is at 'medium scale'. The report claims that the project will not sever forest connectivity.

Summary

It is reasonable to assume that infrastructure development such as what will occur for the proposed Project and other HEPs would increase human settlement and therefore an expansion of agriculture will likely occur, potentially at the expense of remaining forest types in the lowland areas thereby potentially removing some of the little remaining (although degraded) forest around the Project Area.

Land clearing and submerging associated with dam creation is a major impact on terrestrial ecosystems as they are unable to move away from the flooding, although the nature of dam placement being on rivers in valley floors means that most land cover lost is agricultural land with the more forested land occurring up the slopes and away from the valley floor. Terrestrial fauna are able to move away from the inundation area up the slopes.

There will be an increase in accessibility of the more distant forest areas at the upper reaches of the watershed due to the reservoir creation as it will provide easier access for people to reach these areas which could potentially lead to an increase in human use of the terrestrial biodiversity in these formally remote and less anthropogenically impacted forest areas (i.e. hunting, poaching and logging).

These situations could occur at each of the seven proposed HEPs in the Nam Ngiep watershed. It is likely that an increase in human populations and resource use will have a negative impact on species and populations through a predicted increase in hunting however this is discussed further in *Section 6.1.3*.

Known Cumulative Impact Issues in the Region

The most significant relevant past and present actions affecting terrestrial biodiversity and habitats within the Study Area are human activities on wildlife, wildlife habitat and forests/vegetation. These are summarised below:

- illegal poaching, hunting, and capturing of wildlife: this is often indiscriminate and extensive causing elimination of species, or retreat of species to higher grounds;
- slash and burn agriculture/shifting cultivation; and
- exploitation of forests and Non-Timber Forest Products (NTFPs): logging of forests for commercial tree species, and collection of NTFPs for food, household use, medicine and cash income (although the latter is less common within the Project Area due to the distance from Town and market).

The main dam area was surveyed for fauna during the 2007 survey with additional data collected in 2013. The diversity of fauna in the main dam inundation area (upper Nam Ngiep) was high in comparison to other areas sampled in 2013 (the candidate offset sites). Habitats varied in condition with human disturbance evident in areas downstream of the main dam location. The habitats of the main surveyed areas include:

- The main dam area - The upper area of the Nam Ngiep River is dominated by primary forest. The habitat in this area if in good condition for wildlife in comparison to other areas surveyed. Site surveys detected (through interviews with villagers or direct observation) at least 46 mammals species, 50 bird species, 28 reptiles species and 10 amphibian species.

- The resettlement area - The resettlement area is mostly and heavily disturbed as a result of slash and burn activities. There is evidence of some regeneration and secondary growth. Site surveys detected (through interviews with villagers or direct observation) at least 9 mammals species, 24 birds species, 19 reptiles species and 8 amphibian species.

- Downstream of the Project (lower Nam Ngiep River) - This area is mostly disturbed and dominated by agricultural landuse. There is high human activity in this area. Site surveys detected (through interviews with villagers or direct observation) at least 12 mammals species, 27 birds species, 21 reptiles species and 7 amphibian species.

The forests of the Luang Prabang Montane Rainforests Ecoregion have been subject to heavy logging pressure and much of the forest cover of central Lao PDR is subject to existing forestry operations, or occurs within approved forest leases. Humid evergreen forest occurs at lower elevations around 800 m and the low stature of trees in this community and open understory with an abundance of broad-leaved monocots and grasses suggest severe past impacts from burning and clearance (Wikramanayake *et al* 2002). Slash and burn agriculture is a land use that is still practiced widely in central Lao PDR, including the Project Area (ERM 2013a).

The lower slopes of mountains and the valleys used to be among the most important wildlife habitats in the Project Area and in the Northern-Central Highlands (where the Project is located), were originally predominantly dry evergreen and mixed deciduous forests (NCC EAT 2012). However in the Project Area, the land is a medley of vegetation communities, with local agricultural practices (shifting cultivation, i.e. converting forested land into agricultural land) that have heavily impacted on forest tree species composition and maturity (ERI 2012). This in combination with burning forests for hunting and illegal logging has removed much of the original forest forcing the wildlife into the higher and less accessible slopes so that large areas of grassland, bamboo and other secondary vegetation are now present (ERI 2012). Hunting is further exerting pressure on these wildlife populations and this is discussed further in this Section and in *Section 6.1.3 VEC 3: Ecosystem Services*. Shifting cultivation is practiced widely near the Nam

Ngiep River and the dam sites (ERI 2012). Official forest classification for most of the Project Area is largely:

- unstocked forest that is part of the cycle of slash and burn agriculture; and
- mixed forest that is located either on areas of steep land where the forest is inaccessible or on poor soils unsuitable for upland rice and other crop production (ERI 2012).

Data on the dominant tree and fauna species within the Project Area was collected in interviews and field surveys in 2007 by ERI, as part of the Project EIA (ERI 2012). The results are not presented here in detail, as they are provided in full in the EIA (ERI 2012).

Due to rather extensive forest degradation and destruction in recent decades, much of Lao PDR's wildlife can now be found mainly in the designated NBCAs (ERI 2012). Threatened species recorded in Lao PDR, based upon November 1998 data from the World Conservation Monitoring Centre of United Nations Environment Program, included 220 plants and 150 animals (ERI 2012).

The richness of Lao PDR's wildlife has less to do with conservation efforts than with the country's low population density and consequent remaining extensive forest cover (ERI 2012). Although there is still considerable hunting in the country (most villagers depend on hunting for part of their diet), the relative abundance of forest habitat and, in some cases, its considerable distance from human settlements and inaccessibility have provided some protection for the country's wildlife. However, human population and development pressures are increasing, especially since 1990, and consequently the wildlife population has declined dramatically throughout the country due to hunting pressure exerted by human populations (ERI 2012).

