Appendix F

NNP1 Transmission Line from the Main Dam to Vientiane Initial Environment Examination

(Originally Prepared by ERIC and Amended by ERM)

Nam Ngiep 1 Hydropower Project

Initial Environmental Examination (IEE) for NNP1 230kV Transmission Line Report

NAM NGIEP 1 POWER COMPANY LIMITED

May 2014

0229866

www.erm.com

The world's leading sustainability consultancy

ERM

FINAL REPORT

NAM NGIEP 1 POWER COMPANY LIMITED

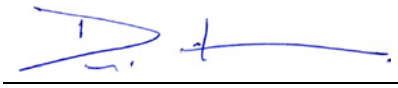
Initial Environmental Examination (IEE) for NNP1 230kV Transmission Line Report

May 2014

Reference 0229866

For and on behalf of
ERM-Siam Co., Ltd.

Reviewed by: David Nicholson

Signed: 

Position: Principal Consultant – Biodiversity Lead

Approved by: Cristina Pellegrino

Signed: 

Position: IAP Partner

Date: 22 May 2014

CONTENTS

CONTENTS

PARTICIPATION

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXES

EXECUTIVE SUMMARY

The Nam Ngiep 1 Power Company Limited (NNP1PC) is developing the Nam Ngiep 1 Hydropower Project (NNP1) with assistance from the Asian Development Bank (ADB). The distribution of electricity from NNP1 will require the development of a 230 kV transmission line to transmit electricity from the Main Dam site to Nabong collector substation in Vientiane Capital. The transmission line will extend a length of 125 km, with a required 35 m right of way.

An Initial Environmental Investigation (IEE) was undertaken for the transmission line in 2012 by Environmental Research Institute, Chulalongkorn University (ERIC). Since this time, the alignment has been revised based on new information available on the social and environmental constraints surrounding the alignment. The Project Area for the revised alignment includes the alignment right of way (extending 125 km with a width of 35 m) and access roads with a total length of approximately 8 km. This document presents a revised IEE based on the revised alignment, currently available information and comments received from the ADB on the 2012 IEE. This document:

- *identifies the main environmental and social resources of the areas in and adjacent to the proposed transmission line;*
- *identifies the nature of potential adverse impacts that could occur from the construction and operation of the Project; and*
- *outlines mitigation measures to avoid and/or minimize such adverse impacts.*

Preparation of the IEE involved: desktop review of available information, including the 2012 IEE, documentation related to other NNP1 project components, satellite imagery and mapping for the project area; and a two day site reconnaissance visit in January 2014.

Consultation has been undertaken with stakeholders along the transmission line corridor. This has included meetings with to Provincial and District representatives and local villages. The meetings provided an opportunity share (or disclose) information about the transmission line, including potential impacts and proposed management measures, as well as gain feedback from stakeholders. A key part of the consultation process has been to identify existing land uses, infrastructure and culturally significant sites along the transmission line corridor, in order to incorporate this information into the corridor selection process and avoid where possible. Consultation findings have been incorporated into the development of this IEE.

The IEE has been prepared in consideration of the requirements of the Lao PDR Department of Electricity and Ministry of Natural Resources and Environment for the preparation of environmental assessments, as well as in accordance with the ADB Environmental Safeguard Policies.

Baseline Social, Physical and Biological Environments

The proposed transmission line is located on the western bank of the Nam Ngiep river. The northern portion of the alignment is located in a mountainous area, while the southern and western portions are located in the relatively flat Mekong Lowlands.

The area around the proposed transmission line includes 24 villages. These villages share a number of similar characteristics. Houses within these villages tend to be situated alongside the river, in this case the Nam Ngiep, or beside roadways in clusters.

Land cover mapping indicated that approximately two thirds of land within the RoW consists of fallow land (both young and old) and rice paddies. Some areas of agricultural plantations and slash and burn also exist.

Land cover mapping indicated that approximately a third of land within the proposed Project Area is natural habitat, dominated by deciduous forest, with small areas of swamp, bamboo forest, scrub/heath and evergreen forest.

A critical habitat assessment was undertaken to identify if the Project Area provided critical habitat for IUCN listed species, nationally listed species or migratory species. Based on vegetation mapping and consultation with species specialists the assessment identified that the transmission line Project Area is unlikely to be associated with habitat considered to be critical habitat for these priority biodiversity values.

Potential impacts

The IEE identified potential impacts on the social, physical and biological environment for the design, construction and operation phases. The IEE identified the following impacts as requiring management through the design, construction and operation of the Project:

- ***Hydrology** – potential impacts to surface flows due to earthworks and in-stream works;*
- ***Water quality** – potential degradation of water quality due to erosion and sediment run off, hazardous materials and domestic sewage waste;*
- ***Air quality –** potential reduction in air quality due to dust and vehicle emissions;*
- ***Noise and vibration** – potential disturbance to people and fauna due to construction noise pollution and ongoing noise emissions from transformers and transmission line;*
- ***Biodiversity** - permanent loss of habitat, disturbance and displacement of species, creation of barriers to fauna movement, degradation of habitat due to*

edge effects and fragmentation, and fauna mortality. In general the significance of these impacts to biodiversity and priority biodiversity values was considered to be minor or negligible.

- ***Land Use*** *– temporary and permanent clearing of productive land, and changes to allowable uses of land within the RoW;*
- ***Economy and livelihoods*** *– potential employment opportunities during construction and operation of the Project;*
- ***Damage to property*** *– potential damage to property including houses, farmlands, aquaculture ponds, and irrigation canals;*
- ***Community health and safety*** *– potential increase in risk of disease transmission, road accidents and flood damage during construction, and health risks resulting from electromagnetic radiation, noise and herbicide use during operation;*
- ***Occupational health and safety*** *– risk of accident and injury while working, and risk of disease transmission;*
- ***Culture and customs*** *– potential for social conflict between workers and local communities;*
- ***Physical heritage*** *– potential damage to unidentified heritage items/places; and*
- ***Traffic*** *– potential temporary disturbance to traffic during construction.*

Mitigation measures

Refinement of the transmission line alignment can minimize the impacts to biodiversity, land use and community health and safety, however some risks will remain. Mitigation measures have been develop for implementation during the design, construction and operation phases to further minimize and manage risks to local communities and the environment. The measures set out in the IEE will guide the development of a more detailed Environment and Social Management and Monitoring Plans for the construction phase to be developed by NNP1PC and the construction contractor, prior to the commencement of construction.

To manage the potential for community grievances, NNP1PC have established a grievance redress mechanism (GRM) for the NNP1 Project (including the transmission line). The GRM involves a series of committees including a Village Grievance Committee, District Grievance Committee, and Provincial Grievance Committee. In the instance that the grievance cannot be resolved through the committee structures, redress can be sought through the Court of Law. The GRM has been communicated to stakeholders.

1 INTRODUCTION

The Nam Ngiep 1 Power Company Limited (NNP1PC) is developing the Nam Ngiep 1 Hydropower Project (NNP1) with assistance from the Asian Development Bank (ADB). The distribution of electricity from NNP1 will require the development of a 230 kV transmission line to transmit electricity from the Main Dam site to Nabong collector substation in Vientiane Capital.

An IEE for the Nam Ngiep1 Transmission Line Project (the Project) was compiled by the Environmental Research Institute, Chulalongkorn University (ERIC) in association with The National Consulting Company (NCC) in 2012. Since this time, the alignment has been revised, new information has been obtained, and comments on the previous IEE have been received from ADB. This report presents a revised IEE to reflect the current preferred alignment and available information.

The scope of the Project is the construction of the 230 kV transmission line between the Main Dam site and the Nabong collector substation, and the associated access roads.

Information and data used in this IEE are based on review of available documentation, site visits, regulations, current baseline data available for the project, analysis of geospatial datasets (mapping) and inputs provided by the NNP1PC engineering team.

1.1 PURPOSE OF THE STUDY

The Laos PDR Department of Electricity (DOE) requires electricity development projects to prepare an Environmental Assessment and obtain official approval from the Ministry of Natural Resources and Environment (MONRE) prior to commencing any activities that may impact the environment. The DOE requires the Environmental Assessment to:

- Outline the proposed Project's environmental impacts on physical, biological, socio-economic and cultural environments; and
- Define measures to prevent or mitigate any adverse environmental effects expected from the design, construction, operation and closure of the Project.

In order to achieve this requirement, this report:

- identifies the main environmental and social resources of the areas in and adjacent to the proposed transmission line;
- identifies the nature of potential adverse impacts that could occur from the construction and operation of the Project;

- provides an initial examination of the magnitude, scale, and significance of the identified potential impacts; and
- outlines mitigation measures to avoid and/or minimize such adverse impacts.

1.2 DEFINITION OF THE PROJECT AREA

The transmission alignment is approximately 125 km in length with a required 35 m wide 'right of way' (RoW) to be established. In addition, access roads are required to facilitate the construction and maintenance of the transmission line. For the purposes of this study the Project Area is defined as the area required for the RoW and access roads, as shown on *Figure 2-1*. It is acknowledged that not all of the RoW will be permanently cleared or disturbed given that the infrastructure consists of the establishment of intermittent towers with other clearing for safe operation and maintenance.

1.3 APPROACH

The study consists of three main components:

- A description of the existing environment in the Project area. This involves review of exiting baseline environmental data available associated with the proposed alignment. Particular focus is given to the data and description of baseline conditions that are important to the prediction of impacts and to the determination of measures to avoid and/or minimize anticipated adverse impacts;
- An evaluation of impact levels and feasible mitigation measures. This study used standard methods that follow acceptable EIA procedures for the preliminary evaluation of impact levels for each environmental aspect. Where impacts were quantifiable or had the potential to be observable, measures to prevent or minimize such impacts were identified; and
- Preparation and presentation of the IEE report.

1.4 KEY TERMS

Key terms used in this report are provided in *Table 1-1*.

Table 1.1 Key terms used in document

Term	Meaning
NNP1	The NNP1 Hydropower Project
the Project	The 230kV Transmission Line Project as described in *Section 2* of this report.
Project Area	The area required for the RoW and access roads, as shown on *Figure 2-1.*

1.5 *STRUCTURE OF THIS REPORT*

This report is structured in eleven chapters:

- *Chapter 1* provides an introduction to this document and the Project, including the purpose of this document, approach to the study and the legal and administrative framework governing the Project;
- *Chapter 2* describes the Project, and it is this description that forms the bases of the impact identification;
- *Chapter 3* describes the environmental baseline, including physical, biological and social resources;
- *Chapter 4* identifies potential impacts of the Project during the construction, operation and rehabilitation phases, and outlines measures to mitigate these impacts;
- *Chapter 5* outlines the alternative Project scenarios that have been considered, and the relative environmental and social impacts of these scenarios;
- *Chapter 6* describes the information disclosure and consultation process planned for the Project;
- *Chapter 7* outlines the grievance redress mechanism for the Project;
- *Chapter 8* provides an Environmental Management Plan (EMP) to address the identified impacts;
- *Chapter 9* provides an indicative budget for the implementation of the EMP; and
- *Chapter 10* provides a conclusion and general recommendations.

1.6 *LEGAL AND ADMINISTRATIVE FRAMEWORK FOR ENVIRONMENTAL AND SOCIAL PROTECTION IN LAO PDR*

One of the main principles of the Nam Ngiep 1 Hydropower Project (NNP1) is to ensure that the Project conforms to the environmental and social statutes and policies of the GOL, and relevant local government standards. This IEE has been prepared in conformance with these statutes, policies, directives and procedures.

The Project is also to conform to international treaties to which the Lao PDR is signatory, to standards and safeguard policies of the Asian Development Bank (ADB), and to the Equator Principles. Where there is overlap in GOL and international standards, the most stringent standard will be used. In the case

that a less stringent standard is used, justification will be provided within this document or other relevant documents.

1.6.1 National Laws And Decrees

The key laws and decrees relevant to environment assessment and protection issues for NNP1 are:

- The Law on Environmental Protection (1999);
- The Law on Water and Water Resources (1996);
- The Forestry Law (2007);
- The Wildlife and Aquatic Law (2007);
- The Land Law (2003);
- The Electricity Law (2008);
- The Decree on Environmental Impact Assessment (2010);
- The Decree on State Land Lease or Concession (2009);
- The Decree on Compensation and Resettlement of People Affected by Development Projects (2006);
- The Technical Guidelines on Compensation and Resettlement of People Affected by Development Projects; and
- The Decree on the Environmental Protection Fund.

Environmental Protection Law (1999)

The Environmental Protection Law (National Law 02/99) (EPL) was approved by the President on April 3, 1999. This law provides a legal framework for environmental management of development projects. It establishes the framework for unified environmental management with the aim of preserving the environment and making rational and sustainable use of natural resources. The sustainable use of natural resources is to contribute to the national socio-economic development and to the guaranteed health and improved quality of life of the people of Lao PDR. The Ministry of Natural Resources and the Environment (MONRE), previously the Water Resources and the Environment Administration (WREA), which was formerly the Science Technology and Environment Agency (STEA), is responsible for the implementation of EPL. While other ministries issue guidelines for implementing provisions of the EIA and of environmental protection, it is MONRE that is responsible for review of the EIA and that will issue the environmental compliance certificate.

Governmental Decrees, Regulations, and Standards relevant to the EPL are:

- The Implementing Decree of 2002, which provides the legal tool for implementation of the law, and
- The Environmental Management Standard of 2001, which stipulates the minimum environmental standards to develop a project.

MONRE has also developed a set of regulations for conducting the EIA of proposed hydropower projects (2000 and 2001). These regulations and standards establish general impact assessment requirements, including a timing of the EIA in the Project development cycle. They stipulate detailed project screening, initial Environmental Examination and Environmental Impact Assessment requirements, including content and format of reporting, and approval of the report.

Law on Water And Water Resources (1996)

The Law on Water and Water Resources (1996) is intended to assure sustainable water use through policies related to ownership, preservation, use and management of water and water resources. It establishes a basis for classifying water according to use, defining catchments, and setting requirements for EIA for any 'large scale uses', inclusive of construction of water reservoirs for the purpose of irrigation, consumption, and energy production. In this respect the law mandates the requirement for the current EAMP work and should necessitate a review of the Environmental Assessment and Management Plan (EAMP) among the appropriate groups within GOL. The Water Resources Committee under the Prime Minister's Office administers the Water Law and is responsible for the review and evaluation of EIAs related to use of water resources.

Amended Lao Forestry Law (No.06/Na-Dec.2007)

The Amended Forestry Law, No 06/NA (Dec. 2007) stipulates the basic principles, regulations and measures concerning forest conservation, management, and use. It aims to make the forests and forestland a stable source of livelihood and use for the people, by ensuring sustainable preservation of water sources, preventing of soil erosion and maintaining soil quality, conserving plant and tree species and wildlife species, preserving the environment, and contributing to national socio-economic development.

The Amended Forestry Law (2007) confirms that natural forests and forestlands are the property of the national community and that these are centrally managed by the State. The State can grant individuals or organizations the right to plant and own trees. Forests are classified into three general categories: Protection Forest, Conservation Forest (or National Biodiversity Conservation Areas), and Production Forest. Each category of forest is designated a different and distinct zone and area, within which there

can be rich or dense forest, degraded forest, bare forestland and village use forest according to each zoning plan.

Conversion of public forestland to another land use type is only possible when allowed if it is to bring maximum benefits to the nation and to the wellbeing of people and is included in the national socio-economic development plan. Such conversion is only allowed in designated areas. Entities given approval for forestland conversion are responsible for paying fees for technical service, royalties and conversion fees. For temporary conversion such as mining exploitation and other production activities, the land must be restored and trees must be replanted. If the State converts the forestland, which is allocated to individuals or organizations for agreed upon and determined purposes, the State shall compensate according to laws and regulations. For permanent forestland conversion into another land use type for long-term purposes, such as for roads or hydropower construction, the State owns the timber and forest resources that are cut or harvested in those forests or forestlands.

The law stipulates which administrative authorities have the right to approve conversion of degraded forestland that cannot naturally regenerate or of barren forestland. While district, municipal, or provincial authorities can approve conversion of smaller areas of forestland, the conversion of more than 100 ha to 1,000 ha of degraded forestland per activity and of more than 200 ha to 10,000 ha of barren forestland per activity must be approved by the government, through proposals by the National Land Management Authority and agreement by the Ministry of Agriculture and Forestry and the Provincial Agriculture and Forestry Office. The National Assembly Standing Committee must endorse the conversion of forestland greater than those amounts (1,000 ha of degraded forestland or 10,000 ha of barren forestland).

Wildlife and Aquatic Law, No 07/NA (2007)

The Wildlife and Aquatic Law regulates the management, monitoring, conservation, and protection of wildlife and aquatic species in their natural habitats. Wildlife and aquatic species living within the territory of the Lao PDR are considered property of the national community, with the State representing the national community in managing those species. If an individual or organization has permission to raise and reproduce any of these species, it is then considered their own property so long as they abide by the laws and regulations.

Wildlife includes both terrestrial and aquatic life, and all forms of animal life, whether mammals, birds, reptiles, amphibians, or insects. Wildlife is classified into three categories for protection: 1) prohibition, 2) management, and 3) common or general. Whether species are classified as prohibition or management depends upon the level of threat to them (endangered, threatened, rare), the condition of their habitat, and the condition of their regeneration and reproduction. The Ministry of Agriculture and Forestry recommends to the government for consideration and approval the list of

species under the prohibition and management categories. The Ministry of Agriculture and Forestry has authority to include or remove species itself from the list of animals in the common or general category.

Land Law (2003)

The land law was enacted on October 23, 2003. The law determines the management, protection and use of land to ensure its efficient use and to conform with land-use objectives, with other laws and regulations, to contribute to national socio-economic development, and to contribute to the protection of the environment.

Electricity Law (2008)

The Electricity Law No 03/NA dated 8 Dec 2008, requires a license for the generation and transmission of electricity. The Law also requires that:

- EIAs be prepared for at least the larger hydroelectric dams, along with budget estimates for environmental mitigation measures;
- Transmission lines and related activities are done in such a way as to limit any damages to natural environment and people's property; and
- The concessionaire is required to pay compensation for damages to the environment and to the lives and property of people, if any resettlement or other movement of people is required.

Prime Ministerial Decree No. 112/PM on Environmental Impact Assessment (2010)

The 2010 Prime Ministerial Decree No. 112/PM established the procedures and guidelines for conducting Environmental Impact Assessments in Lao PDR. It stipulates the rights of those affected by projects, including their rights of participation. The decree outlines the process, both for WREA (now MONRE) and the developer of projects, of conducting the EIA, preparing environmental management and monitoring plans, social management and monitoring plans, issuing environmental compliance certificates, monitoring compliance with the various plans, and establishing the institutional framework for implementing the EIA of the Nam Ngiep 1 Hydropower environmental and social components of projects, and for hearing and deciding on grievances of affected parties.

Decree on State Land Lease or Concession (2009)

The Decree on State Land Lease or Concession, dated May 25, 2009, establishes the principles, procedures and measures for the leasing or providing concessions of land, for purposes of development for agriculture, industry, tourism, and other activities.

Among the obligations of those leasing or obtaining a concession are that they should not cause damages to the land quality, nor cause negative impacts to the environment or society.

Decree on Compensation and Resettlement of People Affected by Development Projects (2006)

The Decree on Compensation and Resettlement of People Affected by Development Projects defines the principles, rules, and measures to mitigate adverse social impacts and to compensate for damages that may result from involuntary acquisition or repossession of land and of fixed or movable assets, including changes in land use and restrictions to access of community or natural resources, which would affect sources of community livelihood and income. This decree aims to ensure that people affected by a project are compensated fairly and are assisted in ways to improve or maintain their pre-project incomes and living standards, so that they are not worse off than they would have been without the Project.

Technical Guidelines on Compensation and Resettlement of People Affected By Development Project (2005)

Pursuant to Prime Ministerial Decree No. 112/PM, GOL endorsed the Technical Guidelines on Compensation and Resettlement of People Affected by Development Projects, first issued in November 2005. These guidelines were initially adopted under the Decree on Compensation and Resettlement of People Affected by Development Projects in 2006, and have now been endorsed and promulgated as official GOL policy and procedure for the assessment, planning, and mitigation of environmental as well as social impacts from development projects.

These guidelines include detailed procedures for the conduct of public consultation and other participatory processes, to inform affected people of the environmental and social impacts, and to assure their involvement in all aspects of the mitigation and compensation process, from planning to implementation.

Decree on the Environmental Protection Fund (2005)

This Decree defines the principles, rules and procedures for the organization and operation of the Environmental Protection Fund (EPF). The fund is to finance eligible activities that can strengthen environmental protection, sustainable natural resources management, and specifically, biodiversity conservation and community development in Lao PDR. Among the objectives of the EPF are to implement chapter V of the Environmental Protection Law, Article 47 of the Forestry Law, and Article 15 of the Decree to Implement the Law on Water and Water Resources. Sources of funds for the EPF are grants and loans from domestic and foreign entities, State budget, development

projects and other activities, and interest or benefits accrued from investing the EPF endowment.

Key Provisions of Lao PDR Laws and Decrees Pertinent To Environmental Aspects of The NNP1 Project

The table below provides a brief summary of the key provisions of the various laws and decrees of the Lao PDR, as they relate to the environmental components of the Project.

Table 1.2 Key Provisions in the Laws, Decrees and Regulations of the Lao PDR Pertinent to the EIA of the Nam Ngiep 1 Hydropower Project

Law or Decree	Article	Relating to	Content
Constitution of the Lao People's Democratic Republic (1991, amended 2003)	Article 17	Environment in general	"All organisations and citizens must protect the environment and natural resources: land, underground, forests, fauna, water sources and atmosphere."
Environmental Protection Law (1999)	Article 5	Environment in general	Conservation takes priority over mitigation and restoration. Socio-economic development planning must include planning for environmental protection.
	Article 8	EIA Process	MONRE is main agency to issue regulations for EIA. People affected by projects, mass organizations, and local administrations are to be involved in the EIA process.
	Article 10	Responsibility of those engaged in development works	Those engaged in development works must adhere to safeguards, and to standards and regulations issued by GOL agencies.
	Article 14	Responsibility of those engaged in development works	Those engaged in development works must abide by laws on land, forests, water, etc.
	Article 16	Responsibility toward cultural, historical, natural heritage sites	Those engaged in development works must abide by laws and regulations to protect such heritage sites.
	Article 22	Pollution control	All are responsible for control of pollution, and applying technologies appropriate to control such pollution.
	Article 23	Hazardous wastes / emissions	Restrictions to hazardous wastes and means to control such wastes and emissions.
	Article 28	Damage to environment	Those causing damage to environment are responsible for repair through appropriate GOL agencies.

Law or Decree	Article	Relating to	Content
	Article 38, 39	Local environmental management and monitoring	Stipulates responsibilities of local administrations (provinces, municipalities, special districts, districts) to establish environmental management and monitoring units.
	Article 40	Local environmental responsibilities	Stipulates responsibilities of village administrations to follow environmental regulations.
Water and Water Resources Law (1996)	Article 4	Rights to use water resources	Defines rights, obligations, and procedures to gain approval for use of water resources.
	Article 18	Permission for use	Stipulates that medium and large scale uses require feasibility studies, EIAs, and mitigation plans, before permission is granted for use of the resource.
	Article 22	Principles in water resource development management	Stipulates that water resource development must be consistent with national and sector plans, must ensure preservation of the natural beauty of the resources, and must protect against harmful effects of water.
	Article 25	Promotion of Watershed and Water Resource Protection for Hydropower Development	Stipulates that 'hydropower projects must be developed with due concern for environmental protection, flood protection, water supply, irrigation, navigation, fisheries and others."
	Article 29	Water and water resource protection	Requires that water resources be protected from becoming spoilt, polluted, or drying up, and that forest and land resources be protected to help protect the water resources.
Lao Forestry Law (amended 2007)	Article 5	Policy on forest and forest land	The GOL has the policy to preserve, regenerate, and develop forests and forest land to help preserve the environment, water resources, biodiversity, and people's livelihoods.
	Articles 9 to 13	Forest types	Classify the various types of forests according to use, including forests for village use.
	Article 26	Preservation of water resources in forest zones	Stipulates the preservation of water resources in forest zones for those areas where waterways originate and flow, including strict management and regulations to control logging, shifting cultivation, and destructive forest uses.
	Article 70	Conversion of forestland	Stipulates that forestland can be converted to other land type if it brings a high level of benefits to the nation and to livelihoods of the people, and is included in the national development plan.

Law or Decree	Article	Relating to	Content
	Article 71	Types of converted forestland	Stipulates that for uses such as dam construction, the timber and forest resources to be harvested in those areas are property of the State.
Wildlife and Aquatic Law (2007)	Article 31	Use for Household purposes	Allows use by village households of wildlife and aquatic species in the common and general category list in particular seasons or permitted areas, using tools or equipment that do not adversely affect habitats or compromise the species population.
	Article 32	Customary Use	Allows use of wildlife or aquatic species in the common and general category list by village households for "necessary cultural beliefs".
	Article 52	Prohibitions	Prohibits taking of wildlife, including parts of the animals, from their habitats; tormenting wildlife and aquatics; illegal catching, hunting, trading and possession; catching aquatic and hunting in conservation zones, in breeding season, or when pregnant; devastation of habitats and feeding zones.
Land Law (2003)	Article 6	Protection of Land and Environment	Declares that all individuals and organizations are obliged to protect the land from degradation.
	Article 14	Changes in Land Category	Land use can be changed if it does not cause social or environmental harm and if prior approval is obtained from the authorities.
Decree on Land Lease or Concession (2009)	Article 39	Obligation of Person or Legal Entity Who Leases or Obtains Concession	The person or legal entity who leases land or obtains a concession is obligated, among other things, "not to cause any damage to the quality of land and negative impact to the natural environment and the society".
Electricity Law (1997)	Article 6	Environmental Protection	Stipulates the need to assess the impact of electricity enterprises on the natural environment, ecological system, society and wildlife habitats
	Article 13	Feasibility Study	Requires a feasibility study and indicates the contents to be included in such a study.
	Article 14	Environmental Impact Assessment	Requires an environmental impact assessment and indicates the contents to be included in such an assessment
	Article 18	Obligations of Concessionaires	Includes the obligations to protect the environment and to pay compensation for any damage to the environment, or to the lives and property of people, or for resettlement.
	Article 27	Transmission Lines	Installation and construction of electricity transmission lines to be done in ways to limit damage to environment and to people's property

Law or Decree	Article	Relating to	Content
Prime Ministerial Decree No. 112/PM on Environmental Impact Assessment (2010)		Stipulates the need for Environmental Impact Assessment	Stipulates rights of those affected by projects, and need for participation. Outlines the process of conducting the EIA, preparing environmental management and monitoring plans, social management and monitoring plans, issuing environmental compliance certificates, monitoring compliance with the various plans, establishing the institutional framework including grievance procedures.
Decree on Compensation and Resettlement of People Affected by Development Projects (2006)		Establish the procedures for compensation and resettlement for project affected people	Defines the principles, rules, and measures to mitigate adverse impacts and to compensate for damages that may result from involuntary acquisition or repossession of land and of fixed or movable assets, including changes in land use and restrictions to access of community or natural resources.

1.6.2 International Treaties

The Lao PDR is party to several major international environmental treaties, which oblige it to abide by conditions of those treaties. Among those potentially relevant to this project are:

Convention on Biological Diversity

The government of the Lao PDR accepted the Convention on Biological Diversity in September 1996. Under this convention, the Lao PDR accepted several obligations, among them the establishment of protected areas, management of those areas, identification of key components of biological diversity, monitoring of those key components, increase public awareness and participatory management of biodiversity, and assessment of proposed projects that could have an adverse impact on biological diversity. The Prime Minister Decree 164 of 1993 to establish National Biodiversity Conservation Areas, the Environmental Protection Law of 1999, the Wildlife and Aquatics Law of 2007, and the Amended Forestry Law of 2007 were all enacted in part to meet the obligations of the Convention on Biological Diversity.

In 2004, the Lao PDR prepared a Biodiversity Strategy to 2020 and Action Plan to 2010. Recognizing the importance of hydropower for national development, the strategy and action plan found that most hydropower projects to date did not take adequate measures to assure protection of biodiversity. Issues of particular concern were that:

- Watershed management and protection is currently inadequate;

- Hydropower development often results in reduced forest cover, wildlife habitats and biodiversity resources;
- Dam construction has a direct impact on fisheries and local income, especially in downstream areas;
- Some hydropower construction has occurred without prior detailed studies;
- The resettlement of the local people can have a direct and indirect impact on biodiversity;
- Dam construction changes the natural water flow; and
- The compensation schemes for lost land and property are not clearly defined according to different scale. (Science, Technology and Environmental Agency, National Biodiversity Strategy to 2020 and Action Plan to 2010, STEA, GOL:2004, p.35)

The report recommends addressing these issues through several options:

- Ensure that hydropower development takes social and environmental concerns into consideration;
- Manage and protect forests in watershed areas;
- Effectively enforce relevant laws and regulations; and
- Ensure that environmental and social impact assessments are effectively applied for hydropower projects. Promote effective and economical energy use, as well as the utilization of renewable energy. (Ibid)

Convention on Climate Change

Having ratified the Convention on Climate Change in January 1995, the Lao PDR is obligated to mitigating greenhouse gas emissions. Of concern to this project are the possible impacts of the reduction of forest area, the emission of greenhouse gasses from organic matter in the reservoir, the development of renewable sources of energy, and the promotion of sustainable forms of agriculture.

Agreement on The Cooperation For Sustainable Development Of The Mekong River Basin

In April 1995, the Lao PDR ratified the Agreement on the Cooperation for Sustainable Development of the Mekong River Basin. This agreement, between the countries of Cambodia, Lao PRD, Thailand and Vietnam, established the Mekong River Commission and formed the basis for the joint management and development of the water resources of the Mekong River and its tributaries.

The four signatory countries agreed "to cooperate in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin including, but not limited to irrigation, hydro-power, navigation, flood control, fisheries, timber floating, recreation and tourism, in a manner to optimize the multiple-use and mutual benefits of all riparians and to minimize the harmful effects that might result from natural occurrences and man-made activities." (Article 1)

Key provisions that concern this project are:

- "To promote, support, cooperate and coordinate in the development of the full potential of sustainable benefits . . . and the prevention of wasteful use of Mekong River Basin waters . . . through the formulation of a basin development plan . . ." (Article 2);
- "To protect the environment, natural resources, aquatic life and conditions, and ecological balance of the Mekong River Basin from pollution or other harmful effects resulting from any development plans and uses of water and related resources in the Basin." (Article 3);
- In cases of utilization of waters "On tributaries of the Mekong River, . . . intra-basin uses and inter-basin diversions shall be subject to notification to the Joint Committee." (Article 5, Paragraph A);
- "To cooperate in the maintenance of the flows on the mainstream from diversions, storage releases, or other actions of a permanent nature . . ." (Article 6); and
- "To make every effort to avoid, minimize and mitigate harmful effects that might occur to the environment, especially the water quantity and quality, the aquatic (eco-system) conditions, and ecological balance of the river system, from the development and use of the Mekong River Basin water resources or discharge of wastes and return flows." (Article 7).

Agreement on International Trade in Endangered Species of Wild Fauna And Flora (CITES)

The Lao PDR joined the Convention on International Trade in Endangered Species of Wild Fauna and Flora (or CITES) in March 2004, with it coming into force on 30 May 2004. The Wildlife and Aquatics Law of 2007 includes provisions that meet the obligations of the Lao PDR to CITES.

Inter-Governmental Agreement On Regional Power Trade In The Greater Mekong Sub-Region

The Inter-Governmental Agreement on Regional Power Trade in the Greater Mekong Sub-Region between Cambodia, China, Lao PDR, Myanmar, Thailand and Vietnam sets the framework for electricity development and

trade among the countries of the sub-region. The agreement is based on principles of:

- Cooperation: That issues related to regional interconnection be handled in a spirit of cooperation and mutual benefit, that the Parties have equal rights and obligations, act in solidarity, and refrain from taking advantage of one another;
- Gradualism: That the Parties consider the progressive development of regional electricity trade; and
- Environmentally Sustainable Development: That regional electricity trade is operated within a framework of respect for the environment. (Article 2, Paragraph 2.2).

1.6.3 ADB Environmental Safeguard Policies

Funding for the project is expected from the Asian Development Bank (ADB), and the ADB's Safeguard Policy Statement (SPS) and associated Safeguard Requirements apply to the project. The objectives of the SPS are to avoid, or when avoidance is not possible, to minimize and mitigate adverse project impacts on the environment and affected people, and to help borrowers strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

The Environmental Safeguard Requirements include requirements for:

- environmental assessment as prescribed in ADB's SPS;
- preparation of an Environmental Management Plan (EMP) to manage unavoidable impacts;
- meaningful consultation with affected people;
- establishment of grievance redress mechanisms;
- monitoring and reporting activities;
- planning for unanticipated environmental impacts;
- Biodiversity Conservation and Sustainable Natural Resource Management;
- pollution prevention and abatement;
- health and safety; and
- physical cultural resources.

The NNP1 Project is classified as a Category A project, which requires full environmental assessment of the potential negative and positive impacts and assessment of alternatives, recommended mitigation measures, and participation of the affected people and other stakeholders.

The key environmental concerns of the ADB as noted in its policy that need to be addressed in the NNP1 project EIA are: deforestation and land degradation, biodiversity loss, aquatic resources, water pollution, and climate change.

Of particular relevance to NNP1 are the requirements for Biodiversity Conservation and Sustainable Natural Resource Management. The Safeguard Policy includes requirements for operating in areas of modified, natural and critical habitat, and legally protected areas. The following standards are an extract from the ADB SPS:

A. Modified Habitat

25. In areas of modified habitat, where the natural habitat has apparently been altered, often through the introduction of alien species of plants and animals, such as in agricultural areas, the borrower/client will exercise care to minimize any further conversion or degradation of such habitat, and will, depending on the nature and scale of the project, identify opportunities to enhance habitat and protect and conserve biodiversity as part of project operations.

B. Natural Habitats

26. In areas of natural habitat,[3] the project will not significantly convert or degrade such habitat, unless the following conditions are met:

(i) No alternatives are available.

(ii) A comprehensive analysis demonstrates that the overall benefits from the project will substantially outweigh the project costs, including environmental costs.

(iii) Any conversion or degradation is appropriately mitigated.

27. Mitigation measures will be designed to achieve at least no net loss of biodiversity. They may include a combination of actions, such as post-project restoration of habitats, offset of losses through the creation or effective conservation of ecologically comparable areas that are managed for biodiversity while respecting the ongoing use of such biodiversity by Indigenous Peoples or traditional communities, and compensation to direct users of biodiversity.

C. Critical Habitats

28. No project activity will be implemented in areas of critical habitat[5] unless the following requirements are met:

(i) There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function.

(ii) The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species[6] or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.

(iii) Any lesser impacts are mitigated in accordance with para. 27.

29. When the project involves activities in a critical habitat, the borrower/client will retain qualified and experienced external experts to assist in conducting the assessment

D. Legally Protected Areas

30. In circumstances where some project activities are located within a legally protected area, in addition to the requirement specified in para. 28, the borrower/client will meet the following requirements:

(i) Act in a manner consistent with defined protected area management plans.

(ii) Consult protected area sponsors and managers, local communities, and other key stakeholders on the proposed project.

(iii) Implement additional programs, as appropriate, to promote and enhance the conservation aims of the protected area.

1.6.4 Equator Principles

Private Banks cover a large amount of the financing for international development. Initiated by several of the world's largest banks, the Equator Principles were established to assure that borrowers from the private banks for development projects abide by similar environmental and social standards as those applied by the World Bank, the ADB and other international financial institutions. The Equator Principles incorporate the International Finance Corporation's Environmental and Social Performance Standards. Of particular relevance to the environmental aspects of the NNP1 project are the need and means for biodiversity conservation and sustainable natural resource management, and pollution prevention and abatement. More than 60 of the world's leading banks have adopted the principles, which require them to stop lending if the borrower is found not to abide by the processes.

As with the ADB, projects deemed to have potentially great environmental impact, such as dams, are classified as Category A projects. These are required to have social and environmental impact assessments, adequate consultation with project affected people and local organizations, and adequate

management and grievance mechanisms, similar to those required by the ADB.

Some of the environmental issues of concern in the Equator Principles that relate to the NNP1 project are:

- protection and conservation of biodiversity, including endangered species and sensitive ecosystems in modified, natural and critical habitats, and identification of legally protected areas;
- sustainable management and use of renewable natural resources (including sustainable resource management through appropriate independent certification systems);
- use and management of dangerous substances;
- major hazards assessment and management;
- consideration of feasible environmentally and socially viable alternatives; and
- pollution prevention and waste minimization. (The Equator Principles, July 2006, Exhibit II: Illustrative list of potential social and environmental issues to be addressed in the Social and Environmental Assessment documentation, p.7).

These issues are not considered exhaustive, but indicative of the types of issues to be addressed.

1.6.5 World Bank Group Environment Health and Safety Guidelines

The World Bank Group Environment Health and Safety (EHS) Guidelines were developed to define applicable standards for projects involving members of the World Bank Group, however, the guidelines can provide useful guidance to all projects. The EHS Guidelines define performance levels and management measures that are generally considered to be achievable in new facilities by existing technologies at reasonable costs. The EHS guideline for Electric Power Transmission and Distribution identifies the following potential risks associated with transmission line Projects, and provides guidance on the management of these risks:

- Terrestrial habitat alteration, including construction and maintenance, risk of wildfire, avian and bat collisions and electrocutions;
- Aquatic habitat alteration;
- Environmental impacts of electric and magnetic fields;
- Hazardous materials;

- Health and safety risks relating to live power lines, working at heights, electromagnetic fields and exposure to chemicals; and
- Community health and safety risks, including electrocution, electromagnetic interference, noise and ozone, and aircraft interference.

2 DESCRIPTION OF THE PROJECT

2.1 PROJECT OVERVIEW

The 230 kV transmission line for NNP1 will extend for approximately 125 km, connecting the powerhouse at the Main Dam site with the Nabong collected substation. The design will involve approximately 291 towers, based on criteria design of tower ruling spans of 430 m for 230 kV lines.

Many types of linear infrastructure, such as roads and railways, are limited by physical constraints such as steep gradients and wide river crossings; however transmission lines afford considerably more flexibility. Preliminary route selection for the design of transmission lines was based on a review of 1:50,000 scale topographic maps and ground surveys. The consideration and selection of the transmission line route was based on engineering principles together with environmental concerns for the locations of towers, ground clearance and slope, geological condition for foundations and other obstructions. Alternative routes considered are discussed in *Section 5.1*. *Figure 2-1* shows the overall layout of the Project.

2.2 PROJECT COMPONENTS

The following sections outline the components of the Project including the RoW, the transmission line, transmission towers, access roads and worker camps. No quarries will be required, as rocks will be purchased from suppliers and aggregates made by batcher plants. No spoil areas are required as excavated material will be used for backfill and embankments at tower sites. Refer to *Figure 2-1* and *Table 2-2* for the location and dimensions of Project components.

2.2.1 *Right of Way*

During construction, the construction footprint will be confined to within a 35 m wide RoW, except for the construction of external access roads required in remote parts of the RoW. During construction and operation, vegetation below 3.0 m will be retained within the RoW where land is not required for tower footprints or access.

Preliminary route selection for the design of transmission lines was based on a review of 1:50,000 scale topographic maps and ground surveys. The consideration and selection of the transmission line route was based on engineering principles and environmental factors, such as slope, geological condition for foundations and other obstructions. Key aspects considered included:

- For maximum safety, minimum construction cost and effective material use the alignments were created as straight as reasonably possible between the

start and end points of the transmission lines, as well as between tower spans;

- Wherever possible, the alignments were located relatively parallel to an existing road or right-of-way of existing transmission lines, thereby facilitating access for construction, operation and maintenance, and reducing the need for new land clearance and disruption to people;

- Distance from residential areas (in particularly houses and other built up areas) to minimize relocation or resettlement;

- Distance to valuable lands or social, religious or culturally important lands, particularly village forest conservation areas, village cemeteries, and agriculture lands;

- Distance to mature forests and other environmentally sensitive areas, especially the Phou Khao Khoay NBCA, and eco-tourism sites;

- Line reliability (ie. minimal risk of outage and ability to repair); and

- Costs were also considered (ie. through route length minimisation, ease of construction and maintenance).

Based on these criteria, the alignment has undergone a number of revisions as further information on environmental and social constraints has become available. Alternative alignments are outlined in Section *5.1*. The alignment is expected to undergo further refinement following more detailed ecological assessments to be undertaken.

2.2.2 Transmission Line

The proposed transmission line comprises 230 kV, 50 Hz, 3 phases, double circuit line on self-supporting lattice steel structures, using 1272 MCM ACSR/GA conductor with one 3/8 inch nominal diameter high strength grade galvanized steel ground wire and one 24-core OPGW. The work for this transmission line includes:

- installation of the tension insulator sets at Gantry and the lead-in to the switchyard equipment at the Nam Ngiep; and

- supply and installation of optical OPGW and joint box for the OPGW at the nearest towers or Gantry at switchyard of the Nam Ngiep Power Plant and Nabong substation.