Based on a field survey and interviews with local residents undertaken by the (ERI 2012), it is apparent that the only significant remaining wildlife habitats are in the forested areas on the steep upper slopes or in the still abundant forests outside the Project Area. Whatever remaining wildlife found in the Project Area lives mostly in the higher elevations, and are still being indiscriminately and extensively hunted and captured (ERI 2012). There are still some wildlife habitats, though not as significant, within the proposed reservoir area where the mixed deciduous forest still remains. In the other more accessible lower and less steep slopes, the forests have been destroyed by indiscriminate logging, bush fires, and shifting cultivation, and the wildlife and their habitats that occur have also been severely disturbed (ERI 2012).

The IEE (2012) for the NNP1 Project describes wildlife conditions along the proposed transmission line routes. The field survey and comments from the villagers' interviews revealed that the only significant remaining wildlife habitats near the transmission line routes are on the steep inaccessible areas of Nam Ngiep and in the Phou Khao Khouay NPA to the west of the Nam Ngiep

River and the parallel transmission lines, and then to the north of the 230 kV transmission line, quite distant from the Project Area. Wildlife in the Project Area, including areas near the transmission line alignments, has been hunted extensively, so much so that the majority of all significant wildlife species have either been eliminated or they have retreated to the comparative safety afforded by the higher and comparatively inaccessible habitats (more than a day's walk from settlements) of the highlands and the NBCA (IEE 2012).

The Project Area is not near any NBCAs however it still does contain some important forests, including village conservation forests and special spirit pool forests at Namyouak, Sopyouak and Sopphuane Villages, Hom District and at Hatsaykham Village, Bolikhan District. These are on quite steep terrains, on lands relatively inaccessible to humans, allowing the vegetation to remain relatively intact and keeping the areas as viable sites for a number of species. These forests are at elevations above the flood level of the proposed reservoir of this Project (ERI 2012).

Figure 4.1 shows the NBCAs relative to the regional setting of the Project Area. There are no NBCAs in the NNP1 project catchment. Two NBCAs occur near the Nam Ngiep River channel downstream from the NNP1 project area: Huay Ngua Provincial Protected Area (PPA) and Phou Ngou PPA.

- Huay Ngua PPA: Located approximately 8 km downstream of the NNP1 project and is 5435 ha in area.

- Phou Ngou PPA: Located approximately 11 km downstream of the NNP1 project and is 6610 ha in area. Phou Ngou PPA is a narrow, elongated shape that follows a ridge line running north-west to south-east and contains no major watercourses or lakes

Neither of these PPAs include aquatic environments that will be impacted by the NNP1 project.

Consultation to supplement the biodiversity surveys (ERM 2013b) occurred as market surveys (where researchers observed what was available for sale at local markets) in 2012/3 and interviews at the focus group level and in-depth interviews. These occurred in both the impact area (Nam Ngiep catchment) and the proposed resettlement area (Nam Xan). Although not presented as direct concerns raised by affected people during consultation the resettlement team noted that every few years in Hat Gnuen elephants had come into the village and destroyed crops. Villagers at Houaypamom similarly noted that in past years a tiger had occasionally ventured into the village and taken small piglets.

Two small locally-managed conservation areas are in the forest areas near Thong Noi Village in Pakxan District, Bolikhamxay Province. The location of these two areas, referred to as Dong Kampha and Nong Boa, is near the proposed route of the 115kV transmission line (IEE 2012).

Concerns Generally Recognized As Important On The Basis Of Scientific Concerns

Wildlife surveys and interviews with people in the Nam Ngiep River Study Area recorded forty species listed on the IUCN Red List of Threatened Species. These are discussed in the following sections.

IUCN Listed Flora Species

A total of nine species of plants listed as threatened under the IUCN were identified within the Project area during 2007 and 2013 surveys. These include one species listed as critically endangered, five as endangered and three as vulnerable (*Table 6.3*).

Table 6.3 IUCN Listed Flora Species recorded in the Project Area

Scientific Names	Main Dam Site and Reservoir	Resettle-ment Site	Re-regulation Dam site	Lower Nam Ngiep	Trans-mission Line	IUCN Status
Dipterocarpus turbinatus	X		X			CR
Afzelia xylocarpa	X	X	X	X	X	EN
Dalbergia oliveri	X	X	X		X	EN
Dipterocarpus alatus	X			X		EN
Hopea ferrea	X					EN
Shorea roxburghii	X	X		X	X	EN
Dalbergia cochinchinensis	X					VU
Hopea odorata	X	X	X	X	X	VU
Ternstroemia wallichiana	X					VU
IUCN Status: CR – Critically Endangered; EN – Endangered; VU - Vulnerable						

IUCN Listed Fauna Species

The fauna species have been categorised by the IUCN (2012) and a number have been recorded within the Project area. The 2007 and 2013 surveys recorded two species, the Northern white-cheeked gibbon and White-backed vulture (*Gyps bengalensis*) listed as critically endangered within the Project Area.

Overall, the surveys identified these types of threatened species:

- Twenty-one mammal species (1 critically endangered, 7 endangered, 13 vulnerable);
- Six reptile species (1 endangered, 5 vulnerable);
- Four bird species (1 critically endangered, 1 endangered, 2 vulnerable);
- No amphibian species.

Table 6.4 summarises the species recorded.