Ground Clearance

The most severe state for ground clearance of conductors could occur when the conductor's temperature rises to 75^{o}C under still air conditions. For this

Project, the minimum heights of the conductors above ground are specified in *Table 2-1.*

Table 2.1 Minimum Specification for Heights of Conductors

Minimum vertical clearances	High (m)
Streets/highways	10.0
Cultivated areas, ground accessible by vehicles	8.4
Ground accessible to pedestrians only	8.4
Crossing navigable river (above maximum water surface)	11.5
Telecommunication lines	5.2
Distribution lines 33 kV and shield wires	3.5
Power lines	5.8

Side Clearance

For any portion of the transmission line that has another transmission line running parallel to it, side clearance required between two transmission lines shall be:

- Between 115 kV and 230 kV transmission lines 12 + 20 meters from center line to center line;
- Between 230 kV and 230 kV transmission lines 20 + 20 meters from center line to center line;

2.2.3 Transmission Towers

Transmission towers for the Project are self-supporting lattice steel structures. Two types of suspension towers will be used, with heights of 46.78 m and 46.18 m. Tension towers will have a height of 46.04 m. The total footprint for tower construction will be approximately 101.9 ha, however during operation the footprint will be limited to 2.4 ha of hardstand area. Plans of the transmission tower designs are shown *in Annex A*.

2.2.4 Access Roads

In flat areas of the transmission line, access roads will be provided within the RoW, to minimise the project footprint. In steeper and more remote parts of the RoW external access roads will be required. In particularly, the northern extent of the transmission line has been located in an area of limited access and complex topography to avoid Huay Ngua PPA. A new road will be required in this area to facilitate access to the RoW during operation.

2.2.5 Worker Camps

To minimize travel, worker camps will be set up at each tower site during construction. Worker camps will consist of temporary shelter, such as tents.

2.3 PROJECT FOOTPRINT

The total footprint of the above Project components is approximately 441.6 ha. Not all of this area will be modified from its current state. During construction approximately 217.3 ha will be cleared of vegetation and the remaining portion of the footprint will suppress vegetation to 3.0 m. Suppression of vegetation allows for safe clearance for the construction of the transmission line, while retaining substantial ecological value. During operation, land will only be required for tower footprints and access tracks, limiting the amount of cleared land to approximately 69 ha, and allowing retention of low-growing vegetation in approximately 372.6 ha of the RoW.

Table 2-2 provides the approximately dimensions and footprints of Project components. These areas are conservative estimates based on design progress to date, and experience in similar Projects.

Table 2.2 Approximate dimensions and footprints of Project components

Project Component	Temporary Footprint		Permanent Footprint	
	Area (ha)	*Comment*	*Area (ha)*	*Comment*
Total RoW	437.5	35 m width 125 km length	437.5	35 m width 125 km length
• Access road within RoW (dirt or grassed surface)	38.5	5 m width 77 km length[1]	62.5	5 m width 125 km length[1]
• Towers (temporary dirt, permanent hardstand)	101.9	100 m length per tower 35 m width per tower 291 towers	2.4	9 m length per tower 9 m width per tower 291 towers
• Worker camp	72.8	65 m length per tower 35 m width per tower 291 towers	0	Temporary only
• Remaining RoW (vegetation suppressed to 3 m)	224.3	Total RoW footprint, minus cleared areas	372.6	Total RoW footprint, minus cleared areas
Access Roads outside RoW (dirt or sealed road)	4.1	8140 m length 5 m width	4.1	8140 m length 5 m width
Total cleared footprint	217.3		69	
Total vegetation suppression footprint	224.3		372.6	
Total footprint	441.6		441.6	

1. Temporary length is 77 km due to approximately 48 km cleared for construction zones. In practice, length of access road within RoW will be lower, as RoW will not be used for access in steep or mountainous areas, or in areas where access is currently sufficient.

2.4 ASSOCIATED INFRASTRUCTURE

2.4.1 Substation

Nabong substation is an existing substation located approximately 60 km to the north east of the central Vientiane Capital at Ban Nabong, Xaythany District. Nabong substation was designed and constructed to step up

electricity from multiple IPPs from 230 kV to 500 kV for export to Thailand. Currently, Nabong substation and Nabong transmission line is owned, operated and used solely by Nam Ngum 2. The substation will either be upgraded to accommodate input from NNP1, or a new substation will be developed adjacent the existing substation. The option selected will depend on the agreement reached between GoL and Nam Ngum 2. This is discussed further in Section *5.2*.

2.4.2 Associated 115 kV Transmission Line

A 115 kV transmission line will be developed to distribute electricity from NNP1 to a substation in Pakxan. The 115 kV line is being developed by Electricite du Laos (EdL) and is outside the scope of the report. However, the 115 kV line is critical to the Project and is considered associated infrastructure.

Prior to the re-routing of the 230 kV line to avoid Huary Ngua PPA (*Section 5.1.1*), the 115 kV line was designed to run parallel to the 230 kV line until branching east to Pakxan. It is not yet confirmed if the 115kV line will also be re-routed to avoid Huay Ngua PPA. When available, a revised project description and timeline for preparation of environmental assessments will be included in a further revision of this document.

2.5 CONSTRUCTION TIMING

According to the construction schedule of the Nam Ngiep 1 Hydropower Project, the total construction period of the 230 kV transmission line and its substation will be approximately 30 months.

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
- Access Road (Main Dam)
- Proposed Access Road (Transmission Line)
- Proposed Transmission Line

N
0 10 20 30Km
1:600,000

Basemap: ESRI World Imagery
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
Huay Ngua Provincial Protected Area
Phou Ngou Provincial Protected Area
Thinkeo
Longxan
Phonhong
Nam Ngum Reservoir
Nam Kading National Protected Area
Nam Leuk reservoir
Phou Khao Khouay National Protected Area
Mekong River
Nam Mang 3 Reservoir
Pakxan
Ban Keun
Phou Pha Nang National Protected Area
Hai
Tha Ngon

Client:	Nam Ngiep Power Company Ltd.		
Drawing No:	0185065b_TL_IEE_G001_R0.mxd		
Date:	17/01/2014	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 2.1 - Project Layout

Nam Ngiep 1 Hydropower Project
Transmission Line Initial Environmental Examination

Environmental Resources Management ANZ

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

ERM

3 DESCRIPTION OF THE ENVIRONMENT (BASELINE DATA)

3.1 PHYSICAL RESOURCES

3.1.1 Atmosphere

The transmission line is located in the Bolikhamxay Province and Vientiane (municipality), Lao PDR, which is influenced by a Southwestern monsoon climate regime. The Project area is located in a tropical climate. Weather is dominated by monsoons, which divides the year into clearly defined wet and dry periods.

Approximately 70-80% of the annual rainfall occurs during the southwest monsoon from mid-May to late September or early October. The northeast monsoon leads to drier and cooler conditions from early November to March. A hot season commonly lasts from April to early May.

Air temperatures in the project area would be highest in April, with an average daily maximum of 37°C. During the coolest months of December and January, the average daily maximum is 28 to 30°C.

The rainfall records were reviewed for the hydrological study and dam designs. The records of hydrological gauging locations in areas peripheral to the planned basin were evaluated.

Rainfall data was collected from three gauging stations within the basin and another eleven stations from the peripheral areas. Other meteorological data such as air temperature, relative humidity, barometric pressure, solar radiation, sunshine hours, evaporation, and wind velocity were not collected from the gauging stations. According to NNP1PC's Technical Report from 2007, the mean basin rainfall from 1971 to 2000 was assumed to be 1,870mm/year after comparing to the isohyetal map.

The mean rainfall in the Nam Ngiep River basin was lower than that of Pakxan because of the topographical characteristics of the region. According to the meteorological data of Pakxan District (DMH, 2005), the seasonal variation of monthly rainfall follows the general pattern of the Southeast Asia monsoon, with about 90% of rainfall during the six month wet season from May to October. In the dry season from November to April, the monthly precipitation levels are quite low, ranging from 3.7mm to 67.5mm, or about 10% of the annual precipitation for this region.

3.1.2 Topography

The eastern portion of the transmission line running north-south is located adjacent the Nam Ngiep river in mountainous terrain. The western portion of the alignment (running east-west) runs parallel to the Mekong River within the relatively flat Mekong Lowlands (grades of 0 to 1%). Site features found along the proposed route comprise riverbanks, canal and drain banks, road

and rail embankments, and low-lying paddy fields. The lower floodplain land in this area is interspersed with shallow water bodies and in places settlements where tree crops are often grown.

Portions of the proposed transmission line route, which extends from the Ngiep River Powerhouse to the Nabong substation, cross major rivers and streams. These waterways include the Nam San, Nam Ngum, Nam Mang, Nam Jing, and Nam Lo. These rivers and streams are tributaries for the Mekong River. In addition to these waterways, the proposed transmission line traverses a swamp located between Pakxan and Thaphabath.

The elevation of the route ranges between 160 to 290 m above sea level (ASL), with most of the route ranging from 175 to 280 m ASL. The lowest point of the route occurs where the line terminates on the border of Vientiane Province. Seasonal flooding occurs over an estimated 24% of the proposed route, based on levels recorded along the route from the survey, including anecdotal information on flood levels (see *Table 3-1*). Flood level depths of up to 1.5 m can occur in areas along the proposed transmission line. However, the majority of seasonal flooding is estimated to be less than 1 m deep.

Table 3.1 Estimated Seasonal Flooding along the proposed Transmission Line

Transmission Line	Total Line Length	Flood-Prone	
		Length (km)	% of Total Line
230 kV	125 km	25	20

3.1.3 Geology and Landform

The geology along the proposed transmission line routes is characterized as containing Cenozoic alluvial plain deposits, terrace alluvial, pediments, alluvial fans, and floodplains. Surface soils found along the route are reasonably uniform. These soils are mainly classified as the Prateah Lang soil group, characterized by a sandy surface layer with clay or loam subsoil. Soil fertility is often low, with little potential to improve rice yields by more intensive management. The soil is subject to being waterlogged due to the low permeability of the underlying subsoil. These soils can be saturated for up to a week, even after short periods of heavy rainfall. The soil is also subject to drought-like conditions due to the low water holding capacity of the sandy surface soils and the difficulty of root penetration into the heavy subsoil.

Information on soil conditions in the Bolikhamxay and Vientiane Provinces were obtained from the National Agriculture and Forestry Research Institute (NAFRI), and Ministry of Agriculture and Forestry (MAF). These organisations describe the soils in this area as mainly derived from siltstones, and sandstones on an ancient uplifted peneplain, which was heavily dissected by rivers over time. These soils are generally highly weathered, moderately deep (about 1.0 m to 1.5 m or more), and well drained. The soil conditions in Central Lao PDR, as well as in the project area and along the proposed transmission lines, are still in good condition with relatively medium to high

organic matter and available phosphate. This is especially true in the forested areas and agricultural lands that have been recently converted from other types of land use. There are also small areas of limestone outcrops, but these are generally steep with shallow soils, and not widely used for agriculture especially on degraded lands.

The soils in this region, such as Alisols, Acrisols, Luvisols, Lixisols and Cambisols, are generally suitable for rice cultivation and tree plantation, including fruit trees, except on steep slopes where severe erosion can occur after heavy rains. Creation of more permanent agricultural systems (that is, those involving annual cropping on flatlands) would require a combination of practices such as adoption of soil and water conservation measures, use of nitrogen-fixing legumes, and application of manure, compost or other soil amendments. A wide range of perennial crops such as various fruit trees, agricultural and industrial crops, and vegetables can also be grown successfully in this region.

Areas where the transmission line project will pass through generally are flatter lands and contain a considerable amount of vegetation; thus are less prone to erosion. However, surface erosion can occur where most of the vegetation has been removed, either from extensive logging or from slash and burn cultivation.

3.1.4 Surface Water and Groundwater Quality

The Nam Ngiep River originates in mountainous areas of Xieng Khouang province and runs through lowlands to the Mekong River in Bolikhamxay province. Its tributaries (Huay Peun, Huay Ngua, Nam Xao and Nam Tak) within the access road Project area are small compared to Nam Ngiep River.

Surface Water Quality

Water quality data was collected near Ban Hat Gnium (N: 18°39'15.25''; E: 18°39'15.25'') in April and October 2007. Water quality results were assessed against Lao water quality standards and Thai water quality standards, as Thai standards provide a more detailed classification of water quality. The results of the water quality monitoring indicate that the water around Ban Hat Nguim meets the Lao PDR ambient water quality standards. The majority of parameters met the criteria for Class 2 water, which is 'very clean fresh surface water resources used for consumption which requires ordinary water treatment process before use, and is appropriate for conservation of aquatic organisms, fisheries and recreation. The exception is Cadmium, which would require non-detection to be considered Class 2, and was detected with a concentration of less than 0.001mg/L. Water quality standards and results for the 2007 monitoring events are provided in *Table 3-2*.

Table 3.2 Water quality standards and monitoring results at Ban Hat Gnium

Parameters	Unit	Lao PDR Ambient Standards of Water Quality[1]	Thai Water Quality Standards[2]					April 2007	October 2007
			Class 1	Class 2	Class 3	Class 4	Class 5		
Temperature	°C	-	-	-	-	-	-	29.5	25.3
pH	-	5 – 9	-	-	-	-	-	7.09	7.09
Alkalinity	meq/L	-	-	-	-	-	-	0.26	0.14
DO	mg/L	>5.0	-	-	-	-	-	7.21	7.23
BOD_5	mg/L	1.5	n	1.5	2.0	4.0	-	1.4	1.2
Oil and Grease	mg/L	-	-	-	-	-	-	<0.01	<0.01
Turbidity	FTU	-	-	-	-	-	-	17.9	16.2
Suspended solids	mg/L	-	-	-	-	-	-	21.4	22.1
TDS	mg/L	-	-	-	-	-	-	33.1	19.7
Hardness	mg/L	-	-	-	-	-	-	78.0	73.0
Conductivity	µS/cm	-	-	-	-	-	-	60.56	48.9
Phosphate-P	mg/L	-	-	-	-	-	-	0.48	0.10
Total P	mg/L	-	-	-	-	-	-	0.11	0.04
Ammonium-N	mg/L	0.2	n	0.5	0.5	0.5	-	0.05	0.02
Nitrate-N	mg/L	5.0	n	0.5	0.5	0.5	-	0.14	0.21
Total N	mg/L	-	-	-	-	-	-	0.07	0.05
Total coliform	MPN/100	5000 MPN/100 ml	-	5000	20,000	-	-	NA	NA
Fecal coliform	MPN/100	1000 MPN/ml	n	1000	4000	-	-	NA	NA
Cadmium, Cd	mg/L	0.005	n	0.00	0.005	0.005	-	<0.001	<0.001
Mercury, Hg	mg/L	0.002	n	0.002	0.002	0.002	-	<0.001	<0.001
Copper, Cu	mg/L	0.1	n	0.1	0.1	0.1	-	<0.10	<0.10
Iron, Fe	mg/L	-	-	-	-	-	-	0.22	0.20
Manganese, Mn	mg/L	1.0	n	1.0	1.0	1.0	-	0.18	0.11
Nikel, Ni	mg/L	0.1	n	0.1	0.1	0.1	-	<0.10	<0.10
Lead, Pb	mg/L	0.05	n	0.05	0.05	0.05	-	<0.01	<0.01
Zinc, Zn	mg/L	1.0	n	1.0	1.0	1.0	-	<0.02	<0.02
Arsenic, As	mg/L	0.01	-	-	-	-	-	<0.001	<0.001

n naturally

- not indicated

1. Ambient Water Standards of Lao PDR, MONRE, GOL
2. Standard Methods for the Examination of Water and Wastewater recommended by APHA : American Public Health Association, AWWA: American Water Works Association and WPCF : Water Pollution Control Federation.

Green shading indicates that the relevant standards have been complied with.

Groundwater Quality

Groundwater quality at Ban Hat Gnium was not measured during the preparation of the environmental impact assessment (ERIC 2007), as, although there is a well at Ban Hat Gniun, the villagers use it only for disposal of waste,

and do not draw water from the well. Spring water from a gravity-flow system built under Action Contre la Faim (ACF) and the Nam Ngiep River are the main water sources that supplied water to the village.

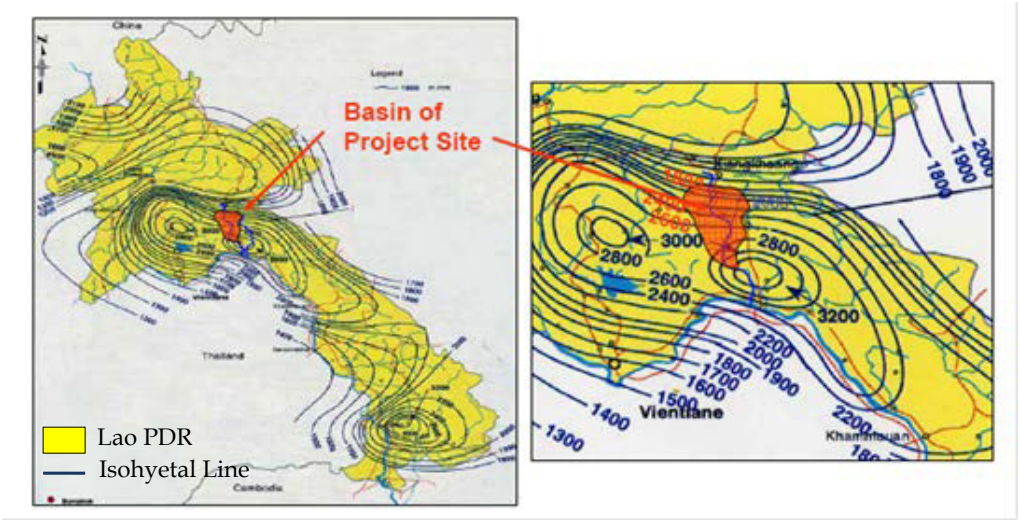
3.1.5 *Seismology*

During the past 20 years, there has been no record of an earthquake in the area exceeding magnitude of 5 (ERIC 2007). It can be concluded that the investigated region is characterized by a geological structure with good stability and that seismic activities in the Nam Ngiep river basin are rare (ERIC 2007). This conclusion is supported by the report on "Lao PDR: Natural Hazard Risks", edited by the OCHA Regional Office for Asia Pacific, issued on 08 March 2007.

3.1.6 *Hydrology*

Based on the isohytel map in ***Figure 3-1***, the mean rainfall for the Project area ranges between approximately 1800 mm/year in the north-eastern and western extremities of the trnamsission line, to as high as 3000 mm/year in the area around Pakxan. The tropical low pressure system, developed in the China Sea and moving along the Mekong Valley, is blocked by high mountains and steep cliffs of the northwestern region. Due to this formation of peaks and high elevation, there is a tendency for storm formations to stall there until the low pressure dissipates.

Figure 3-1 ***Isohyetal map***



Note: Isohyetal lines represent points of equal rainfall.

Based on actual measurements of discharge at the Mouang Mai station over a fourteen year period, the estimated discharge for Nam Ngiep River at Ban Hat Gnium was calculated. The difference between measured discharge and calculated discharge was minimized through a trial-and-error method. This "tank model" methodology and low flow analysis resulted in annual average discharge (1971 to 2000) of 148.4 m^3/s.

3.2 BIOLOGICAL RESOURCES

Biological resources were assessed using a variety of information sources. The full NNP1 Transmission Line Biodiversity Assessment Report, is provided in *Annex C* and a summary is provided in this chapter.

3.2.1 Assessment Methods

The baseline biodiversity values of the transmission line have been determined using a number of information sources including:

- Geospatial datasets including aerial photography and vegetation mapping;
- Desktop literature and other sources;
- Field survey undertaken for the NNP1 Project components; and
- Field reconnaissance visit to identify key biodiversity areas for consideration in refining the alignment.

These sources provide description of vegetation communities, habitats and species that occur in the region surrounding the Project Area, and therefore have potential to occur within the Project Area. The data collated for the purposes of this report can be categorised into two types:

Direct: Species recorded during biodiversity field surveys of NNP1 Project components undertaken during 2013 are considered direct counts. In general the location and details of this data has been recorded and a higher level or certainty can be inferred.

Indirect: Species reported from village surveys or within reports using a more regional study area are considered indirect records. These data sources provide a valuable understanding of the biodiversity of the locality and region however should be afforded further analysis or applicability considered. Data obtained from village surveys can contain errors in some instances, especially when considering identification of species with more challenging diagnostic features.