Table 6.4 IUCN Listed Species Reported within the Project Area

Scientific name	Common name	2007 Survey		2013 Survey			
		Main Dam	Nearby Main Dam	Main Dam	Re-regulation Dam	Resettle-ment	IUCN Status
Mammals							
Nomascus leucogenys	Northern white-cheeked gibbon		X*	X			CR
Cuon alpinus	Asian wild dog, dhole	X#	X#	X*			EN
Elephas maximus	Asiatic elephant	X#	X#				EN
Manis javanica	Sunda pangolin	X*	X*	X*			EN
Panthera tigris	Tiger	X#	X#	X			EN
Prionailurus viverrinus	Fishing cat	X#	X#				EN
Pygathrix nemaeus	Red-shanked douc langur		X*				EN
Trachypithecus phayrei	Phayre's leaf monkey	X#	X#	X*			EN
Aonyx cinerea	Asian small-clawed otter			X*			VU
Arctictis binturong	Binturong			X			VU
Bos gaurus	Gaur	X#	X#				VU
Capricornis milneedwardsi	Chinese serow	X*	X*				VU
Helarctos malayanus	Malayan sun bear		X*	X			VU
Lutrogale perspicillata	Smooth-coated otter			X*			VU
Macaca arctoides	Stump-tailed macaque	X#	X#	X*			VU
Macaca leonina	Northern Pig-tailed macaque			X*			VU
Nycticebus bengalensis	Bengal slow loris	X#	X#	X*			VU
Nycticebus pygmaeus	Pygmy slow loris	X#	X#	X*			VU
Pardofelis marmorata	Marbled cat	X#	X#				VU
Rusa unicolor	Sambar deer	X*	X*	X			VU
Ursus thibetanus	Himalayan black bear	X#	X#	X*			VU
Reptiles							
Platysternon megacephalum	Big-headed turtle			X*			EN
Amyda cartilaginea	Southeast Asian softshell turtle			X*	X*	X*	VU
Malayemys subtrijuga	Snail-eating turtle			X*		X*	VU
Naja siamensis	Indo-Chinese spitting cobra			X*	X*	X*	VU

Scientific name	Common name	2007 Survey		2013 Survey			
		Main Dam	Nearby Main Dam	Main Dam	Re-regulation Dam	Resettle-ment	IUCN Status
Ophiophagus hanah	King cobra			X	X		VU
Siebenrockiella crassicollis	Siamese temple turtle			X*			VU
Birds							
Gyps bengalensis	White backed vulture		X*				CR
Cairina scutulata	White winged duck		X*				EN
Aceros nipalensis	Rufous-necked hornbill		X*				VU
Aquila heliaca	Imperial eagle	X*	X*				VU

* denotes inquiry record

# denotes secondary data source

IUCN Status: CR – Critically Endangered; EN – Endangered; VU – Vulnerable.

Restricted and Protected Species

The Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF identifies wildlife into two categories, restricted species (List I), and protected species (List II). A number of species under these categories were recorded during field surveys in the Project area undertaken by ERI (2009) and TISTR (2013).

The recent surveys (2013) in the main dam area (upper Nam Ngiep), Lower Nam Ngiep and the Resettlement site detected the following fauna species listed in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF:

- Thirty-two mammal species (15 restricted (List I), 17 protected (List II));
- Six bird species (1 restricted (List I), 5 protected (List II));
- Eight reptiles (2 restricted (List I), 6 protected (List II));
- No amphibians.

A list of the species is provided in the Baseline Biodiversity Report.

6.1.2 VEC 2: Aquatic Biodiversity and Habitats (Including River Flows)

Known Or Suspected Impacts By The Project And RFFAs

This section relies on information presented in the Biodiversity Baseline Report (ERM 2013b).

The Project will cause flooding of areas along the Nam Ngiep upstream of the main dam and into some tributaries, as well as in some of the sections between the main dam and the reregulation dam. The main dam inundation area is 70 km in length (representing approximately 44 per cent of the total length of the 160 km long Nam Ngiep River). The maximum areas of the reservoirs when full will be 67.98 km^2 (main dam) and 6.99 km^2 (re-regulation dam) totalling 74.97 km^2 (ERI 2012; ERM 2013b).

The scoping of project impacts identified a number of potential impacts to aquatic biodiversity, habitats and river flows, including:

- Permanent and temporary loss of habitat;
- Creation of a barrier to fauna movement;
- Permanent or temporary fragmentation of habitat;
- Downstream impacts due to changes in the flow regime;
- Degradation of habitat as a result of introduction of, and competition with, alien species; and
- Degradation of habitat in the event of release of hazardous substances or pollution.

Baseline studies undertaken for the Biodiversity Impact Assessment (ERM 2013b) identified a diversity of aquatic fauna species and ecosystems in the Nam Ngiep River including some species listed on the IUCN Red List of threatened species.

The aquatic species listed by the IUCN as critically endangered, endangered or vulnerable that have been recorded or have potential to occur within the Project area are summarised in *Table 6.5*.

Table 6.5 IUCN Listed Aquatic Fauna Species recorded in the Project Area

Scientific Names	Common Name	Land Cover Code	Area of habitat to be directly disturbed (ha)	Status
Fish				
Poropuntius deauratus	Yellow tail brook barb	W	410	EN
Cirrhinus cirrhosus	Mrigal carp	W	410	VU
Cyprinus carpio	Wild common carp	W	410	VU
Scaphognathops bandanensis	Bandan sharp-mouth barb	W	410	VU
Yasuhikotakia splendida	Jaguar loach	W	410	VU

By holding back a very large quantity of water, the proposed dam will significantly change the natural water flows of the river, converting stretches of lotic water to semi-lacustrine. This affect could lead to the invasion of many exotic fish, algal and fungi species and the localised extinction of native species. The reduced flow creates an unnatural habitat for many stream lined species including loaches and catfish. The reduction of flows can also result in stagnant water, where algal blooms easily occur and can lead to anoxic environments, further reducing the abundance of native species within the river.

Stagnant waters trigger the settling of fine particles such as silt and suspended and dissolved solids. This will adversely affect the reservoir as the resulting nutrient enrichment causes eutrophication, whereas downstream waters would receive turbidity free and low nutrient water. This turbidity free water is beneficial for aquatic biodiversity, but increases the erosion capacity and decreases the self-purifying capacity of the waters.