The reliability of the records has been considered throughout the report and the category of any species records are denoted throughout.

3.2.2 Vegetation

Land Cover

The Lao landscape has historically been dominated by dense forest and, despite more recent clearance, retains significantly more forest coverage than neighbouring countries Thailand, Vietnam and China (Yunnan Province) (Duckworth *et al.*, 1999). The original forests of the Northern-Central Highlands, where the Project Area is located, were predominantly dry

evergreen and mixed deciduous forests. However, shifting cultivation has removed much of the original forest and large areas of grassland, bamboo and other secondary vegetation are now present. Non-timber forest products (NTFPs) such as leaves, shoots, flowers, fruits and bark are used extensively by the Lao people and are of great importance both as a food source and also medicinally and culturally.

Land cover type mapping based on DFRM 2010 forest mapping identifies the dominant landcover types within the Project Area to be deciduous forest and old fallow land, with smaller portions of young fallow land and rice paddies. The land cover types mapped within the Project Area are presented in *Table 3-3*, based on the 35 m wide RoW, and shown in *Figure 3-2*.

Table 3.3 Land cover types within the Project Area

Type (code)	Description	Total within Project Area (ha)
Natural Habitat		**151**
Deciduous forest (DF)	Deciduous forest occurs when deciduous tree species represent more than 50% of the stand. The forest storeys are not as dense as those of evergreen type. Most often bamboo occurs in this type of forest. Deciduous Forest includes both Upper and Lower deciduous forest types and this definition is based on relative altitude, forest occurring above 200 m is classified as Upper Mixed deciduous Forest and deciduous forest occurring at an altitude 200 m and below is classified as Lower Deciduous Forest.	122
Evergreen forest (EF)	Area dominated by trees where 75% or more of the tree species maintain their leaves all year. Canopy is never without green foliage.	1
Bamboo (B)	Bamboo area where the over storey has a crown cover less than 5%.	6
Scrub, Heath (SR)	This is an area covered with scrub and stunted trees. The soil is shallow and rocky.	2
Swamp (SW)	Areas where the soil is saturated with water. The soil may basically be fertile but the lack of oxygen limits its agricultue or forest capacity. The swamp could have high ecological or environmental value and the flora and fauna may be rich.	7
Modified Habitat		**247**
Agriculture Plantation (AP)	Agricultural plantation currently in use.	7
Old fallow land (OFL)	Land that has been ploughed and tilled and left un-seeded during a growing season.	124
Young fallow land (YFL)	Land that has been recently ploughed and tilled and left un-seeded during a growing season.	68
Rice paddy (RP)	Areas permanently being used for rice cultivation.	53
Slash and burn (SB)	Slash-and-burn is a description of land that has been subjected to an agricultural technique which involves cutting and burning of forests or woodlands to create fields.	4
Unclassified		**8**

Type (code)	Description	Total within Project Area (ha)
Water (W)	The land cover class Water includes rivers, water reservoirs (i.e. ponds and dams for irrigation and hydro power) and lakes. Water reservoirs and lakes with an area of 0.5 ha and rivers should be at least 10m wide to be classified as Water.	3
Shadow (SH)*	Shadow indicates limitations in the dataset from shadows and cloud contained in the aerial imagery.	<1
Cloud (CL)*	Cloud indicates limitations in the dataset from shadows and cloud contained in the aerial imagery.	4
Other Land (O)	Other land types.	<1
Rock (R)	Rock surfaces.	<1

270000 280000 290000 300000 310000 320000 330000 340000 350000 360000

2070000 2060000 2050000 2040000 2030000 2020000 2010000

Legend

- Nam Ngiep Catchment Boundary
- City, Town or Village
- Lao PDR Boundary

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Proposed Access Road (Transmission Line)
- Proposed Transmission Line (Western Alignment)
- Proposed Transmission Line (Eastern Alignment)

Land Cover:

- 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

N

0 2.5 5 7.5Km

1:250,000

Basemap: ESRI World Imagery
Land Cover: DFRM
Datum: WGS84

Xiengmi
Ban Hat Gniun
Ban Thahuea
Ban Hatsaykham
Longxan
Ban Sisavath
Ban Nonsomboun
Mekong River
Pakxan
Thabok
Papek
Na
Nakhai
Nangommay
Ban Natan
Xienglaena
Hai
Veunthan
Somsamay
Palai
Nakhao
Donsangphai
Phao
Dongneng

Client:	Nam Ngiep Power Company Ltd.		
Drawing No:	0185065b_TL_IEE_G003_R0.mxd		
Date:	17/01/2014	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 3.2- Land Cover

Nam Ngiep 1 Hydropower Project
Transmission Line Initial Environmental Examination

Environmental Resources Management ANZ

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

ERM

Vegetation Condition

Vegetation condition based on the NDVI data within the Project Area is divided into four categories. NDVI data identified that:

- The majority of land (94%) is moderate or low condition;
- 5% of the Project Area is high condition, and this is mostly concentrated in the northern segment, from south of Huay Ngua PPA to the Main Dam;
- Approximately two thirds of the Project Area is in moderate condition, and this is evenly distributed throughout the Project Area; and
- Approximately a third of the Project Area is low condition, and this is primarily concentrated in the Pakxan region in the south east.

The representation of these categories within the Project Area is summarised in *Table 3-4* and shown *Figure 3-3*.

Table 3.4 Vegetation Condition in the Project Area

Condition Category (NDVI range)	Area within Project Area (ha)
Impacted (- to 0)	7
Low (0 to 0.4)	159
Moderate (0.4 to 0.6)	212
High (0.6 to 0.8)	25

270000 280000 290000 300000 310000 320000 330000 340000 350000 360000

2070000 2060000 2050000 2040000 2030000 2020000 2010000

Legend

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

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Access Road (Main Dam)
- Proposed Access Road (Transmission Line)
- Proposed Transmission Line (Western Alignment)
- Proposed Transmission Line (Eastern Alignment)

Condition Class:

- High
- Moderate
- Low
- Impacted

N 0 2.5 5 7.5Km

1:250,000

Basemap: ESRI World Imagery
Datum: WGS84

Xiengmi
Longxan
Ban Hat Gniun
Ban Thahuea
Ban Hatsaykham
Phou Ngou Provincial Protected Area
Ban Sisavath
Huay Ngua Provincial Protected Area
reservoir
Phou Khao Khouay National Protected Area
Pakxan
Thabok
Papek
Nam Mang 3 Reservoir
Na
Nakhai
Nangommay
Ban Natan
Xienglaena
Mekong River
Hai
Veunthan
Somsamay
Palai
Phao
Nakhao
Donsangphai
Dongneng

Client:	Nam Ngiep Power Company Ltd.		
Drawing No:	0185065b_TL_IEE_G004_R0.mxd		
Date:	17/01/2014	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 3.3 - Condition Class (NDVI)

Nam Ngiep 1 Hydropower Project
Transmission Line Initial Environmental Examination

Environmental Resources Management ANZ

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

ERM

3.2.3 Flora Species

The following sections outline the flora species, diversity and condition identified for Huay Ngua PPA, the resettlement area, the NNP1 Access Road and Phou Khao Kouay NPA.

Huay Ngua PPA

Sampling undertaken during 2013 surveys by TISTR recorded 451 species of vascular plants in the Huay Ngua PPA sampling locations and 410 at the resettlement area sampling locations on the west bank of the Nam Ngiep River. Huay Ngua PPA vegetation is dominated by mixed deciduous forest with some areas of mixed evergreen forest and secondary growth of mixed deciduous forest. Canopy cover was recorded at approximately 60-70 per cent.

Resettlement Area

Resettlement area vegetation is dominated by secondary growth of mixed deciduous forest. Canopy cover was recorded at approximately 40% (TISTR 2013).

NNP1 Access Road

The botanical inventory collected within the disturbance footprint by NUL identified 139 species of vascular plants (Phengsintham 2013) that included one Bryophyta species, nine Pteridophyta species, 102 Dicotyledones species, 25 monocotyledons species and three mushroom species (NUL 2013).

Phou Khao Kouay NPA

The central portion of Phou Khao Kouay NPA contains the lower basins of the Nam Leuk and Nam Mang. This area is predominantly upper dry evergreen forest. This forest has plant families and genera typical for other parts of Southeast Asia, such as the genera Dipterocarpus and Shorea. Mixed deciduous forest is found on lighter, shallow soils. Large stands of coniferous forest, usually monospecific stands of *Pinus merkusii*, grow on shallow, nutrient deficient, sandy soils, particularly in the western portion of the park, where it occurs in association with extensive, fire-climax grasslands.

The dominant species recorded by TISTR in each canopy strata are summarised in *Table 3-5*.

Table 3.5 Dominant Flora Species in survey sites

Canopy class	Dominant species
Resettlement Site Secondary Growth of Mixed Deciduous Forest	
Top canopy (~15m)	*Taliparitimacrophyllum, Peltophorum dasyrachis, Macaanga denticulata, Lepisanthes rubiginosa, Cratoxylum formosum, Aporosa villosa, Chaetocarpus castanocarpus, Maesa ramentacea, Irvingia malayana, Lagerstoemia calyculata.*
Lower canopy (<10m)	Densely covered by seedlings of original forest type, shrubs, climbers and herbs such as *Cleistanthus papyraceus, Ardisia helferiana, Chionanthus velutinus, Connarus semidecandrus, and Amomum biflorum*. The typical species of bamboo found in the area is *Gigantochloa albociliata.*
Access Road (Huay Ngua PPA) Mixed Deciduous Forest	
Top canopy (20-35m)	*Anisoptera costata, Lagerstroemia calyculata, Shorea roxburghii, Irvingia malayana, Alstonia glaucescens, Schima wallichii, Vitex pinnata, Stereospermum fimbriatum*
Middle canopy (10-20m)	*Acronychia pedunculata, Peltophorum dasyrachis, Nauclea orientalis, Microcos tomentosa, Mallotus paniculatus, Gonocaryum lobbianum, Cratoxylum formosum*
Lower canopy (<10m)	*Croton cascarillicdes, Breynia glauca, Ardisia helferiana, Glycosmis pentaphylla, Melicope pteleifolia, Allophylus cobbe, Salacia chinensis*

IUCN Listed Species

A total of 11 plant species listed under the IUCN Red List were recorded during vegetation surveys of the Re-settlement area and Huay Ngua PPA in 2013, the NUL vegetation ground-truthing survey and desktop review of PKK. The species are considered the subject species for the transmission line Project Aea. The IUCN listed species are shown in *Table 3-6* and include:

- one species listed as critically endangered;
- five species listed as endangered; and
- five species listed as vulnerable.

Table 3.6 IUCN Listed Flora Species Reported

Scientific Names	Status	Huay Ngua PPA (TISTR)	Phou Khao Khouy NPA (Indirect)	Re-settlement Site (TISTR)
Dipterocarpus turbinatus	CR	✓		
Afzelia xylocarpa	EN	✓		✓
Anisoptera costata	EN	✓	✓	
Dalbergia oliveri	EN	✓		✓
Dipterocarpus alatus	EN	✓	✓	
Shorea roxburghii	EN	✓		✓
Cycas pectinata	VU	✓		
Dalbergia cochinchinensis	VU	✓		
Hopea odorata	VU	✓		✓
Syzygium vestitum	VU	✓		
Ternstroemia wallichian	VU	✓		

3.2.4 Fauna Species

Huay Ngua PPA

A total of 38 terrestrial species of fauna from 19 families, and 31 genera were recorded from the field surveys in 2013 surveys in Huay Ngua PPA by TISTR. Species diversity of animals recorded in this area was low in comparison to other areas surveyed nearby however this is expected to be due to the lack of secondary data, all records were obtained by direct observation during the TISTR field surveys.

The Huay Ngua Provincial Preserved Area Management Plan reports (indirect data) fauna species occurring within the PPA to include wild pig, munjac, clouded leopard (*Pardofelis nebulosa*), civet, flying squirrel as well as Green peafowl (*Pavo muticus*), Hill myna (*Gracula religiosa*), Red junglefowl (*Gallus gallus*) and the Siamese fireback (*Lophura diardi*).

Overall, the TISTR surveys and indirect data reported:

- Nine amphibian species;
- Fifty-nine bird species;
- Twenty-seven mammal species;
- Nine reptile species; and
- Thirty-nine fish species (including twelve species considered to be migratory).

Resettlement Area

Field surveys of the Resettlement area in 2013 found that the area is 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.

Restricted Species

Species listed as Restricted under the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF includes wild animals and fish which are rare, endangered, high conservation value, and special significance to the economy and national environment.

The 2013 surveys of the Resettlement area and Huay Ngua PPA by TISTR in 2013 (direct data) and indirect data sources identified the following species listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF that may also occur within the transmission line RoW:

- Two mammal species;
- Six bird species;
- One reptile;
- One fish;
- No amphibians.

These species are considered subject species for the transmission line Project Area.

Table 3.7 No. 0360/MAF Restricted Fauna Species Reported

Common Name	Scientific Name	Direct Data	Indirect Data	No. 0360/MAF Status
Mammals				
Leopard	*Panthera pardus*		✓	Restricted
Asiatic golden cat	*Pardofelis temminckii*		✓	Restricted
Bengal slow loris	*Nycticebus bengalensis*		✓	Restricted
Birds				
Great hornbill	*Buceros bicornis*		✓	Restricted
Greater coucal	*Centropus sinensis*	✓	✓	Restricted
Siamese fireback	*Lophura diardi*		✓	Restricted
Silver pheasant	*Lophura nycthemera*		✓	Restricted
Grey peacock-pheasant	*Polyplectron bicalcaratum*		✓	Restricted
Red-breasted parakeet	*Psittacula alexandri*	✓	✓	Restricted
Reptiles				
Reticulated python	*Broghammerus reticulatus*		✓	Restricted
Fish				
	Wallago leeri		✓	Restricted

IUCN Listed Species

Three IUCN Red Listed critically endangered, endangered or vulnerable fauna species were recorded within the Huay Ngua PPA area during 2013 surveys by TISTR while 16 additional species listed as critically endangered, endangered or vulnerable on the IUCN Red List that may occur within the Huay Ngua PPA were identified. Information regarding the PKK identified a number of IUCN Red List species to occur within the national protected area, including ten mammal species (1 critically endangered, 4 endangered and 5 vulnerable).

Table 3.8 IUCN Listed Fauna Species Recorded/Reported

Common Name	Scientific Name	Direct Data	Indirect Data	IUCN Status
Mammals				
Northern white-cheeked gibbon	*Nomascus leucogenys*		✓	CR
Asian wild dog, dhole	*Cuon alpinus*		✓	EN
Asian elephant	*Elephas maximus*		✓	EN
Sunda pangolin	*Manis javanica*		✓	EN
Fishing cat	*Prionailurus viverrinus*		✓*	EN
Phayre's leaf monkey	*Trachypithecus phayrei*		✓	EN
Asian small-clawed otter	*Aonyx cinerea*		✓	VU
Gaur	*Bos gaurus*		✓	VU
Malayan sun bear	*Helarctos malayanus*		✓	VU
Northern pig-tailed macaque	*Macaca leonina*		✓	VU
Clouded leopard	*Neofelis nebulosa*		✓	VU
Bengal slow loris	*Nycticebus bengalensis*		✓	VU
Sambar deer	*Rusa unicolor*			VU
Himalayan black bear	*Ursus thibetanus*		✓	VU
Large spotted civet	*Viverra megaspila*		✓	VU
Birds				
White-winged duck	*Cairina scutulata*		✓*	EN
Green peafowl	*Pavo muticus*		✓	EN
Imperial eagle	*Aquila heliaca*		✓	VU
Reptiles				
Big-headed turtle	*Platysternon megacephalum*		✓	EN
Southeast Asian softshell turtle	*Amyda cartilaginea*		✓	VU
Snail-eating turtle	*Malayemys subtrijuga*		✓	VU
Impressed tortoise	*Manouria impressa*		✓	VU
Indo-Chinese spitting cobra	*Naja siamensis*		✓	VU
Fish				
Giant barb	*Catlocarpio siamensis*		✓	CR
Striped catfish	*Pangasianodon hypophthalmus*		✓	EN
Yellow tail brook barb	*Poropuntius deauratus*	✓*		EN
Thicklipped barb	*Probarbus labeamajor*		✓	EN
Bandan sharp-mouth barb	*Scaphognathops bandanensis*	✓		VU
Jaguar loach	*Yasuhikotakia splendida*	✓		VU

CR = Critically endangered, EN = Endangered, VU = Vulnerable

*Specialist consultation identified potential for unreliable record

3.3 SOCIAL AND CULTURAL RESOURCES

3.3.1 Population

Table 3-9 identifies the 24 villages that are located along the transmission line corridor. It is anticipated that this number will change once the corridor alignment has been confirmed.

These villages presented in *Table 3-9* share a number of similar characteristics. All are predominantly ethnically Lao Loum, the majority group in Lao PDR. Their culture, religious beliefs, practices and livelihoods are typical of Lao Loum.

Table 3.9 Potentially Affected Villages

Province	District	Affected Villages	Total of households	Total of population	No. of affected households	
Bolikhamxay	Bolikhan	1.Hat Gniun	67	371	3	14 households
		2.Houykhoun	358	2,180	4	
		3.Nampa	84	584	7	
	Pakxan	1.Thong Noi	165	839	22	76 households
		2.Thong Yai	86	437	15	
		3.Sanaxay	274	1,156	4	
		4.Anusonxay	390	1,120	33	
		5.Pak Ngiep	137	659	2	
	Thaphabat	1.Xaysavang	87	123	3	73 households
		2.Vuenthat	356	523	14	
		3.Paktuay Tai	126	278	7	
		4.Pakthouay Neu	174	391	7	
		5.Nongkuen	256	342	8	
		6.Sisomxay	275	371	10	
		7.Thabok	364	946	5	
		8.Palai	221	315	5	
		9.Somsaath	121	321	7	
		10. Na	179	462	7	
Vientiane Capital	Pak Ngum	1. Vuenkabao	125	749	1	20 households
		2. Xienglea Na	115	639	8	
		3. Xienglea Tha	237	1,416	4	
		4. Nonh	111	498	4	
		5. Thakokhai	178	378	1	
		6. Nabong	365	456	2	
Total		24	4,851	15,554	183	

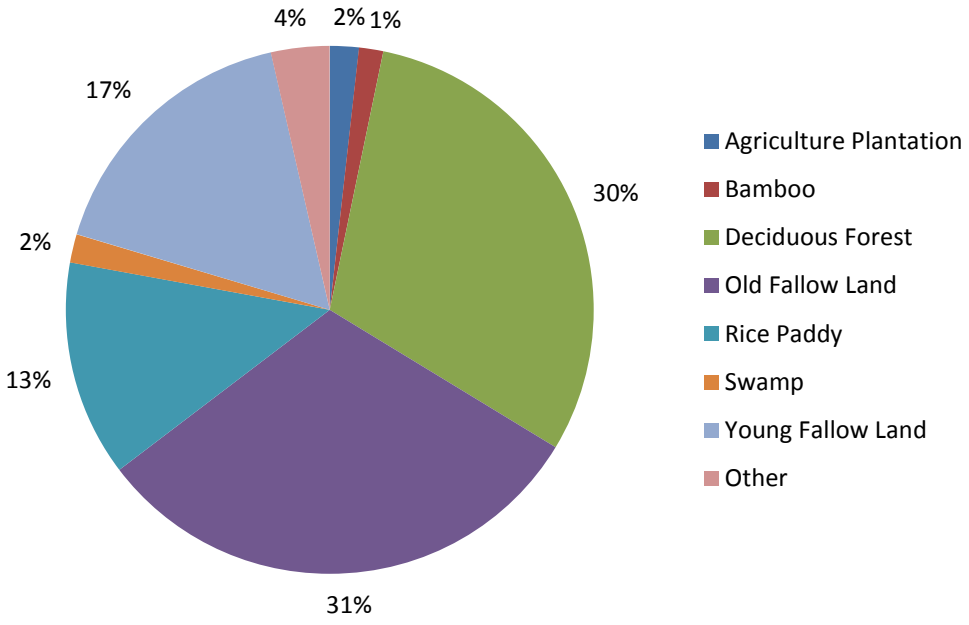
The houses tend to be situated alongside the river, in this case the Nam Ngiep, or beside roadways in clusters. The houses of the Lao Loum are built above ground on wooden posts to cope with seasonal flooding and to allow better

airflow. This style provides space under the house for daytime activities and to keep livestock at night. Most households rely mainly on agriculture for their livelihood, with forest products and fish important secondary sources.

The administrative structure of each village is similar to that of other communities in the country: with a village headman, deputy village headmen, local militias, local police, a branch of the Lao Youth Union, a branch of the Lao Women's Union, and a committee of the Front for Construction.

3.3.2 *Land Use*

A review of land cover mapping identified that almost 50% of land within the Project Area was fallow. The largest productive use at the time land cover mapping was undertaken was land used for rice paddies, (13% of the Project Area). Approximately a third of the Project Area was mapped as supporting natural habitats. Although not specifically used for cultivation, natural habitats may provide resources such as non-timber fiber products and wild-caught food. Ground truthing of land uses in the Project Area will be undertaken prior to construction.



3.3.3 *Livelihood*

Table 3-10 provides an overview of the sources of income in the local villages. This information is based on a field survey with local villagers along the transmission corridor. The main sources income include agricultural and livestock production, followed by small businesses and services. Most households also had more than one source of income, as reflected by the occupations and livelihood systems of local villagers.

Table 3.10 Sources of Income

Sources of Income	District			
	Bolikhan (14 Villages)	*Pakxan (76 Villages)*	*Thaphabat (66 Villages)*	*Pak Ngum (20 Villages)*
	No. of HH	*No. of HH*	*No. of HH*	*No. of HH*
Agricultural Production and Livestock	13	52	61	17
Small Businesses and Services	5	27	16	9
Non-timber Forest Products and Fishing	4	2	5	3
Handicrafts and Small Scale industry	3	2	4	5
Daily Labor	4	43	24	7
Others	3	11	8	2

The relative importance of income from small business operations and handicraft sales is likely because most of the villages within the transmission line corridor are located along major roadways, in particular National Road No. 13 South. This provides access to buyers and markets.

Other sources of income that are often important in rural communities in the Lao PDR, such as NTFPs, were relatively minor by comparison.

3.3.4 Community Infrastructure

Table 3-11 provides information on infrastructure in the villages along the transmission corridor. Compared with other villages in the Project area, especially compared with those close or upstream of the dam site, the communities along the transmission line corridor tend to have better infrastructure and services.

Table 3.11 Community Infrastructure

Type of Facility or Infrastructure	Bolikhan 3 Villages	Pakxan 5 Villages	Thaphabat 10 Villages	Pak Ngum 6 Villages
Primary School	3	5	3	6
Lower Secondary School	1	2	4	3
Upper Secondary School	1	1	2	2
Dispensary or Village Clinic	0	1	3	2
Rice Mill	3	4	9	6
Electricity	2	5	9	6
All Weather Road	2	5	9	6
Village Market	2	3	9	6
Public Transport or Bus from Village to Districts/Provinces	2	5	9	6
Factory Nearby	0	3	2	3
Guesthouse	0	2	3	2
Restaurant	1	2	4	3

Type of Facility or Infrastructure	Bolikhan 3 Villages	Pakxan 5 Villages	Thaphabat 10 Villages	Pak Ngum 6 Villages
Garage	1	3	7	6
Communication Network	2	5	9	6
Toilet	3	5	9	6
2-Wheel or Small Tractor	2	5	9	6

The access to better infrastructure may be attributed to proximity of the villages to major roadways, including the National Road 13 South. In addition, feeder roads to the villages are being improved by GOL and are in or will soon be in good condition. Another reason may be the close proximity to the city of Pakxan, a key market and portal to Thailand.

3.3.5 Archaeology

There is one significant historic site and tourist attraction located along the transmission line corridor. Wat Prabat Phonsan is located next to National Road No.13 South, in Ban Prabat, Thaphabat District. Important relics/ artefacts at the temple include a model of the footprint of the Lord Buddha, a giant reclining Buddha, and an ancient drum.

4 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Impacts have been identified based on the project as described in *Section 2*. The transmission line alignment will be refined throughout the design process.

In summary, project activities will include:

Construction

- Clearing of vegetation for the RoW;
- Earthworks for installation of the transmission towers;
- Construction of towers and stringing;
- Rehabilitation of RoW areas not required to be permanently cleared; and
- Operation of worker camp.

Operation

- Vehicle travel within the RoW for maintenance activities;
- Maintenance of the RoW, including repairs to transmission lines, and trimming vegetation;
- Presence of roads and bridges; and
- Road maintenance.

4.1 DESIGN AND PRE-CONSTRUCTION STAGE

4.1.1 Hydrology

The following impacts to hydrology may occur during the operational phase, therefore, the below aspects shall also be considered during the design phase:

- The presence of hardstand areas in place of vegetated areas will prevent infiltration and may increase the velocity of surface runoff. Given the small area of hardstand areas (81 m^2 per tower) this impact is expected to be minor; and
- If poorly designed, the presence of bridges (as part of the access roads) has the potential to disrupt streamflows. In particular, restriction of flows may lead to increased upstream flood levels and accelerated erosion due to increased flow velocities. Removal of a beneficial restriction could also lead to increased downstream flows.

Mitigation Measures

- Drainage will be designed to safely convey runoff from developed areas at non-erosive volumes and velocities;
- Bridges and culverts will be designed in accordance with the Best Available Techniques provided in *Annex D*. Measures include: minimizing the use of pylons to retain the existing channel section; operating with a freeboard between the flood level and bridge deck; and avoiding encroachment of bridge abutments into the channel; and
- Construction will be scheduled to occur during the dry season wherever possible.

4.1.2 Water Quality

Poorly designed infrastructure layouts, including siting of towers, material stockpiles, worker camps and access roads, can lead to:

- High levels of erosion and sediment run off, which may increase turbidity of surface waters;
- Contaminated run off from waste and hazardous materials storage areas; and
- Leaching of sewage and domestic waste from camp and construction areas.

Mitigation Measures

- Construction in steep areas and watercourse crossings will be minimized wherever possible;
- Adequate waste and materials storage areas will be provided for in the site layout;
- Material stockpiles will be located at least 30 m away from steep slopes, watercourses or drainage paths; and
- Solid and septic waste management systems will be provided.

4.1.3 Noise

Noise in the form of buzzing and humming can often be heard around transformers, and may be heard from transmission lines, particularly during rain or fog. These noise emissions do not present any known health risks, but could disturb local residents and fauna.

Mitigation Measures

- Locate RoW away from human receptors and areas of critical habitat for noise-sensitive species.

4.1.4 Biodiversity

Inappropriate layout design can lead to unnecessary, avoidable impacts to habitat and species, for example by locating towers, access roads and other infrastructure within protected areas, or natural habitat, where alternatives are available. In addition, inappropriate transmission tower design can present a risk of electrocution to avifauna.

Mitigation Measures

- The design and layout has been planned in consideration of alternative routes to avoid protected areas (refer *Section 5);*
- A flora assessment and other environmental assessments will occur within the RoW and proposed access roads to identify areas of biodiversity value, prior to construction commencing;
- Based on these assessments, refinement of the alignment will minimise tree cutting, protected area disturbance and critical habitat disturbance where possible; and
- Transmission lines will be designed to minimise risk of electrocution, including maintaining a 1.5 m spacing between energised components and grounded hardware, or covering energised parts.

4.1.5 Land Use

Inappropriate layout design can lead to unnecessary, avoidable impacts to existing land uses and subsequent impacts to livelihoods.

Mitigation measures

Siting of towers, as well as temporary infrastructure, such as access roads and stockpiles, will minimize the acquisition of productive land. Compensation for the loss of property will be provided to the affected people.

4.1.6 Community Health and Safety

Poor siting of transmission lines can impact community health and safety by:

- Locating transmission lines in flight path envelopes, thereby increasing the risk of aircraft collision with overhead powerlines. Power transmission towers can impact aircraft safety through direct collision and interference with radar equipment.

Mitigation Measures

- Transmission lines and towers will be sited outside of known flight path envelopes where possible; and
- If installation is required in flight sensitive areas, buried lines will be used.

4.1.7 Public Property

Transmission lines may impact visual amenity, which can be undesirable to residents.

Mitigation Measures

- Powerlines will be sited in consultation with the community, and with due consideration of landscape views;
- Changes to property values due to powerline proximity will be assessed, and appropriate compensation will be provided.

4.2 CONSTRUCTION STAGE

4.2.1 Hydrology

Impacts to hydrology may include the following:

- Clearing of vegetation may speed the movement of surface run off;
- Earthworks required for tower footprints, access roads, stockpile areas and other infrastructure may alter the flow of surface runoff; and
- Construction of access roads may involve in-stream works, which may alter water flows.

Mitigation Measures

- Wherever possible, construction will occur during the dry season;
- River diversion during in-stream works will be designed with the intent of maintaining water flows within the watercourse. If river diversion is expected to alter flows to an extent that would lower the downstream water level, local people will be informed of changes to water levels, including expected extent and duration of change;
- Earthworks will be undertaken to minimize changes to surface water flows and to avoid collecting standing water.

4.2.2 Water quality

Impacts to water quality can occur from erosion and sediment run off, discharge of inadequately treated sewage and domestic waste, and release of hazardous materials. These pollution sources are discussed further below.

Erosion and Sediment

Sources of erosion and sediment run off include:

- Erosion and sediment run off from construction activities that expose or move soil (including clearing of vegetation and earthworks);
- Release of sediment laden effluent during construction, for example drilling wastes; and
- Erosion and sediment released from stream bed and bank disturbance at watercourse crossings required for access roads.

Erosion has the potential to lead to deposition of sediment and increased turbidity of water which can limit photosynthesis, suffocate benthic fauna and more broadly degrade aquatic habitat.

Effluent

Sources of sewage and domestic waste include:

- construction camps, which can discharge litter, sewage, and wastewater containing high levels of nutrients, organic matter, pathogens, oils and heavy metals; and
- concrete batching plants, which if not adequately managed can produce highly alkaline wastewater.

Hazardous Materials

Hazardous materials that may be used in the Project include:

- Paints and solvents;
- Petroleum products such as oils, fuels, and grease;
- Concrete curing and repair compounds; and
- Contaminated waste material.

There is potential for hazardous materials to be released to the environment, particularly during storage and handling, and equipment/vehicle maintenance.

Mitigation Measures

Implementation of appropriate mitigation measures can significantly reduce the impacts of the project on water quality. The following general water quality management measures will be implemented:

Erosion and Sediment

- Clearing and earthworks will be undertaken in the dry season wherever possible to minimize erosion and subsequent release of sediment;

- The period of soil exposure will be minimized by phasing clearing and construction activities, and covering exposed areas (for example by planting fast growing ground cover or covering with riprap, sand bags, erosion mats, bale dikes, mulch, or excelsior blankets) at the earliest time possible. Exposed areas of stream banks will be covered immediately, and preferably be replanted with locally native herbaceous and woody vegetation;

- If in-stream diversion is required during access road construction (e.g. if bridges are required), any diversion infrastructure will be clean and made of suitable materials that will not contribute to turbidity or salinity;

- At watercourse crossings, machinery will operate from stream bank, not the stream channel, whenever practicable with minimal streambed disturbance. All disturbed streambeds will be returned to their original condition or better as soon as possible;

- If vegetation clearing is required on stream banks, vegetation will be cut near or at ground level to leave root mass in the ground. This helps to reinforce soil stability and reduce erosion;

- For areas in direct runoff path to a watercourse, sediment and erosion control devices will be installed and maintained until vegetation replanting can occur to stabilise disturbed surfaces;

- Stockpile materials will be located at least 30 m away from steep slopes, watercourses or drainage paths;

- Water quality will be monitored regularly, and if found to exceed standards defined in Annex *B*, additional water quality measures will be implemented.

Effluent

- Prior to operation of concrete batching plants and casting yards, the contractor shall install wastewater treatment systems that have the capacity to treat wastewater to a quality compliant with relevant standards (refer to Annex *B*); and

- Solid and septic system waste management systems will be installed and maintained in good working order.

Hazardous Material

- All fuel and hazardous material storage will be adequately bunded to prevent any spillage problem;
- Only minimal chemicals, hazardous substances and fuel will be stored on site works;
- Whenever feasible, mobile fueling/maintenance units will be used for construction equipment to avoid/reduce on-site fuel/lubricant storage; and
- Discharge of oil contaminated water into the environment is prohibited.

4.2.3 Air Quality

Air quality can be impacted by:

- Dust emissions from exposed soils (e.g. due to clearing of vegetation, earthworks);
- Dust emissions from increased traffic on new and existing unsealed roads;
- Dust emissions from transport of soils and materials; and
- Chemical pollutants from fuel combustion for road vehicles and equipment.

Air emissions have the potential to impact the health of workers, as well as flora and fauna (*Section 4.2.5**Error! Reference source not found.***). With appropriate mitigation measures in place, impacts to air quality are expected to be minimized to an appropriate level.

Mitigation Measures

Measures include:

- Restricting vehicle movement to designated access routes;
- Covering all loads;
- Watering exposed surfaces during windy conditions;
- Maintaining the condition of the vehicle fleet;
- Daily monitoring of dust levels through visual inspection; and

- Implementing measures to limit vehicle speeds, particularly around sensitive receptors, for example by installing speed bumps.

4.2.4 Noise and Vibration

Operation of construction machinery has the potential to cause noise disturbance to nearby villages, as well as flora and fauna. Noise can also present a health and safety risk to workers.

Noise Impacts

The WHO report entitled "Guidelines for Community Noise" establishes health-based guideline values of noise exposure, for which no adverse effects of community noise exposure on human health would be expected. The report provides guidance on various levels of risk to public health due to noise. This concept allows countries and developers to adopt their own level of noise control, according to affordability and technical feasibility versus public health risks. It is also recommended that community noise exposure should be managed through the use of environmental health impact analyses.

Potential noise impacts associated with construction have been assessed using methodology developed by FTA (Federal Transit Administration, 1995). Noise levels generated from construction equipment are provided in ***Table 4-1***.

Table 4.1 Noise Levels Generated from Construction Equipment

Type of Equipment	Maximum Level (dBA at 50 feet)
1. Grader	85
2. Scrapers	89
3. Bulldozers	85
4. Heavy Tracks	88
5. Backhoe	80
6. Pneumatic Tools	85
7. Concrete Pump	82
8. Crushing Equipment	77

Source: Federal Transit Administration (1995)

Typically, construction equipment operates intermittently, and multiple pieces of equipment can operate simultaneously. In order to model the possible effects from construction equipment at the Project site, a typical scenario in which a grader (85dBA) and a scraper (89 dBA) operate concurrently and continuously in the same area was assessed. The combined sound level of these two pieces of equipment would be approximately 90 dBA at a distance of 50 feet from the construction site.

Noise outputs from grading activities have been investigated, and noise estimates at various distances are provided in ***Table 4-2***. Noise estimates are based on a source level of 90 dBA (measured at 50 feet). Distance attenuation,

molecular absorption, and anomalous excess attenuation were taken into account in the calculation.

Vibration Impacts

Vibration levels from different construction activities must be calculated. Using reference source vibration levels and typical usage factors, peak particle velocities (PPV) must be calculated for construction activities.

Using the method recommended by FTA (Federal Transit Administration, 1995) known as reference vibration amplitude (PPV_{ref}), the vibration produced by the grading activities of a large bulldozer was 0.089 in/s at 25 feet of distance. The vibration was assumed to attenuate over changing distance according to the following equation:

$$PPV = PPV_{ref} \text{ X } (25/\text{distance})^{1.5}$$

Using the above equation and recommended reference amplitude, the estimated vibration amplitude at various distances was calculated and summarized in ***Table 4-2***.

Table 4.2 Estimated Grading-Related Construction Noise in the Project Area*

Distance to Receptor (feet)	Sound Level at Receptor (dBA)	PV (in/S)
25	-	0.08900
50	90	0.03100
100	84	0.01100
200	78	0.00390
400	71	-
500	-	0.00100
600	67	-
800	65	-
1,000	-	0.00035
1,200	60	0.00027
1,500	58	-
2,000	55	0.00012
2,500	52	-
3,000	49	-
4,000	45	-
5,280	41	-
7,500	34	-

The above table is based on the following assumptions:

- Basic sound level drop-off rate: 6.0 dB per doubling of distance
- Molecular absorption coefficient: 0.7 dB per 1,000 feet
- Analogous excess attenuation: 1.0 dB per 1,000 feet
- Reference sound level: 90 dBA
- Distance for reference sound level: 50 feet
- Vibration estimate is based on the vibration of a large bulldozer

Mitigation Measures

The following general measures will be applied to limit impacts from noise and vibrations

- All noise and vibration generating construction equipment shall be operated and maintained to minimize noise emissions, including using appropriate sound dampening equipment and avoiding unnecessary revving and idling of vehicles;
- Construction equipment and vehicles will be subjected to regular inspections to check noise emissions and noise control equipment;
- Stationary noise sources will be positioned as far as practicable from dwellings, worker camps, schools, business and sensitive receptors;
- Hearing protection will be made available for all construction personnel;
- High noise activities, such as blasting, will be carried out only within the hours of 6am to 7pm, and residents should be informed of these activities; and
- The contractor will maintain communication with any schools within 3 km of the Project area, and will avoid high noise activities during school hours.

4.2.5 Biodiversity

Anticipated impacts to biodiversity due to construction include:

- Temporary disturbance of habitat in areas required to facilitate construction. Temporary disturbance will mainly be associated with construction areas surrounding tower pads, any required access tracks to tower locations, and temporary stockyards, workers camps and mobile offices;
- Disturbance and displacement of resident fauna due to noise, light and/or vibration as a result of construction activities (excavation, drilling, blasting, clearing, operation of camps, plant and vehicle movement);
- Degradation of habitat due to introduction of alien species and competition with native communities, accidental release of hazardous substances, and the creation of newly disturbed forest edges around the margins of access roads, transmission towers and associated infrastructure;
- Fauna mortality due to vehicle/machinery strike, hunting, poaching and collection for trade due to the creation of access roads within and outside of the RoW;

The biodiversity assessment report (Annex C) assessed the impact of the above items on biodiversity as having minor or negligible significance,

however impacts to IUCN Listed threatened species and nationally listed restricted species was assessed as having moderate significance.

Mitigation Measures

Loss of habitat

- Implement the mitigation measures proposed in relation to hydrology, water quality, air quality and noise and vibration;
- 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 violate rules and regulations;
- The planned clearance area for the construction works shall be clearly identified and marked to avoid accidental clearing;
- Disturbed areas shall be rehabilitated as soon as possible following construction activities;
- Construction Contractor will establish biological resource management program and management plan to manage the construction activities to be conducted and monitor compliance with relevant permits and environmental regulations in order to prevent potential impacts to terrestrial ecology, in particular, vegetation and wildlife; and
- In natural habitat areas to be cleared, microhabitat features such as hollow logs will be relocated to adjacent natural habitat areas rather than being destroyed where possible.

Disturbance to fauna

- Construction vehicles and machinery will be maintained in accordance with industry standard to minimise unnecessary noise generation;
- Traffic signs will be installed on all roads throughout construction areas depicting speed limits;

- For construction and operation areas requiring night-time lighting, lights will be used only where necessary and will be directed toward the subject area and away from habitat areas where possible; and

- Commitment will be made to raise awareness of values of natural habitat areas to construction work force and make arrangements for restriction of poaching.

Habitat degradation

- Construction and domestic waste will be appropriately stored and disposed of to avoid attracting native and alien species to the construction areas;

- For areas in direct runoff path to a watercourse, sediment and erosion control devices will be installed prior to commencement of vegetation clearance or earthworks and maintained until vegetation replanting can occur to stabilise disturbed surfaces;

- Monitoring of erosion and sediment control will be conducted to inspect the proper function of devices;

- Oil, chemical and solid waste will be stored, and handled and disposed of by appropriately licensed waste management contractors; and

- Weed and pest management measures should be implemented in accordance with a Project weed and pest management plan to avoid introduction of weeds to natural and modified habitat areas.

Fauna mortality

- Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to minimise potential for fauna strike;

- Commitment will be made to raise awareness of values of natural habitat areas to personnel and arrangements will be made for restriction of poaching and forest product collection; and

- Hunting wild animals will be strictly prohibited to apply for all staff;

4.2.6 Land Use

The project will alter land uses by:

- temporarily removing land uses from areas required for access roads, and other temporary infrastructure;

- permanently converting a small area of land to use for lattice towers;

- permanently limiting the types of land uses allowable within the RoW to those compatible with the transmission line, including:
    - prohibiting dwellings;
    - prohibiting growth of vegetation greater than 4.5m;
    - allowing growth of low growing crops, except in areas previously consisting of natural habitat; and
    - opening access to additional land through the creation of new roads.

The changes in land use, and the effects these changes have on communities will vary throughout the Project area. The level of impact will depend on the current level of utilization, availability of alternative resources, and diversity of the local economy.

The scale of land use changes (approximately 217.3 ha of land to be cleared, and 224.3 ha of land limited to vegetation below 3.0m) are not expected to have a significant impact on the social conditions of the surrounding communities.