Previous investigations into the biological characteristics of both the Nam Ngiep and Nam Xan River indicate that the waters are clean and free of organic pollution. There are no point sources of pollutants and diffuse sources are sparse. During construction, it is expected that impacts will result from the disposal of muck, effluent from crushers and other sources and sewage from the nearby labour camps. The unsorted waste entering the river channel will greatly contribute to the turbidity of the water for long periods. This increased turbidity will reduce the photosynthetic efficiency of primary producers within the river and as a result, the biological productivity would be greatly reduced. Increased organic content in the river may result in eutrophication and lead to changes in species composition, resulting in an alteration of the natural food chains and trophic structure in the river channel.

Installation of the dam will introduce a barrier to water flows and flushing, and biota movement not previously experienced in the region of the watershed. Fish migration is an important component for many fish species life cycle and the barrier that the dam wall creates will limit spawning area for a number of species known to occur in the Nam Ngiep River (including threatened species). An impact to breeding area availability has potential to influence native fish populations within and downstream of the Project (including threatened species). Overall the dam infrastructure will reduce the area of waterway available for spawning within the watershed.

It is reasonable to assume that the Project reservoir will create an easily accessible body of water on which people will hunt aquatic resources. Infrastructure built for the Project could potentially lead to an increase in human population in the Project Area which could potentially lead to an increase in the number of people hunting aquatic biota for sustenance and/or economic reasons (i.e. to sell at markets), however these issues are discussed further in *Section 6.1.3*.

NNP2 HEP

The EIA for the Nam Ngiep 2 Hydropower Project (NCC EAT 2010) identifies that the reservoir areas will be 754 ha for the main reservoir and 19 ha for the tributary dam. The impoundment of the water and creation of the reservoir for the NNP2 project will turn 10 km of free-flowing river into a lake. NCC EAT (2010) present limited understanding of the aquatic environments of the NNP2 area due to limitations caused by:

- Limited study observation time and history; and
- Inter-seasonal and inter-annual variability.

Despite these limitations, the authors acknowledged some potential impacts to aquatic environments as:

- the importance of the rivers for fish migration and that the reservoir will sever this migration passage;
- an increase in habitat presence for those species preferring still water and a decrease in available habitat for those species preferring fast moving water;
- suspended particles can damage fish eggs leading to abnormality or no hatching although it is not clear if the project will lead to this, or prevent it from happening; and
- a significant increase in the abundance of fish due to the creation of a reservoir.

NCC EAT (2010) claim current anecdotal evidence from local fishermen is that fish availability is declining. NCC EAT (2010) provide no discussion of the cumulative impacts of the NNP2 HEP in their EIA.

Nam Phouan HEP

No information is available on the length of river that will be turned from a free-flowing river into a reservoir although the area of the reservoir when full is likely to be in the order of 30-50 ha (Velcan and Lem 2012). The ESIA report for Nam Phouan HEP (Velcan and Lem 2012) identifies that the aquatic ecology of the Nam Phouan project site is typical of the rivers in that part of Laos. The report identifies an impact to species assemblages with the introduction of a lake with those species adapted to fast-flowing rivers unlikely to adapt however the species adaptable to the lake conditions will experience an increase in population numbers. Velcan and Lem (2012) predict a 20-40 per cent reduction in the biodiversity of the fish of the reservoir due to the limited number of species whose preference is fast-flowing rivers that will be able to adapt to the reservoir environment. They conclude that most of those species preferring fast flowing rivers will be able to survive in the upstream parts of the catchment and therefore will experience an insignificant

impact. Velcan and Lem (2012) also conclude that the reservoir will eradicate short distance migrant fish species from the upper reaches of the catchment.

Summary

The total length of the Nam Ngiep River that could potentially be modified by dam construction for NNP1 and the other proposed HEPs is not known as there is no information available on five of the seven proposed HEPs in the catchment. The Nam Ngiep River is approximately 160 km long. The NNP1 project will result in approximately 70 km of river being altered, representing 44 per cent of the total length of the Nam Ngiep River. The NNP2 project will result in the alteration of 10 km of river length representing 6 per cent of the total length of the Nam Ngiep River. Therefore from these two HEPs alone, it is expected that 80 km of the Nam Ngiep River will be converted from lotic water to lacustrine water representing 50 per cent of the total Nam Ngiep River length. No data are available on the total length of the reservoirs of the five other proposed HEPs in the Nam Ngiep catchment but they are relatively small compared to the NNP1 and NNP2 projects.

The creation of major dams in the Nam Ngiep watershed provides barriers to fish migration and alterations to flow regimes. This is potentially a large impact on the aquatic environments in the entire watershed and the downstream environments including the Mekong River. The NNP1 biodiversity baseline assessment (ERM 2013b) identified a diversity of aquatic biota that utilise the main river and tributary habitats for the catchment for both foraging and breeding. The community includes species that migrate upstream for spawning. Some species will adapt to the modified conditions however a number of the species detected during surveys (ERM 2013b) are migratory, requiring movement within the catchment for spawning. Fish that require migration to complete their life cycle could potentially reduce in abundance over the next 10-15 years if the planned HEPs are constructed as the proposed HEP infrastructure will reduce the area of waterway available for spawning within the catchment. The NNP1 project presents the largest barrier to fish migration of the proposed HEPs and it has the potential to alter the fish assemblages of the downstream and upstream environments due to this barrier creation. The location of the NNP1 project being near the downstream extent of the Nam Ngiep River near the confluence of this river with the Mekong means that construction will provide a significant barrier to fish migrating from the Mekong River up the Nam Ngiep River. The construction of HEPs upstream of the NNP1 reservoir could also have an impact on those short-distance migratory species that migrate from the Nam Ngiep main channel up into higher reaches of the catchment. Essentially, the construction of these HEPs will have a large impact on migratory fish species. Habitat alteration could potentially change the fish species assemblages with a reduction in fast-flowing water due to river regulation. This alteration could be rather widespread across the Nam Ngiep watershed as up to seven of the proposed HEPs are constructed over the next 10-15 years. The habitat alteration via creation of large reservoirs of stagnant water could actually

provide an increase in the numbers of some species with a preference for these conditions.