After approval of the NNP1 by the Lao PDR government, NNP1PC will recheck the RoW and access road alignments and place signs around affected areas to inform the public and to limit the extent of land intrusion for agriculture purposes. Within villages, NNP1PC must reach agreement with the chief of the community and the villagers for infrastructure alignment.

Mitigation Measures

Agriculture productivity in the Project area will be restored as timely and efficiently as possible. The following improvement activities in the Project area should be taken into account.

- Livestock in affected areas will be relocated, where necessary;
- Productive land acquisition for the road alignment will be minimized as far as possible, and where unavoidable, compensation for the loss of property will be provided to the affected people;
- A separate Resettlement Plan will be prepared to address land acquisition and compensation issues, and will be reviewed by the Provincial Resettlement Management and Living Conditions Restoration Committee; and
- In the unlikely event that resettlement is required, the provisions of the Technical Guidelines on Compensation and Resettlement in Development Projects of the Lao PDR concerning resettlement and compensation will be followed strictly.

4.2.7 Economy and Livelihoods

Construction of the transmission line and associated infrastructure will provide employment opportunities to local people and may have a positive impact on the local economy and livelihoods. In addition, employment in the Project, and associated training, is expected to improve the skills and experience of local people in construction projects, including an improved working knowledge of health and safety practices.

The impact of productive land acquisition is discussed in Section *4.2.6*.

Mitigation Measures

The following measures should be implemented to maximize the benefits of the project to the economy and livelihoods:

- NNP1PC will carefully manage labor conditions;
- The construction contractor will hire local people during construction where local people have the required skills and experience. It is acknowledged, however, that much of the labor, especially skilled labor, will come from outside the Project area; and
- Training in health and safety and technical areas will be provided to all personnel.

4.2.8 Damage to Property

Detailed design of the access road will aim to avoid properties (such as houses, farmlands, aquaculture ponds, and irrigation canals) and community facilities (such as water supply, existing power supply and communication facilities). However, in some cases community infrastructure may be disturbed. This could affect viability of farming practices, water supply, power supply and communication, thereby affecting livelihoods and public attitudes toward the Project.

Mitigation Measures

- When constructing in the vicinity of irrigation and drainage channels, channels will be pegged and marked out to avoid unnecessary disturbance (such as driving over/through channels);
- If irrigation/drainage channels are to be intersected by Project infrastructure, they will be reinstated in the final infrastructure design. For example, if interrupted by a tower pad irrigation channels will be re-routed around the pad; if intersected by an access road, pipes will be installed below ground to maintain flow.

- The contractor shall immediately repair and/or compensate for any damage caused by the project to properties and community facilities.

4.2.9 Community Health and Safety

The negative effects on community health and safety during the construction phase may include the following:

- A possible increase in the transmission of communicable diseases (i.e., malaria, dengue fever, diarrhea, HIV/AIDs and STDs, and other endemic diseases) in the Project area. This impact should be minor and most cases prevented if the necessary mitigation and monitoring measures are carried out as detailed in the assessment;

- A possible decrease in the availability of food sources resulting in malnutrition of the local residents due to the requisition of land for the Project activities. However, the probability of this situation occurring is considered to be low as compensation will be provided by NNP1PC to enable residents have an equal or better level of nutrition;

- Naturally occurring floods may move loose construction equipment and materials, potentially causing accident or injury to the community, and damaging property; and

- Risk of vehicle accident due to construction traffic on public roads, as well as Project roads which may be utilised by the public.

The positive impacts on public health may include the following:

- Community development funds from the Project operation could result in greater investment in infrastructure and services such as clean drinking water systems, latrines, health education programs, and mobile clinics.

Mitigation Measures

- A public health education campaign will be provided that addresses: hygiene; disease prevention (including transmission pathways and symptoms of relevant diseases); and basic health promotion. For a rural community with a large number of people living together, public health education would be very helpful in relation to maternal and child health, nutrition, malaria, Japanese encephalitis, intestinal parasitic diseases and some water-borne diseases such as opisthorchiasis and paragonimiasis with vectors and intermediate hosts existing in the area. The Project will cooperate with district and local health authorities in this regard. This will be carried out by the Project's social safeguard staff;

- Impregnated mosquito nets will need to be provided to the Project workers and the general population. The provision of treatment programs and rapid diagnostic testing must also be available in the Project area and will be

implemented in cooperation with health authorities, including volunteer health workers;

- Construction materials and chemicals will be secured and locked down during flooding season.

- Latrines will be provided for each household in the Project area so that villagers have access to clean and safe water as soon as possible, particularly before the construction phase is launched;

- Traffic safety measures will be implemented as described in Section *4.2.13.*

4.2.10 Occupational Health and Safety

Construction activities present health and safety risks to personnel, including:

- accident and injury while working;

- spread of transmissible diseases between workers; and

- contraction of disease due to poor sanitation and environmental conditions in work and accommodation areas.

Mitigation Measures

The following measures will be implemented:

- Health Awareness Training will be mandatory for all personnel, and will address both on-the–job safety, and health awareness;

- Clean drinking water will be provided to all camps and work areas;

- Adequate sewage treatment will be provided;

- First aid kits will be readily accessible by workers and first aid teams will be specifically trained and assigned in groups of two to three persons to the different sites; and

- Vector control of mosquitoes and other pests will be managed including by minimizing mosquito breeding habitat and providing mosquito nets and other barriers.

4.2.11 Culture and Customs

Possible impacts of the temporary migration of workers and work camp followers into the area include:

- Increased demand on local resources and accommodation;

- Degradation of traditional sites;

- Offence to traditional customs;
- Social conflict between local communities and workers; and
- Increased crime and prostitution.

If these impacts occur, they are likely to be temporary.

Mitigation Measure

- The contractor will consult with local authorities to learn of any traditional practices and rules that need to be followed, and to coordinate in the enforcement of laws and regulations;
- A code of conduct will be established and enforced to reduce the potential for conflict between local residents and migrant workers;
- Any entertainment venues or recreational facilities in the vicinity of the project shall be operated strictly according to the local village values and traditions; and
- Local employment will be prioritised.

4.2.12 Physical Heritage

The transmission line has been aligned to avoid direct and visual impacts to the Prabat Phonsan Temple alongside National Road No. 13, which was identified as the only significant site along the transmission line corridor. However, unidentified sites of heritage significance may exist.

Mitigation Measures

The following measures will be implemented to minimize impacts to sites or items of cultural significance:

- ESOs will be trained to identify potential sites or items of cultural significance; and
- If previously unidentified artifacts are identified the contractor will immediately cease operations in the area, and inform the NNP1 Site Manager. The Owner will consult the Head of Village and Culture and Tourism Administration Office to obtain advice regarding the next steps. The contractor will recommence work only after the Culture and Tourism Office has provided official notification accordingly.

4.2.13 Traffic

The development of access roads specifically for Project use will limit impacts to traffic. However, transport of equipment and materials from sources to Project roads may increase traffic and the risk of vehicle accidents.

Mitigation Measures

The following mitigation measures will be applied to minimize impacts from construction traffic:

- All roads within the construction area will be signposted to facilitate traffic movement, provide directions to various components of the construction activities and provide safety advice and warnings in Lao and English;

- Traffic speed regulation devices, such as speed bumps, and signage will be installed at sensitive locations including in the vicinity of villages, construction camps, at busy intersections or before the sharp bend, and in areas of high habitat value if necessary;

- Prior to the movement of special loads on public roads, including hazardous materials or large items of including hazardous materials or large items of construction equipment, the ESMMU will be notified. If the ESMMU require additional measures, the reasonable and practical measures will be implemented to ensure that the risk of harm to the community and environment is minimized during transportation of special loads;

- In cases where heavy loads are required to be transported, some segments of roads and bridges may be reinforced to withstand the load; and

- In the event that stringing conductors present a possible risk to traffic temporary barriers (such as bamboo scaffolds) will be constructed across the roads and rivers to protect the public and property.

4.3 OPERATION STAGE

4.3.1 Water Quality

Transmission line infrastructure may have the following impacts to water quality during the operational period:

- The presence of hardstand areas (i.e. tower pads) has the potential to impact water quality through the operational phase by reducing infiltration, thereby increasing overland flows carrying pollutants to watercourses. Given the small area of tower pads (100m^2) this impact is expected to be minor;

- Heavily used roads can become contaminated with heavy metals, oils and surfactants that may be released to waterways in surface run-off. Sources of contaminants include tyre wear, brake lining wear and vehicle exhaust. Due to the anticipated low levels of traffic during operation of the transmission line, the risk of contamination from these sources is low; and

- The use of herbicides in RoW maintenance can lead to the release of herbicides into waterways via surface runoff.

Mitigation Measures

- Drainage of hardstand areas will be designed and constructed to retain surface runoff and facilitate infiltration to a level similar to pre-construction flows;

- Vegetation management methods that minimize the application of herbicides will be used (refer to Section *4.3.4*); and

- Store and handle pesticides to minimize escape to the environment, for example by storing in a location with appropriate containment measures and implement groundwater supply wellhead setbacks for pesticide application and storage.

4.3.2 Air Quality

Operation and maintenance can affect air quality by:

- The emission of ozone from transmission lines when in active corona, however ozone emitted from transmission lines is not known to carry any health risks[1]; and

- Air pollution due to burning of vegetation for RoW management.

Mitigation Measures

Vegetation will not be burnt for maintenance. Mechanical method will be used to trim tall and encroaching vegetation.

4.3.3 Noise

Noise in the form of buzzing and humming can often be heard around transformers, and may be heard from transmission lines, particularly during rain or fog. These noise emissions do not present any known health risks, but could disturb local residents and fauna.

Mitigation Measures

- Where locating the RoW near human receptors and areas of critical habitat for noise-sensitive species is unavoidable, the use of noise barriers and noise cancelling acoustic devices will be investigated.

[1] World Bank Group (2007) EHS Guidelines: Electric Power Transmission and Distribution

4.3.4 Biodiversity

Anticipated impacts to biodiversity during operation include:

- Permanent loss of 65 ha of habitat, and modification of 373 ha of habitat within the corridor footprint;
- The RoW may interrupt the continuity of forest habitat, as vegetation heights will be limited to below 3 m, however the maintenance of vegetation in the understorey and midstorey is likely to continue to allow arboreal species to move throught the landscape;
- Disturbance and displacement of resident fauna due to noise as a result of electricity transmission, and noise and light as a result of maintenance activities;
- During operation, mortality of avifauna (birds and bats) may occur due to collision with the transmission line and electrocution. Avian collisions could occur in large numbers if lines are located in daily flyways, or if avifauna are travelling during low light conditions.
- Fauna mortality due to hunting, poaching and collection for trade due to the creation of access roads within and outside of the RoW.

Mitigation Measures

Habitat Loss and Degradation

- Within the RoW, vegetation trimming will be restricted to that required to safely operate the transmission line. Groundcover and midstorey vegetation will be retained wherever practicable;
- The Project shall implement landscaping and re-vegetation after completion of construction in suitable areas; and
- Vegetation management during the operation phase will minimise the use of herbicides by using mechanical pruning methods and providing appropriate training to maintenance personnel.

Fauna Mortality

- Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to minimise potential for fauna strike;
- Commitment will be made to raise awareness of values of natural habitat areas to personnel work force and arrangements will be made for restriction of poaching and forest product collection;
- Hunting wild animals will be strictly prohibited; and

- Transmission lines will be designed to minimise risk of electrocution, including maintaining a 1.5 m spacing between energised components and grounded hardware, or covering energised parts.

4.3.5 Land Use

Operation of the project will limit the availability of land use in the RoW by:

- Prohibiting growth of trees greater than 4.5 m; and
- Prohibiting burning of crops (such as rice straw or plant residue).

Mitigation Measures

Compensation for loss of productivity due to the Project will be paid during the construction phase.

4.3.6 Economy and Livelihoods

Ongoing maintenance of the RoW, particularly vegetation management, can provide employment to local residents.

Mitigation Measures

- Local people will be employed for suitable roles wherever possible; and
- Appropriate health and safety measures will be undertaken to protect all Project personnel, as described in Section *4.3.8*.

4.3.7 Community Health and Safety

The presence and operation of transmission lines presents health and safety risks to the public. These include:

- Potential for aircraft collision with overhead powerlines. Power transmission towers can impact aircraft safety through direct collision and interference with radar equipment.
- Potential health impacts due to exposure to electromagnetic radiation. Studies have shown that the electromagnetic field strengths for 230 kV transmission lines at 30m are as low as or lower than that of common household appliances.[1] However, it is the constant exposure to the electromagnetic force that is of concern. Health issues associated with constant exposure include depression and migraine headaches. There is also a possible (although not confirmed) increased risk of childhood leukaemia from exposures greater than 0.4mG. The electromagnetic

[1] From http://www.who.int/peh-emf/about/WhatisEMF/en/index3.html

radiation from transmission lines is lower than 0.4mG when 60m from the centre line for 230 kV lines.[2]

- Noise in the form of buzzing and humming can often be heard around transformers, and may be heard from transmission lines, particularly during rain or fog. These noise emissions do not present any known health risks, but could disturb local residents;

- Overhead transmission line conductors and high frequency currents can create radio noise. Although these are generally designed to limit noise outside of the RoW periods of rain may increase this effect and affect radio reception in nearby residential areas;

- Toxicity of herbicides used in maintenance of RoW, which may come into contact with residents through air, water or direct contact with vegetation;

- Uncontrolled forest fires as a result of inadequate management of vegetation in the RoW; and

- Electrocution due to contact with high voltage electricity, or items (such as tools, vehicles or ladders) in contact with high voltage electricity.

Mitigation Measures

Air craft collision

- Transmission lines and towers will be sited outside of known flight path envelopes where possible and if installation is required in flight sensitive areas, buried lines will be used (Section *4.2.8*); and

- Air traffic authorities will be consulted prior to construction.

Electromagnetic Radiation

- Site transmission lines and other high voltage equipment away from residential properties and areas of high human occupancy (e.g. schools);

- Evaluate potential exposure levels and assess against the standards provided in *Annex B*;

Noise

[2] See Stakeholder Advisory Group on ELF EMFs (SAGE), First Interim Assessment: Power Lines and Property, Wiring in Homes, and Electrical Equipment in Homes, pp. 43-52. This report calculated the distance according to the standard transmission lines in the UK, of 30 meters for 110 and 123 kV lines, and 60 meters for 275 kV lines, which are considered equivalent to the 115 kV and 230 kV lines of this project.

- Where locating the RoW near human receptors and areas of critical habitat for noise-sensitive species is unavoidable, the use of noise barriers and noise cancelling acoustic devices will be investigated.

Toxicity

- The use of herbicides will be minimized through the integrated vegetation management approach described in Section *4.3.4;*
- If application of herbicides is unavoidable, application will not occur during windy or rainy weather; and
- The measures outlined in Section *4.3.1* to minimize impacts of herbicides on water quality will be implemented.

Forest Fires

- Thinning and slashing will be scheduled to avoid the fire season;
- Vegetative debris will be disposed of in locations that do not increase the fire risk; and
- Fuel breaks will be established to slow the progress of fires and allow firefighting access.

Electrocution

- Signs and barriers will be installed to prevent access to high voltage areas; and
- Grounding conducting objects will be installed near transmission lines.

General

- Development (for example construction of homes, shops etc) within the RoW will be strictly prohibited.

4.3.8 Occupational Health and Safety

Hazards relevant to Project personnel include:

- Exposure to EMF at levels higher than those experienced by the general public;
- Electrocution due to contact with high voltage electricity or items in contact with high voltage electricity (such as tools, vehicles or ladders);
- Working at height on towers;
- Exposure to herbicides and PCBs.

Mitigation Measures

Electromagnetic fields

- An EMF safety program will be developed prior to operation which: identifies potential levels of exposure; provides training for all workers; delineates zones appropriate for public access and those restricted to appropriately trained workers; defines measures to limit exposure time, such as through work rotation; and provides personal monitoring equipment for workers.

Electrocution

- Transmission lines will be deactivated and grounded prior to work on, or near, transmission lines;
- Live work will only be conducted by trained workers;

Working at heights

- Fall protection measures will be implemented including provision of appropriate fall protection equipment, training in use of equipment, training in climbing techniques, and rescue of fall-arrested workers;
- All equipment, including hoisting equipment, power tools and tool bags, will be properly rated and maintained;

Exposure to chemicals

- Appropriate personal protective equipment (such as gloves and safety glasses) will be supplied to all personnel handling herbicides or potentially contaminated materials;
- Training will be provided to all personnel in the appropriate application, hygiene and safety requirements for the use of herbicides.

5 ANALYSIS OF ALTERNATIVES

As described in *Section 2*, the purpose of the Project is to transmit electrical power from the Main Dam site to the Nabong collector substation in Vientiane. A number of alternative route alignment scenarios were considered to fulfill this purpose in a financially and technically feasible way, and with minimum environmental and social impact. This included consideration of alternative route alignments and two alternative substation layouts.

Considerations in the selection of alternatives included:

- Reliability of power transmission, by minimizing the risk of line outage and maximizing opportunities to rapidly repair the line if damage occurs;
- Avoidance of significant environmental features, such as protected areas or other forest areas of biodiversity value;
- Avoidance of significant socioeconomic features, such as large settlements, villages, houses, businesses, other infrastructure and industry; and
- Cost effectiveness, including efficient design and minimizing the route length, construction access and maintenance access points.

In addition, options for substation layout exist. The selected option, however, will depend upon agreement between Government of Laos and the current substation operator, Nam Ngum 2. Substation options are described in Section *5.2*.

5.1 ALTERNATIVE ROUTE ALIGNMENTS

The transmission line has undergone a number of route alignment changes since pre-feasibility studies based on changes in the environment and social conditions of the region and the availability of additional information as environmental investigations progress. *Table 5-1* summarizes the changes to the alignment since pre-feasibility assessments in 2002. Section *5.1.1* provides further detail on the changes to the alignment from the route described in the 2012 IEE.

Table 5.1 Alignment adjustments 2002 - 2014

Alignment Version	Description
Prefeasibility route (November 2002)	Intersected areas of mixed forest and two residential areas. Avoided Wat Ptabat Phansane Temple.
EGAT route (August 2007)	Avoided areas of mixed forest, residential areas and Wat Ptabat Phansane Temple. EGAT route was found to intersect area frequently used by elephant herd.
Initial IEE route (February 2011)	Avoided areas of mixed forest, residential areas, Wat Ptabat Phansane Temple and area frequently used by elephant herd. Huay Ngua PPA was established in 2010, and initial IEE route was found to intersect the PPA.
IEE V1 route (January 2014)	Alternative routes considered, and alternative that avoided Huay Ngua PPA was selected.

Alignment Version	Description
Source: NNP1PC 2013	

5.1.1 *Alternative Alignments Following Initial IEE*

The original route alignment was designed prior to the gazette of Huay Ngua PPA. The original route alignment was studied in the initial IEE (ERIC 2012), however following the creation of the PPA, it was identified that the original alignment traversed the PPA. For this IEE, new alternative routes to avoid the PPA were considered. The base alignment considered in this report is referred to as the Eastern Alignment. The alternative considered, which avoids Huay Ngua PPA by remaining on the west bank of the Nam Ngiep River, is referred to as the Western Alignment.

- Eastern Alignment: the alignment runs along the east bank of Nam Ngiep, adjacent an existing access road that intersects Huay Ngua PPA, then from south of Huay Ngua PPA runs parallel to the EDL transmission line route.

- Western Alignment (the option examined in this IEE): the alignment remains on the west bank of Nam Ngiep, avoiding Huay Ngua PPA, and rejoins the original alignment south of Huay Ngua PPA. The gradient on the west bank is steep.

An analysis of considerations with respect to vegetation and habitats for the two alignments was carried out in the NNP1 Transmission Line Biodiversity Assessment Report (Appendix F). The analysis split each route into five different segments, with each segment analyzed for its potential impact to the habitat type and land condition. The results indicated that, overall, the Western Alignment traverses less natural habitat and contains a higher proportion of low condition vegetation in comparison to the Eastern Alignment.