Data on the current flow rates at the location of five of the seven proposed HEPs are unavailable. The changes that these five proposed HEPs might cause to the flows of the rivers on which they are proposed is not known. For NNP1, the current average annual inflow is 148.4 m^3/s (ranging between 200-325 m^3/s in the period June-September and 50-75 m^3/s in February to April). The re-regulation dam will release a minimum dry season flow of 27 m^3/s during the dry season and wet season inflows will equal outflows after dam is at capacity (expected to take one year) as flood water will overflow over the dam walls. There will be a period of one year after construction that the maximum flow will be 5.5 m^3/s during which time the reservoirs will be filling. Data on the impact that NNP2 will have on flow rates in unknown. The proposed HEP on the Nam Phouan River will result in a reduction of flows from the current 29 m^3/s to 0.5 m^3/s (Velcan and Lem 2012). This project involves diverting the water from the Nam Phouan to the Nam Om so that water from the Nam Phouan will flow into the Nam Om at a maximum flow rate of 35 m^3/s (Velcan and Lem 2012). The water will flow out directly into the reservoir of the NNP1 main dam should it be completed.

A change in flows downstream from any of the proposed HEPs has the potential to influence downstream aquatic biota populations that are currently adapted to the seasonal cycle of wet and dry season flow volumes and peaks. For the largest of the proposed HEPs (NNP1), environmental flows assessment identified that annually, inflow and outflow regimes during operation of the Project will be the same as current. For NNP1 the regulation design will regulate the flood discharge during the wet season and increase the dry season flow rates, though the seasonal flow regime shows less fluctuation over the year. The peaks in daily and monthly flow fluctuations are less evident however are modelled to replicate the existing cycle prior to dam construction. Species downstream of the proposed NNP1 re-regulation dam that are adapted to a large inter-seasonal fluctuation in the flow rates may be negatively impacted by the alteration of the flow rates to a more consistent inter-seasonal flow.

Within the impoundment of water for any reservoir of the seven proposed HEPs, water quality is likely to change, in particular relating to dissolved oxygen, temperature and nutrient levels (due to reduced flushing). The effect of impoundment on the growth of plankton and benthos will be high due to organic loading in the first year of any reservoir impoundment. Conversely, the physico chemical characteristics of the water may impact downstream environments as the regulated releases occur. Releasing low oxygen water has potential to lead to fish kills and reduced productivity downstream of the dams.

It is likely that an increase in human populations and aquatic resource use will have a negative impact on species and populations through a predicted increase in hunting although there could potentially be a positive impact for local human populations where fish abundance increases in all of the created reservoirs. This is discussed further in *Section 6.1.3*.

Known Cumulative Impact Issues In The Region

Previous investigations into the biological characteristics of both the Nam Ngiep and Nam Xan River indicate that the waters are clean and free of organic pollution. There are no point sources of pollutants and diffuse sources are sparse (TISTR 2013).

The Aquatic Biota Survey undertaken in March 2013 identified four species listed as threatened on the IUCN Red List in the Project Area. These species are on the IUCN Red List as a result of their decline and/or vulnerability to current and predicted future land use and are discussed further in the later section regarding scientific community concerns.

It is worth noting that a small aquatic conservation zone has already been established in the upper reservoir in which all fishing is banned (ERM 2013a) presumably as a reaction to aquatic species declines.

Concerns Generally Recognized As Important On The Basis Of Scientific Concerns

Biodiversity surveys across the Project area detected two species listed as Protected (List II) in the Regulation of Ministry of Agriculture and Forestry No. 0360/MAF (2003) and ten species listed as endangered, vulnerable or near threatened on the IUCN Red List. The threatened species detected are summarised in *Table 6.6*.

Table 6.6 Threatened Fish Species detected in Project area

Species name	Common name	Status	IUCN Status	Relative Abundance
Poropuntius deauratus	Yellow tail brook barb		EN	VC
Cirrhinus cirrhosus	Mrigal carp		VU	LC
Cyprinus carpio	Wild common carp		VU	
Scaphognathops bandanensis	Bandan sharp-mouth barb		VU	C
Yasuhikotakia splendida	Jaguar loach		VU	C
Cirrhinus molitorella	Mud carp		NT	C
Mekongina erythrospila			NT	VC
Hemibagrus wyckioides	Redtail catfish	P		VC
Luciosoma bleekeri	Apollo shark minnow	P		VC

6.1.3 VEC 3: Ecosystem Services

Known Or Suspected Impacts By The Project And RFFAs

The main reservoir will cover parts of Vientiane and Xieng Khouang provinces, with a surface area of 67.98 km² when at full supply level of EL320 m (ERI 2012).

Apart from the loss of timber species, the submerged forest will reduce the total availability of NTFPs, but only to a relatively minor extent at the watershed scale (ERI 2012). Some of the high value NTFPs (including medicinal plants, fruits, material, value for animals and conservation) that will be affected include medicinal plants or herbs such as cardamom *(Amomum xathioides)*, Beberin *(Coscinium fenestratum)*, *Neolourya pierrei, Ziziphus attopoensus,* while others are used as food, such as mushrooms, bamboo shoots, wild vegetables, and wild fruits (ERI 2012).

It is reasonable to assume that infrastructure development such as what will occur for the Project would increase human settlement and therefore an expansion of agriculture will likely occur, potentially at the expense of remaining forest types in the lowland areas thereby potentially removing some of the little remaining (although degraded) forest around the Project Area. There will be an increase in accessibility of the more distant forest areas at the upper reaches of the watershed due to the reservoir creation as it will provide easier access for people to reach these areas which could potentially lead to an increase in human use of the ecosystem services in these formally remote and less anthropogenically impacted forest areas (i.e. hunting, poaching and logging). These factors could lead to a diminution of the availability of ecosystem services.

NNP2 HEP

NCC EAT (2010) presents a discussion of potential impacts on ecosystem services from the proposed project. Those include:

- Increased fishing by construction workers;
- Potential increases in illegal fishing methods; and
- An anticipated increase in fish abundance in the reservoir providing people with more protein in their diets.

NCC EAT (2010) present no discussion of the cumulative impacts of the NNP2 HEP in their EIA.

Nam Phouan HEP

The environmental impacts assessment report (Velcan and Lem 2012) identifies the NTFPs of general importance in Laos and in the study area identifying as 'very important' for subsistence the following: wildlife/fish, rattan, bamboo, medicinal plants and spices, honey, vegetables, mushrooms and tubers. The investigations identify NTFPs in the proposed inundation area that are at 'exploitable densities' as *Bambusa arundinacea, Calamus spp., mushrooms, Amomum spp., Tea chinensis and Nothaphoebe umbelliflora*. The report identifies some valuable NTFPs to the economies of many local households are wild fish, rattan, mushroom and bamboo shoots.

Velcan and Lem (2012) identify the indirect impacts of human exploitation of wildlife as being the major potential threat to local terrestrial animals of the project area. It identified the potential impacts of exploitation as 'potentially unsustainable' unless adequate wildlife protection measures are put in place.

Velcan and Lem (2012) claims some positive impacts to the ecology of the local area from the proposed project are the increase in controlling illegal logging and animal exploitation, potential community education programs regarding sustainable use of resources and benefits in ecological understanding of the local wildlife through increased monitoring. Although Velcan and Lem (2012) also identify that a potential negative impact could be the increased access for hunters.

Summary

The HEPs across the NNP1 watershed are expected to provide an improved quality of life for people living in settlements to which the generated electricity will be distributed. It is expected that if all of the seven proposed HEPs in the area are constructed, the improvements to quality of life will be rather widespread. It is expected that these improved living conditions in settlements will lead to population increases which will in turn lead to increased pressure on the ecosystem services of the surrounding areas as people will look to gather resources from surrounding forest areas.

It is likely that in general, an increase in human populations and both terrestrial and aquatic resource use will have a negative impact on species and populations through a predicted increase in hunting. There could potentially be a positive impact for local human populations around the created reservoirs if fish abundance increases in the reservoirs due to the creation of large water bodies and large expansion of semi-lacustrine environments. This increase in fish abundance will likely occur in species adapted to the semi-lacustrine environments with a decline in the number of species that require the lotic water to complete their life cycle.

In the short term (1-5 years) it is anticipated that people living in nearby settlements will realise the improved transport infrastructure (i.e. new roads and a water reservoir) will provide increased opportunity to access previously inaccessible areas of forest for gathering non-timber forest products and illegal logging.

There is a potential that in the medium term (10-15 years) the realisation of the benefits of improved transport infrastructure, increased water supply and electricity infrastructure may lead to the expansion of commercial industries such as forestry, mining and potentially large-scale agriculture. These industries are reliant on ecosystem services such as soil regulation, water regulation and pollination vectors. An increase in commercial ventures such as these will potentially attract more human settlement in the region which will further increase the pressure on non-timber forest products.

Known Cumulative Impact Issues in the Region

Forest products, especially NTFPs, play an important role in the rural economy of the Project Area and Lao PDR as they provide animal protein, calories, vitamins and dietary fibre, materials for house and handicraft production, traditional medicines, and cash income (from the sale of NTFPs). Although there is still considerable animal hunting in the country (most villagers depend on hunting for part of their diet), the relative abundance of forest habitat and, in some cases, its considerable distance from human settlements and inaccessibility have provided some protection for the country's wildlife. However, human population and development pressures are increasing, especially since 1990, and consequently the wildlife population has declined dramatically throughout the country due to hunting pressure exerted by human populations (ERI 2012).

Based on a field survey and interviews with local residents undertaken for the EIA (ERI 2012), it is apparent that the only significant remaining wildlife habitats are in the forested areas on the steep upper slopes or in the still abundant forests outside the Project Area. Whatever remaining wildlife found in the Project Area lives mostly in the higher elevations, and these have been and are still being indiscriminately and extensively hunted and captured (ERI 2012). There are still some wildlife habitats, though not as significant, within the proposed reservoir area where the mixed deciduous forest still remains. In the other more accessible lower and less steep slopes, the forests have been destroyed by indiscriminate logging, bush fires, and shifting cultivation, and the wildlife and their habitats there have also been severely disturbed (ERI 2012).

The land is a medley of vegetation communities, with local agricultural practices (shifting cultivation, i.e. converting forested land into agricultural land) that have heavily impacted on forest tree species composition and maturity (ERI 2012). This in combination with burning forests for hunting and illegal logging has removed much of the original forest which has led to a

diminution of the availability of NTFPs and placed further pressure on the remaining areas of forest and NTFPs (ERI 2012).

Consultation to supplement the biodiversity surveys (ERM 2013b) occurred as market surveys (where researchers observed what was available for sale at local markets) in 2012/3 and interviews at the focus group level and in-depth interviews. These occurred in both the impact area (Nam Ngiep watershed) and the proposed resettlement area (Nam Xan). The results found that with regard to Ecosystem Services it is evident that villagers in the Project area regularly use local terrestrial and aquatic biodiversity – e.g. as a food source. However, the dependence on natural resources varies by village and is largely associated with accessibility. For example, remote villages tend to rely more heavily on medicinal plants as access to pharmaceuticals is limited.

Under subheadings following is discussion of the uses and cultural values placed on (and/ or associated with) biodiversity by local villagers in the Project area. Much of the data is from village and market surveys undertaken by ERM in February and March 2013.