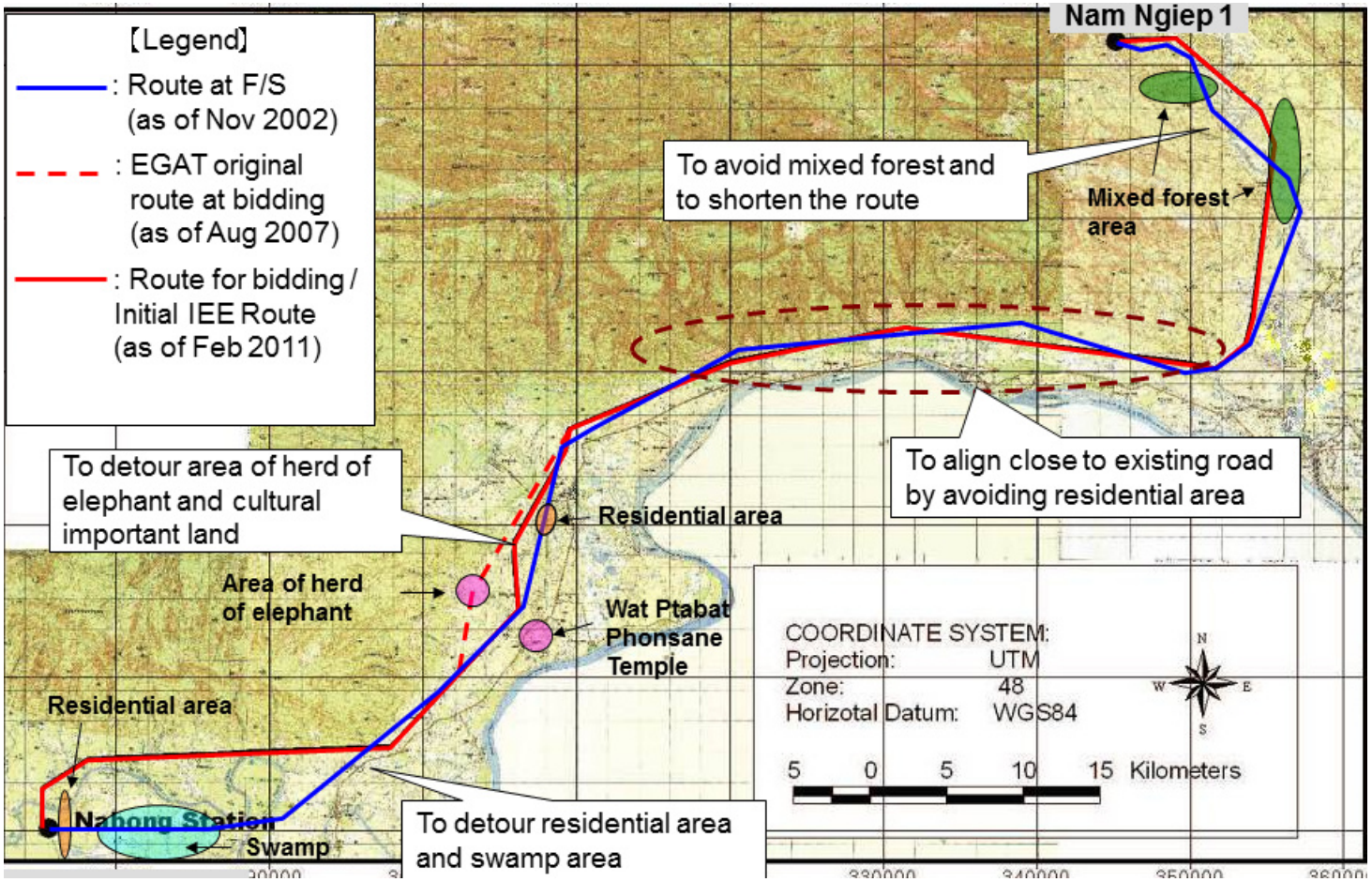
Based on the assessment of the cost, constructability, reliability and environment and social impacts provided in *Table 5-2*, the Western Alignment was considered the preferred option, and is the option examined in this IEE.

Table 5.2 Comparison of environment and social impacts, and feasibility of Proposed Road and Alternative Route

Consideration	2012 Alignment	Eastern Alignment	Western Alignment (subject of this IEE)
Length/cost	Approx. 125 km. Mitigation cost to be considered.	Approx. 136 km (+11km). Higher cost due to long distance.	Approx. 124 km (-1km). Equivalent cost to original budget.
	Poor	Poor	Good

Consideration	2012 Alignment	Eastern Alignment	Western Alignment (subject of this IEE)
Constructability / operability	Aligned in intermountain area with moderate slope, and accessibility with some distance from the existing access road.	Aligned in intermountain area with moderate slope, and easy accessibility adjacent to the existing access road.	Aligned in intermountain area with steep slope, and difficult accessibility away from the existing access road.
	Good	Excellent	Fair
Reliability	A certain distance from NNP River. High reliability due to alignment located in intermountain area with moderate slope.	A certain distance from NNP River. High reliability due to alignment located in intermountain area with moderate slope.	Must avoid the flooded area because of close to NNP River. Must avoid possible landslide area due to rather steep slope.
	Excellent	Excellent	Good
Environmental impact	Impacts on PPA with longer length. Tree cutting and bush clearance are required.	Impacts on PPA with shorter length. Tree cutting and bush clearance are required. Traverses more natural habitat than Western Alignment.	No impacts on PPA Tree cutting and bush clearance are required. Traverses less natural habitat and more low condition vegetation than the Eastern Alignment.
	Fair	Good	Excellent
Social impact	No residential area.	Passing close to Thahuea village.	No residential area.
	Excellent	Poor	Excellent
Evaluation	Fair	Good	Good

Figure 5-1 Alternative alignments considered prior to 2012 IEE (Source: NNP1PC 2013)



270000 280000 290000 300000 310000 320000 330000 340000 350000 360000

2070000 2060000 2050000 2040000 2030000 2020000 2010000

Legend

- Nam Ngiep Catchment Boundary
- Waterbody
- Transmission Line (Thavieng to Nabong)
- Road
- City, Town or Village
- Lao PDR Boundary
- National Park Boundary

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Access Road (Main Dam)
- Proposed Access Road (Transmission Line)
- Proposed Transmission Line (Western Alignment)
- Proposed Transmission Line (Eastern Alignment)
- Transmission Line Segments

N

0 2.5 5 7.5Km

1:250,000

Basemap: Bing Maps
Datum: WGS84

Xiengmi
Longxan
Ban Hat Gniun
Ban Thahuea
Ban Hatsaykham
Phou Ngou Provincial Protected Area
Ban Sisavath
Huay Ngua Provincial Protected Area
1
2
3
4
5
Nam Leuk reservoir
Phou Khao Khouay National Protected Area
Mekong River
Pakxan
Thabok
Papek Nam Mang 3 Reservoir
Na
Nakhai
Nangommay
Xienglaena
Ban Natan
Hai
Veunthan
Somsamay
Palai
Nakhao
Donsangphai
Phao
Dongneng

bing

Client:	Nam Ngiep Power Company Ltd.	
Drawing No:	0185065b_TL_IEE_G005_R0.mxd	
Date:	30/04/2014	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 5.2 - Alternative Alignments following 2012 IEE

Nam Ngiep 1 Hydropower Project
Transmission Line Initial Environmental Examination

Environmental Resources Management ANZ

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

ERM

5.2 *SUBSTATION LAYOUT ALTERNATIVES*

Nabong substation was designed and constructed for collective use, i.e. for collection of electricity generated by multiple IPPs. From the substation, electricity is stepped-up from 230 kV to 500 kV and exported to Thailand by 500 kV Nabong transmission line. Nabong substation and Nabong transmission line should be embedded into the Lao National Grid System. Currently, Nabong substation and Nabong transmission line is owned, operated and used solely by Nam Ngum 2. The transmission line is operated at 230 kV, although has been designed for 500 kV.

There are two options for the use of Nabong Substation by NNP1PC:

- **Option 1 -** Once other IPPs, including Nam Ngiep 1, are accepted to sell electricity by EGAT, ownership of Nabong substation and Nabong transmission line would be transferred from Nam Ngum 2 to the Government of Laos. The substation would then be expanded and upgraded (by installing additional transformers) to allow other IPPs to connect. The transmission line would then be operated at 500 kV. In this option, Nabong substation, including transformers, and Nabong transmission line should be shared by all interconnected IPPs.

- **Option 2 –** If asset transfer is not successful, GoL will need to construct a second substation adjacent the existing Nabong substation to enable NNP1PC to interconnect to Nabong transmission line. In this option, a new substation would be constructed very close to the existing Nabong substation. Based on the collocation of the two substations, the environmental impacts of both options are considered equivalent, with the only difference being a requirement for an extra few hundred metres of 500 kV transmission line to interconnect the existing Nabong transmission line downstream of Nabong substation.

The option selected will depend on the agreement reached between GoL and Nam Ngum 2.

Public consultation has played a key role in development of the Project, and will continue to play an important in its implementation.

The goal has been to ensure opportunities exist for stakeholders to be involved in Project design, including potentially affected people. More specifically, the objectives are to:

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

These objectives are being met through a comprehensive public consultation and disclosure process, which has been ongoing for a number of years. This has included:

- Sharing relevant Project information at the earliest stages of the Project;
- Providing on-going opportunities to input to the Project; receiving feedback from Project stakeholders; and
- Utilising outputs from the consultation process to inform the Project design, including proposed management measures and corresponding management plans.

In terms of the transmission line corridor, disclosure of the alignment and discussion of potential impacts and proposed management measures has occurred. This has been done through a variety of engagement activities - as outlined in *Table 6-1*.

Table 6.1 Public Meetings

Stakeholder Group	Date	Consultation Activity
Stakeholders including international financial institutions, MONRE, GOL organizations and agencies, general public, and NGOs	May 2011	Consultation and discussion at Hom District
	July 2011	Technical workshop and site visit to proposed resettlement site by MoNRE
Provincial Level: Bolikhamxay, Vientiane, and Xieng Khouang Province representatives	April 2008	Consultation and discussion at Bolikhamxay Province
	April 2008	Consultation and discussion at Xieng Khouang Province
	April 2008	Consultation and discussion at Vientiane Province

Stakeholder Group	Date	Consultation Activity
	April 2012	Consultation and discussion at Vientiane, Xieng Khouang and Bolikhamxay Provinces
District Level: Bolikhan, Pakxan, Hom, and Thathom District representatives	January 2008	Public consultation at Bolikhan District
Zone 3 villages, including villagers and village authorities	July 2011	Household and village survey at Ban Hatsaykham
	September 2011	Consultation meeting at Ban Hatsaykham

The consultation activities have helped to identify potential impacts, including impacts to significant historical/ archaeological sites, such as the Wat Prabat Phonsan. The result has been a realignment of the transmission line corridor in order to minimise the potential impacts.

However, as the transmission corridor alignment has recently changed additional consultation will be required. This engagement will be undertaken once the alignment has been confirmed and will provide an opportunity to disclose the revised alignment.

7 GRIEVANCE REDRESS MECHANISM

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

- Promote productive relationships with local communities and identify community concerns through consultation, disclosures, participatory planning and decision making (as described in *Section 6*) with PAPs in order to prevent grievances wherever possible and maximize environmental and social benefits;

- Address and resolve differences or grievances associated with the Project through established GRM procedures, as outlined in the following sections.

The GRM will address all grievances raised by PAPs across the Project, including a grievances raised by stakeholders located along the transmission line corridor.

7.1 GRIEVANCE REDRESS PROCEDURE

The GRM, in the first instance, seeks to resolve disagreements or stakeholder concerns before they evolve into grievances. This is done through ongoing engagement with stakeholders throughout the Project, particularly the PAPs. The resulting informal negotiations and discussions will be conducted in a transparent manner and will be appropriately documented. This includes agreements that are reached, which will be voluntarily signed by all parties involved in the negotiation.

In cases where concerns or conflicts cannot be resolved through consultation and / or discussions, the GRM has established a hierarchy of grievance committees and procedures to receive and resolve grievances. These committees and procedures are summarized below.

Stages and timeframes associated with the GRM procedures are as follows:

- Stage 1: PAPs will register grievances on any aspect of compensation, relocation or unaddressed losses with the Village Grievance Committee. The Village Grievance Committee will organize a meeting within 15 days from the date of formal receipt of the grievance with the complainants to resolve the issue using its traditional methods of conciliation and negotiation; the meeting will be held in a public place and will be open to other PAPs and villagers to ensure transparency. The report on the decision of the Village Grievance Committee must be in writing and must be signed by all members of the committee. If any members of the committee dissent from the opinion of the majority, those members can note their dissent as part of the report of the decision. The aggrieved party and the Project representatives should also sign and indicate their agreement or disagreement with the decision.

- Stage 2: If either the PAP or the Company is not satisfied with the decision of the Village Grievance Committee, or if the Project does not abide with the decision of the Village Grievance Committee, an appeal can be made directly by the Project or by the PAP, or by the Village Grievance Committee on behalf of the PAP. Other persons or organizations, such as local NGOs, mass organizations like Lao Women's Union, or other representatives of the PAP, can ensure that the appeals are forwarded to the District Grievance Committee. The District Grievance Committee will keep a public log of all claims and grievances it receives, including a summary of the decisions made, and must also make public all reports on the decisions made by the committee. The meeting of the District Grievance Committee will be held in a public place, no more than 20 days from the date of formal receipt of the grievance. Representatives from the Company must be available to provide any necessary information to the committee on entitlements, compensation rates, mitigation measures, and any other relevant information concerning the grievance. The report on the decision of the District Grievance Committee must be in written and must be signed by the members of the committee.

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

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

The Court of Law will follow up with the relevant authorities to make the final and binding decision.

- Stage 5: In case that the Project is found responsible for negligence, the Project will cover in full all administrative and legal fees incurred by the PAPs in the GRM process at the district, provincial and MONRE levels and in the Court of Law. Complaints and grievances concerning impacts during construction will be considered up to and for no more than one year after the official date of completion of construction.

7.2 ESTABLISHMENT OF GRIEVANCE REDRESS COMMITTEES

The GRM procedures will be managed by a hierarchy of grievance redress committees, comprising the members outlined in *Table 7-1*.

Table 7.1 Grievance Redress Committee Members

Committee	Committee Members
Village Grievance Committee	• The village head (chairperson); • Representatives of local village authorities; • Village elders; and • Representatives from community organizations, including the Lao Women's Union.
District Grievance Committees	• Representative of the District Authority (chairperson); • Local village leader(s)/ head(s); • Representatives from the PAPs, other than village leader(s)/head(s); • Local village elders and/or other local community organizations, including the Lao Women's Union; • Representatives from local not-for-profit organizations; and • Representatives from the Project team.
Provincial Grievance Redress Committee	• Representative of the provincial authority. This individual will become the chairperson; • Representatives from the provincial or district authority' • Representatives from the PAP (eg a representative from a village directly affected by the Project); • Representatives from community organizations, including the Lao Women's Union; • Representatives from a local not-for-profit organization; and • Representatives from the Project team.

The various committees will be established prior to commencement of the Project, in particular the resettlement activities. This will be done by making a formal request to the GOL for the relevant authorities in each province to establish the Provincial and District Grievance Committees. The District

Grievance Committees will be given the authority to establish Village Grievance Committees in villages affected by the Project.

8 ENVIRONMENTAL MANAGEMENT PLAN

8.1 INSTITUTIONAL ARRANGEMENT

8.1.1 Project Institutional Arrangement

During the pre-construction and construction stage of the transmission line, a specific project's Environmental and Social Team will be established. It is obligated to entail the appointment of new teams and responsibilities as follows:

- Environmental Management Office (EMO); and
- Social Management Office (SMO)

Both offices would be established as the Environmental and Social Division (ESD), managed by the ESD Manager who is responsible for the environmental and social implementation of Environmental Management Plan (EMP) on the site during construction stage. The ESD Manager would be supported by a Deputy Managing Director, Environment and Coordination.

Table 8-1 defines the roles and responsibilities of the Environment and Social Team, and an overview of the Project's management structure and environmental incorporation between the owner and the construction contractor is shown in ***Figure 8-1***.

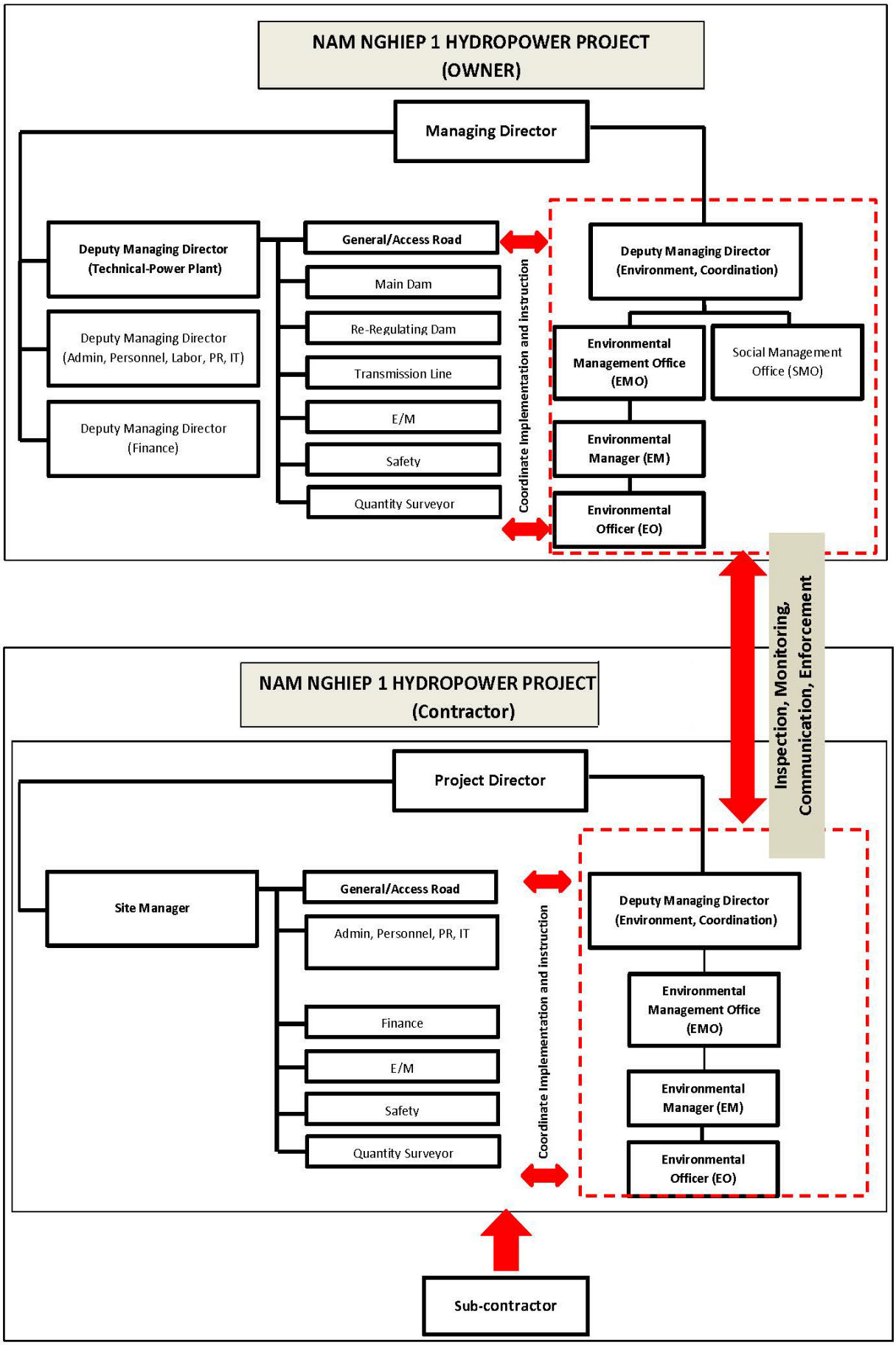
Table 8.1 Roles and Responsibilities for implementation of EMP

Role	Responsibilities
Deputy Managing Director (Environment, Coordination)	• Guide the development of an Environment and Social Management and Monitoring Plan for the Construction Phase (ESMMP-CP) based on the impacts and mitigation measures defined in the IEE; • Have a working understanding of legal environmental obligations of the Project, and the requirements of the ESMMP-CP; • Implement the ESMMP-CP; • Confine the construction site to the demarcated area; • Provide adequate resources and capabilities to implement and maintain the ESMMP-CP; • Verify that sufficient funds are available to properly implement the ESMMP-CP; • Monitor site activities on a regular basis for compliance; • Conduct internal audits of the construction site against the ESMMP-CP; • Rectify transgressions through the implementation of corrective action; and • Submit periodic monitoring reports to ADB.