Hunting and Gathering

Villagers, both Loa and Hmong people, hunt and gather. This is done primarily for household consumption. However, when surplus exists, it is sold within the village or neighbouring villages.

Although the norm is to consume the materials locally, there are a small number of species that are collected for sale. Access to markets from villages is limited due poor road access, so external sales are to intermediaries who travel to the villages.

Hunting for small animals is common across all villages. Villagers rarely admitted to hunting larger animals as all were aware this is illegal. Bamboo traps are predominantly used for capturing squirrels and rats, though hunting dogs, firearms and knives are also reportedly used.

Hmong families tend to hunt together while lowland Lao hunt individually or in small groups of either men or women. Hunting activity is no longer a daily activity, and is only triggered when a change from chicken or fish is desired or a ceremony requires it (i.e. a wedding or Hmong New Year). Villagers will generally travel as far as the need to hunt and gather though based on survey data this is unlikely to be further than 3-5 kilometres from the village (i.e. walking distance).

Villagers have noted that availability of naturally occurring resources, especially forest animals and fish, has been declining in recent years.

Medicinal Plants and Materials

Usage, and therefore dependence, appears to be predicated on access to health services - the easier the access to pharmaceuticals, the lower the usage of natural medicines. In the Project area, villages have indicated a preference for pharmaceuticals but said natural medicines were generally used in the first instance.

Timber Products

Timber products are actively sourced from the forests by villagers and commercial operators. For instance the local villagers were observed sourcing and processing hardwood into planks near the proposed dam site.

Fishing

When compared to hunting, fishing occurs on a more regular basis. This is largely because of the close proximity of villages to waterways.

Fishing may have been more important for income generation in earlier times though with greater availability of alternative protein sources and reported reduction in stock availability and size, villages have adapted.

Fish is generally caught only for household consumption, but it is also a common item used in inter-household exchange and transactions. Surplus fish tends to be sold at below market rates suggesting such transactions may more likely be part of a local gift economy rather than a commercial transaction. This being said, it was common to hear that small fish are eaten at home while big fish, when found, are sold.

The most common fishing method is with a cast weighted net, an item commonly seen in most houses. Larger nets are used during the rainy season to catch larger fish that swim up river from the Mekong River. At Hatsaykham, the survey team observed other methods such as scaring fish into a net hung across a short section of the river and gathering by hand. Other equipment observed in villages included lines, hooks and spear guns. Fishing takes place at established riverside sites at which small shelters are built.

Cultural Services

Most of the villages surveyed in the Project area have been settled only relatively recently signalling a lesser dependence on cultural services provided within proximate ecosystems. While length of residence is not an exclusive factor in determining usage and dependence, the less time people have to form attachments to aspects of an ecosystem, the less significant these features are likely to be. Indeed the relatively new nature of the villages acts to sever any bonds that people may have with prehistoric features within the environment such as tangible objects (i.e. stone tools, brass or ceramic objects)

and intangible knowledge (i.e. creation myths or site specific rituals). This is not to say that the cultural values villagers derive from the ecosystem are insignificant, it is to signal that what values they do use are likely severable and reproducible elsewhere.

Numerous locally collected polished stone tools have been found in the Project area indicating human occupation in the area occurred between 4,000 and 12,000 years ago. However, most of the existing villages were settled in the early-1980s and 1990s.

The most significant social, religious and cultural sites people were able to identify (during the surveys) in villages in the Project area were grave sites. Reflecting the severable nature of connections people have with grave sites, villagers indicated that the ancestor spirits associated with such grave sites are transferrable to a new location through the performance of a complex ceremony conducted by the village shaman (called a Yao in the surveyed villages).

Each of the Hmong villages visited in the lower reservoir zone had a shaman residing there. Each house has a small shrine that is used by the shaman for ceremonies. The shaman is essentially a conduit between the human and spirit worlds. Sickness among Hmong is believed to be the result of contact with evil spirits. At risk of overgeneralising, the shaman's role is to free a person's spirit (or soul) from the malevolence brought through this contact with spirit world. The shaman was identified in these villages as the person most dependent on the naturally occurring forest though little detail was able to be collected about the extent of this dependence. Naturally occurring bamboo is used by both Lao and Hmong to make an animist symbol that is hung above doorways to ward off evil spirits.

Concerns Generally Recognized As Important On The Basis Of Scientific Concerns

No concerns are identified to ecosystem services on the basis of scientific community concerns.

6.2 *ALTERNATIVES TO AVOID, MINIMISE, OR MITIGATE SIGNIFICANT CUMULATIVE IMPACTS*

The ADB review recommended that not only should this project install mitigation measures specific to the impacts of the project, but this CIA should consider what contribution the proponent could make to regional impacts on a more broad scale.

The mitigation measures described in *Section 6.2.1* address the Project specific mitigation and monitoring measures for this NNP1 project from the key documents reviewed for this assessment (the EIA (ERI 2012) and the IEE (2012)). This section includes the recommended mitigation measures that were presented by Velcan and Lem (2012) in the Nam Phouan impact assessment. Mitigating similar impacts from similar activities in the same region should increase the overall efficacy of project impact mitigation. *Section 6.2.2* details the Project's potential contribution to broad-scale impact mitigation in the region.

6.2.1 Project Specific Mitigation Measures

The Nam Ngiep 1 Hydropower Project EIA (ERI 2012) recommends mitigation measures to minimize impacts on terrestrial ecology/wildlife/aquatic biota during the construction and operation phases of the Project, as summarised below:

Construction

- a wildlife protection team will be established to protect and rescue wildlife;
- wildlife specialists should be engaged to collect more detailed data concerning the existing wildlife species in the Project Area, and how these species will be affected during construction and operations;
- strict rules against logging outside the approved construction areas and against wildlife hunting and poaching will be imposed on Project staff, workers, and all contractors and personnel engaged in or associated with the Project, with penalties levied for anyone caught carrying and using fire arms, or using animal snares and traps, including fines and dismissal, and prosecution under the laws of the Lao PDR. The Project owner shall be directly responsible for dissemination to its staff and workers of all rules, regulations and information concerning these restrictions, as well as the punishment that can expected if any staff or worker or other person associated with the project breaks these rules and regulations;
- in the remaining forest areas in the watershed, and especially in those areas near the reservoir, a forest and wildlife conservation and management program needs to be implemented in order to protect the wildlife in the area;
- site clearing and other earth works should use the appropriate method to minimize release of dust and sediment into the river that would increase water turbidity; and
- fishing around the construction area should be prohibited. Use of illegal fishing gear anywhere along the river should also be prohibited (ERI 2012).

Operation

There will be continuous impacts from construction phases that will carry forward to project operation phase. As such, the appropriate mitigation measures recommended are provided as follows:

- wildlife specialists should be engaged to monitor the conditions of the existing wildlife species in the area and to assess if the project owner has taken adequate measures to protect those species;

- see hunting point above; and

- the Project should develop a wildlife protection plan linked with the forest management plan, which aims to manage and protect the forest and wildlife in the watershed area. Participatory Integrated Conservation and Development (PICAD) will be applied for the management of forests and wildlife in the watershed area (ERI 2012).

The NNP1 EIA (ERI 2012) also recommends mitigation measures to minimize impacts on forest vegetation/cover during the options and design consideration phases of the Project. Because the placement of access roads and transmission lines are much more flexible than the placement of the dam, powerhouse, and other structures, planning for the access roads and transmission lines should be sufficiently flexible to avoid as much as possible adverse environmental impacts (ERI 2012). The EIA recommends that the Project should:

- where possible keep the access road and the transmission line alignments as straight as possible between the start and end points. For transmission lines, this will minimize the total number of towers, and for both the transmission lines and access roads, this will reduce the amount of materials that need to be imported, reduce construction costs, minimize the area that needs to be converted from other land uses and minimize the area of forest clearing. However, if there is a choice between a straight path going through a forest or a more circuitous route that avoids the forest, the more circuitous route should be selected, since it will minimize forest destruction;

- minimize the need to expropriate valuable lands, particularly village holy forests, village cemeteries, and agriculture land;

- avoid areas of mature forest and other environmentally sensitive areas including NBCAs, NPAs, and eco-tourism sites;

- ensure adequate clearance between the transmission line and access road alignments and any significant cultural/historical monuments/sites; and

- wherever possible, considerations should be given in minimizing the extent of visual intrusion upon views considered as unique or valuable as tourist resources. This aspect however limited in so far as the technical consideration of the dam is concern, it is still applicable in determining the visual aspect of the dam, the powerhouse as well as the operation villages.

From the field survey carried out as well as from the information available, the most favourable components were recommended and their selections based on the above principles (ERI 2012). However ERI (2012) emphasize that these are subject to further detailed site survey and detailed design, and that these principles should be maintained for these more detailed works (ERI 2012).

The IEE (2012) for the Nam Ngiep 1 Hydropower Project also describes mitigation measures to be implemented for the transmission line routes:

- to ensure that the alignment and new access tracks avoid environmentally sensitivity area, staff of the Environmental Management Office (EMO) of the Project should review the detailed alignment survey based on the IEE (2012) report and work with the appropriate GOL authorities in monitoring the environmental impacts of the construction of the transmission lines. If the detailed alignment confirms that the transmission line must pass through small patches of secondary forest because there are no suitable alternative routes, the arrangements for logging will be made by the Provincial Agriculture and Forestry Department (PAFO), in particular the Provincial Forestry Section (PFS) with District Agriculture and Forestry Office (DAFO), as well as any compensatory tree planting that may be required;

- Right-of-way (ROW) clearing will be carried out by a contractor, whose work will be strictly defined by the contract specifications and special provisions;

- for this Project, transmission lines will be strung under tension to minimize potential damage to vegetation and soils that would be caused by dragging conductor wires over the ground. Where the terrain is particularly difficult and the risk of damage to undergrowth is possible, consideration will be given to the using alternative methods for construction;

- a monitoring program will be implemented by any contractors or subcontractors carrying out the work, who will be responsible for day-to-day monitoring of their activities, and by the EMU and the Project's EMO;

- to protect wildlife, strict rules against wildlife hunting and poaching will be imposed on project staff, workers, and all contractors engaged for the project. Penalties will be levied for anyone caught carrying and/or using firearms; or using animal snares and traps. The Project Owner shall be directly responsible for dissemination of all regulations and information concerning the ban on firearms and hunting to its employees. The Project

owner will also be responsible for any misconduct made by its employees; and

- two small locally-managed conservation areas are in the forest areas near Thong Noi Village in Pakxan District, Bolikhamxay Province. Any construction activities likely to affect these areas, such as logging along the transmission line, material transport, or temporary camps, should be avoided (IEE 2012).

Nam Phouan HEP

Recommended mitigation measures identified in Velcan and Lem (2012) for the Nam Phouan project impact assessment that were not similar to those discussed above include:

- reforestation in degraded areas along water courses
- larger trees to be retained where possible
- avoid chemical use in vegetation clearance
- sequence tree clearing from downstream to upstream to encourage wildlife migration upstream
- separated camp site for construction and operation
- minimise night work

A number of these are worthy of consideration for the NNP1 project and could potentially be considered during the drafting of the forest and wildlife conservation and management program.

6.2.2 Broad-Scale Mitigation Measures

This project will contribute to the impact amelioration at a more broad level through the establishment of a biodiversity offsets. The recommended offsets include:

- Forested and riverine areas of the Huay Ngua PPA;
- Forested and riverine areas of the Phou Khouy Khouy NPA;
- Forested and riverine areas of the Nam Ngiep Watershed (Production and Protection Forest; and
- Watershed management activities within offset sites and the Nam Ngiep watershed.

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