Role	Responsibilities
Environment Manager and Environmental Officers	• Develop the Project ESMMP-CP based on the impacts and mitigation measures defined in the IEE; • Have a working knowledge of the environmental impacts, mitigation measures and recommendations of the ESMMP-CP; • Supervise and provide budget for monitoring activities. • Verify that sufficient funds are available to properly implement the ESMMP-CP. • Review and approve the SS-ESMMP-CPs; • Act as main point of contact between the GOL authorities and the Project on environmental issues; • Review and improve method statements for environmental aspects prior to work starting; • Verify that tender documents and civil works contracts include the Project ESMMP-CP and specify requirement for preparation and implementation of construction SS-ESMMP-CP; • Identify environmental and health and safety competence requirements for all staff, including contractor personnel, working on the project and facilitate delivery of environmental training; • Monitor construction performance to verify that appropriate control measures are implemented to comply with the ESMMP-CP; • Recommend corrective action for any environmental non-compliance incidents on the construction site, and provide advice and liaison with the construction teams to ensure that environmental risks are identified and appropriate controls are developed; • Compile a regular report addressing environmental performance progress and any non-compliance issues to relevant parties, including submitting semi-annual monitoring reports to ADB through the ESD; • Provide the data and information to the lenders' environment specialist tasked to audit the environmental performance of the completed access road. This data and information include the approved ESMMP-CP, SS-ESMMP-CPs, proof of delivery of training program, environmental monitoring reports, engineer's logbook, records of compliance check, contractor's report on environmental performance and incidents, environmental register of all incidents that occurred on the site during construction. • Inform affected parties of any changes to the construction program. The contact numbers of the EO shall be made available to the affected parties. This will ensure open channels of communication and prompt response to queries and claims; • Establish an environmental grievance redress mechanism that is acceptable to ADB, to receive and facilitate resolution of affected peoples' concerns, complaints, and grievances about the Project's environmental performance; and • Liaise and cooperate with GOL authorities responsible in arranging for adequate meeting and reporting to GOL authorities on a regular basis.
Construction Contractor	• Recruit a qualified Environmental Officer on a full-time basis to manage compliance with contractual environmental obligations and implementation of the SSESMMP-CP; • Develop and implement the Construction Contractor's Environmental Management Plan (Construction Contractor's EMP) and SSESMMP-CPs to comply with Project commitments (i.e. Owner's EMP and ESMMP-CP); • Plan and direct construction activities to minimize environmental impacts and comply with environmental management procedures, license and approval requirements;

Role	Responsibilities
	• Verify the implementation of all applicable mitigation measures defined in the SSESMMP-CP during construction of road, bridges and culverts, and associated facilities; • Liaise with EMO to facilitate implementation of environmental mitigation measures; • Provide adequate resources to implement the Construction Contractor's ERM and SSESMMP-CP; • Implement routine inspection and monitoring program, including undertaking the contractor's weekly environmental monitoring; • Implement a process of corrective and preventive action for non-compliance identified through internal and external inspections and audits; • Implement additional environmental mitigation measures where monitoring or other observations indicate opportunities for improved environmental management; • Submit monthly reports to ESD/EMO on the implementation of environmental mitigation measures and environmental monitoring results; • Maintain an environmental register which keeps a record of all incidents which occur on the site during construction and report environmental incidents to Owner; • Manage safety of construction workers and local people during construction; • Receive and manage complaints from the public in accordance with the GRM; and • Facilitate the restoration of community facilities and provision of temporary canals/irrigation channels to avoid disruption of water supply to farmlands.
All Project personnel	• Protecting the environment by implementing relevant aspects of the EMP and ESMMP-CP

Figure 8-1 Project Institutional Structure



8.1.2 Government of Lao PDR Institutional Arrangement

The GOL will establish the national level organizations responsible for setting policy and directions, supervising and monitoring the development of the Project. The project will provide resources so that these organizations can effectively monitor the implementation of the Project's environment and social management programs.

The roles of the GOL at the national level will be provided through the Joint Steering Committee (JSC) and the Ministry of Natural Resources and Environment (MONRE) as the primary supervisory and monitoring body. A Secretariat of the JSC will include key government agencies and organizations involved in the environmental and social components of the Project, specifically EdL, the Department of Environmental and Social Impact Assessment (DESIA) of MONRE, the Department of Energy Business (DEB) of the Ministry of Energy and Mines, and the Resettlement Management Unit (RMU) established for this project.

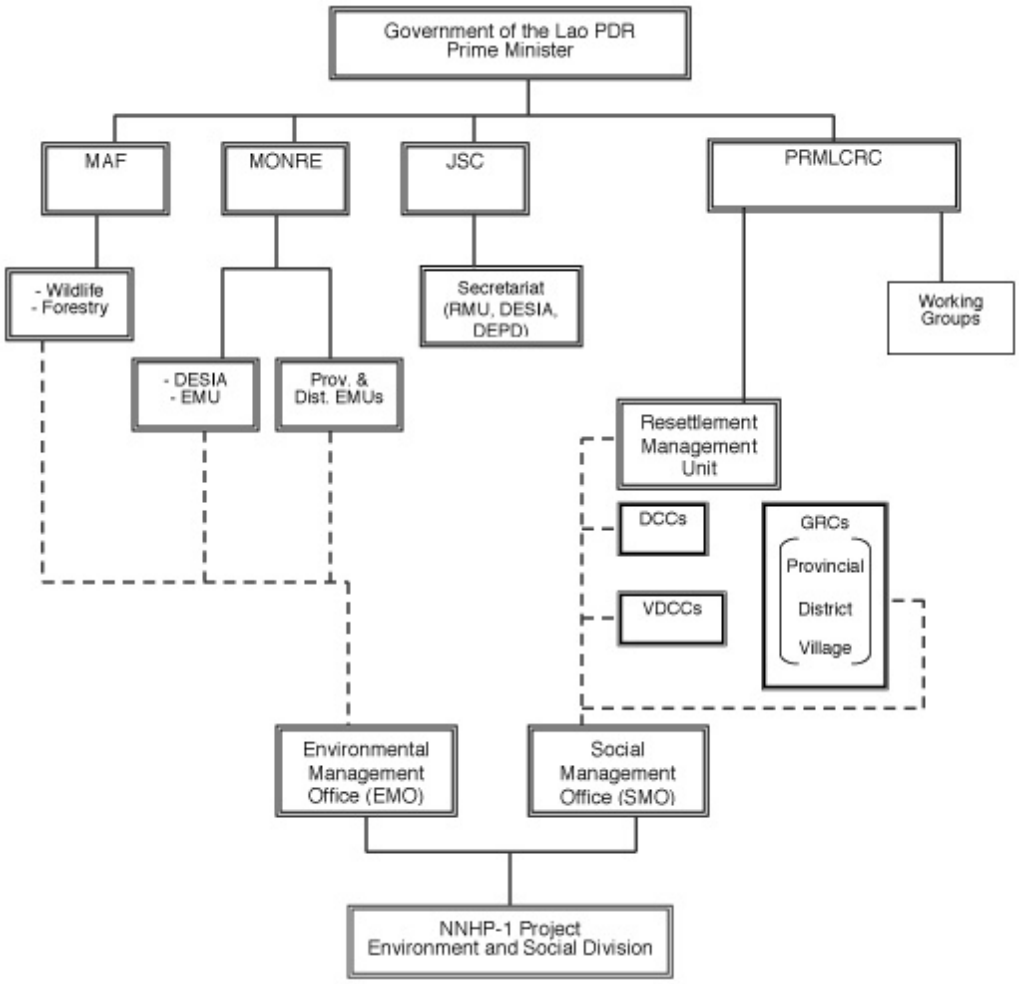
An Environmental Management Unit (EMU) will be established in MONRE to oversee monitoring of the project. Environmental components will be carried out by relevant government agencies in MONRE and in the Ministry of Agriculture and Forestry (MAF). Provincial and District EMUs will be established, consisting of the heads of the relevant government offices for the various environmental aspects of the Project.

A Provincial Resettlement and Living Restoration Committee (PRLRC) has been established to be the lead organization in approving policies and plans, entitlements, and activities, and supervising and monitoring the implementation of social measures, including resettlement, and to provide the mechanism for public involvement, for decisions on compensation, and for the expression and resolution of grievances.

A Resettlement Management Unit (RMU) will be established by the PRMLCRC to coordinate the work of the government in resettling the most severely affected people in the project area, together with the technical assistance, financial support, and related work of the project developers through the Project's Environment and Social Division.

Figure 8-2 shows the relationship between the Project institutional structure and the relevant departments of the GoL.

Figure 8-2 Relationship between Project team and GoL



8.2 ENVIRONMENTAL MEASURES

Environmental management for the Project aims to minimize the negative impacts of the transmission line construction and at the same time, enhance the positive and beneficial impacts.

Table 8.2 presents the mitigation measures of transmission line construction. These mitigation measures are an overview only, based on the potential impacts identified in this IEE. Prior to construction, an Environment and Social Management and Monitoring Plan for the Construction Phase (ESMMP-CP) will be prepared which provides further detail on the implementation of the environmental management. The ESMMP-CP will include a series of sub-plans specific to environmental themes identified in this IEE.

Prior to construction, the construction contractor will develop a suite of Site-Specific ESMMPs which address specific segments of the RoW, based on site conditions (e.g. proximity to villages, waterways and natural habitats).

Table 8.2 Environmental Management Measures

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Design and Pre-construction Phase						
Hydrology	If poorly designed, the presence of bridges has the potential to disrupt stream flows.	• River diversion and bridges will be designed to maintain pre-construction flows, including by designing the bridge to: minimize the use of pylons to retain the existing channel section; operate with a freeboard between the flood level and bridge deck, avoid encroachment of bridge abutments into the channel.	Bridges and in-stream works	At commencement of design phase	Civil Engineers	Deputy Managing Director (EC)
Hydrology	Creation of hardstand areas can increase the velocity of surface run off and lead to erosion.	• Drainage will be designed to safely convey runoff from developed areas at non-erosive volumes and velocities.	All hardstand areas.	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Water Quality	Poor siting of towers, material stockpiles, worker camps and access roads, can lead to: • High levels of erosion and sediment run off, which may increase turbidity of surface waters; • Contaminated run off from waste and hazardous materials storage areas; and • Leaching of sewage and domestic waste from camp and construction areas.	• Construction in steep areas and watercourse crossings will be minimized. • Adequate waste and materials storage areas will be provided for in the site layout. • Material stockpiles will be located at least 30 m away from steep slopes, watercourses or drainage paths. • Solid and septic waste management systems will be planned for in the design process.	All construction areas	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Noise	Noise from transmission lines could disturb people if sited near villages or other areas of frequent	• Refine transmission line route to avoid villages and critical habitat for noise-sensitive species.	Transmission line	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Biodiversity	Loss of natural and modified habitat due to vegetation clearing	• A habitat/flora assessment will be undertaken within proposed transmission line route and proposed access roads to identify areas of natural habitat and locations of threatened flora species. • The design and layout plan will be prepared to minimise tree cutting and to avoid any identified areas critical habitat and threatened flora. • A transmission line route was selected to avoid intersecting Huay Ngua PPA.	All construction areas	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Biodiversity	Some residual impacts will not be able to be avoided through the measures outlined in this EMP. These impacts are to be offset.	• Implement the recommended offset package outlined in the Biodiversity Offset Design Report (ERM 2013).	Offset areas designated in Biodiversity Offset Design Report (ERM 2013)	Beginning in design phase.	Deputy Managing Director (EC)	Deputy Managing Director (EC)
Biodiversity	Bird and bat mortality due to electrocution	• Transmission lines will be designed to minimise risk of electrocution, including maintaining a 1.5 m spacing between energised components and grounded hardware, or covering energised parts.	Transmission Line	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Land Use	Inappropriate layout design can lead to unnecessary, avoidable impacts to existing land uses and subsequent impacts to livelihoods.	• Locations of infrastructure, including permanent infrastructure, will be selected to minimize the acquisition of productive land as far as practicable. • A compensation process will be developed and compensation will be provided for the loss of property during the construction phase.	All areas to be acquired.	Beginning in design phase.	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Community Health and Safety	Potential for aircraft collision, or interference with radar equipment.	• Transmission lines and towers will be sited outside of known flight path envelopes where possible; and • If installation is required in flight sensitive areas, buried lines will be used.	Transmission Line	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Community Health and Safety	Potential health impacts due to exposure to electromagnetic radiation.	• Site transmission lines and other high voltage equipment away from residential properties and areas of high human occupancy (e.g. schools). • Evaluate potential exposure levels and assess against the	Transmission Line	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
		standards provided in Annex *B*.				
Public Property	Transmission lines may impact visual amenity, which can be undesirable to residents.	• Powerlines will be sited in consultation with the community, and with due consideration of landscape views. • Changes to property values due to powerline proximity will be assessed, and appropriate compensation will be provided.	Transmission Line	Beginning in design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)
Construction Phase						
Capacity of Personnel	Project workers fail to implement EMP due to lack of understanding and competencies in environmental skills and awareness.	• Development and provision of environmental induction and regular training for all workers. • A training register containing details and name of training session; date of training session; list of attendees; and signatures and name of trainer will be properly maintained. • The key messages of each training session will be communicated to workers via poster and leaflet form in proper language. In addition, posters will be displayed prominently in construction work camps and construction areas and leaflets will be distributed to staff on a regular basis.	Training and Induction Centre	Prior to personnel commencing work	EM/EO	Deputy Managing Director (EC)
Hydrology	Naturally occurring flooding may cause a risk to the Project, and the presence of construction equipment and materials may exacerbate the risk to surrounding communities. Since the flood flow is fast and high volume, loose materials and equipment might get swept downstream and potentially cause some damage to structures and harm local people.	• A Flood Response Plan will be prepared and communicated as part of the Training and Awareness Program. • Construction materials and chemicals will be secured and locked down during flooding season. • If stream diversion, or flow inhibition is required during in-stream works, the construction contractor must understand the emergency flood plan, and be aware of increased waterway capacity in order to release the excess volume of water.	All construction areas	Wet season	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Hydrology	Temporary diversion of rivers for in-stream works (potentially required for access road construction) impacting hydrology, aquatic biota, and potentially access of villagers to water resources.	• If river diversion is expected to alter flows to an extent that would lower the downstream water level, local people will be informed of changes to water levels, including expected extent and duration of change.	Construction site - watercourses	Prior to river diversion	CC	EM/EO
Hydrology	Earthworks required for tower footprints, access roads, stockpile areas and other infrastructure may alter the flow of surface runoff.	• Earthworks will be undertaken to minimize changes to surface water flows, and to avoid collecting standing water.	All earthwork sites	Prior to and during earthworks	CC	EM/EO
Water Quality (Erosion and Sediment)	Erosion and sediment run off from construction activities that expose or move soil. Release of sediment laden effluent during construction, for example drilling wastes.	• Clearing and earthworks will be undertaken in the dry season to minimize erosion and subsequent release of sediment; • The period of soil exposure will be minimized by phasing clearing and construction activities, and covering exposed areas (for example by planting fast growing ground cover or covering with riprap, sand bags, erosion mats, bale dikes, mulch, or excelsior blankets) at the earliest time possible. Exposed areas of stream banks will be covered immediately, and preferably be replanted with locally native herbaceous and woody vegetation. • For areas in direct runoff path to a watercourse, sediment and erosion control devices will be installed and maintained until vegetation replanting can occur to stabilise disturbed surfaces; • Stockpile materials (excavated soil, quarry materials etc.) will be located at least 30 m away from steep slopes, watercourses or drainage paths. • Sediment trap will be installed in between the stream and the stockpile to control runoff where necessary.	All construction areas	Throughout construction	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
		• Water quality will be monitored regularly, and if found to exceed standards defined in Annex *B*, additional water quality measures will be implemented.				
Water Quality (Erosion and Sediment)	Erosion and sediment released from stream bed and bank disturbance during instream works (for example watercourse crossings of access roads).	• If vegetation clearing is required on stream banks, cut vegetation near or at ground level to leave root mass in the ground. This helps to reinforce soil stability and reduce erosion. • If in-stream diversion is required during bridge construction, any diversion infrastructure must be clean and made of suitable materials that will not contribute to turbidity or salinity. • At watercourse crossings, machinery will operate from stream bank, not the stream channel, whenever practicable with minimal streambed disturbance. All disturbed streambeds will be returned to their original condition or better as soon as possible. • Water quality will be monitored regularly, and if found to exceed standards defined in Annex *B*, additional water quality measures will be implemented.	Watercourse crossings.	During bridge construction	CC	EM/EO
Water Quality (Erosion and Sediment)	Sediment runoff from material stockpiles, including soil stockpiles during earthworks.	• Soil removed and stockpiled during earthworks will be stabilized and constructed with smooth slopes and free drainage patterns. • Stockpile materials will be located at least 30 m away from steep slopes, watercourses or drainage paths. • Ridges may be created on topsoil stockpiles to provide for the moisture retention to assist re-growth and slow runoff. • Sediment trap or other measure will be established to capture sediment runoff. • Sediment or retention ponds will be installed to receive leaching from the spoil at the end of the drainage lines prior to discharge to the watercourse.	Material stockpiles.	Throughout use of spoil and borrow area.	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Water quality (Effluent)	Pollution in effluent from construction sites (point source).	• Prior to operation of concrete batching plants and casting yards, the contractor shall install wastewater treatment systems that have the capacity to treat wastewater to a quality compliant with relevant standards (refer to Annex *B*); and • Wastewater from site activities such as concrete cutting, drilling or excavation will be appropriately treated prior to discharge. • Sediment or retention ponds will be installed to receive drainage water and runoff water from plant before discharge. • Discharge will be immediately stopped if the quality is not compliant with requirements. • Spill respond kit will be provided to prevent spilling and contamination	All construction areas.	During construction	CC	EM/EO
Water Quality (Effluent)	Deterioration in surface water quality when effluent from worker camps untreated.	• Solid and septic system waste management systems will be installed and maintained in good working order. • Septic tanks will be installed to treat domestic wastewater generated from camp. • To avoid water pollution caused by the rubbish and waste, regular waste collection will be provided. • Separate wastewater from runoff water drainage. • Sediment or retentions ponds will be installed to receive runoff water from worker camp before being discharge off-site. • Effluent water monitoring program will be routinely conducted and sampling locations, parameters specified in applicable standards will be identifies.	Worker Camps	Throughout operation of worker camp	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Water Quality (Hazardous Materials)	There is potential for hazardous materials (including paints and solvents, petroleum products, concrete curing and repair compounds, and contaminated wastes) to be released to the environment, particularly during storage and handling, and equipment/vehicle maintenance.	• Hazardous materials will be stored in the suitable storage location such as close area, bund, water trap with open-close valve. • Only minimal chemicals, hazardous substances and fuel will be stored on site works. • Whenever feasible, mobile fueling/maintenance units will be used for construction equipment to avoid/reduce on-site fuel/lubricant storage. • Hazardous waste will be disposed of according to the most appropriate best practices. Discharge of hazardous wastes (including contaminated water) to the environment is prohibited. • Any release of hazardous material will be cleaned up as soon as practicable.	Refuelling sites, hazardous material storage areas.	Throughout construction period.	CC	EM/EO
Air quality	Dust emissions from exposed soils, transport of materials and increased traffic.	• Restricting vehicle movement to designated access routes; • Covering all loads; • Watering exposed surfaces during windy conditions; • Daily monitoring of dust levels through visual inspection; and • Implementing measures to limit vehicle speeds, particularly around sensitive receptors, for example by installing speed bumps. • All vehicles will be washed or cleaned before leaving the site, when appropriate. . • Stockpiles will be located to avoid wind dispersion of dust. • Blasting will be avoided in windy conditions.	All construction areas	Throughout construction period	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Air quality	Chemical pollutants from road vehicles and equipment.	• Vehicles and equipment will be regularly maintained and serviced in accordance with manufacturer's specifications. • All vehicles engines will be switched off when stopped, and vehicles will not be left idling. • Air quality will be monitored near villages. • Air monitoring program will be routinely conducted and sampling locations, parameters specified in applicable standards will be identified. • PPE for emission protection will be provided to all workers working in activities generating emission and any workers who requests PPE.	Vehicles and all construction areas where vehicles and equipment are operating	Throughout construction period	CC, EM/EO	EM/EO
Noise and Vibration	Increased noise and vibration levels may disturb local residents and fauna, and can present a risk to personnel.	• All noise and vibration generating construction equipment shall be operated with appropriate sound dampening equipment. • Construction equipment and vehicles will be subjected to regular inspections to check noise emissions and noise control equipment. • Stationary noise sources will be positioned to avoid impacts to sensitive receptors. • Hearing protection will be made available for all construction personnel and required for personnel working in areas with noise above 80dB. • High noise activities, such as blasting, will be carried out only within the hours of 6am to 7pm, and residents should be informed of these activities. • The contractor will maintain communication with any schools within 3 km of the Project area, and will avoid high noise activities during school hours.	All construction areas	Throughout construction period	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Biodiversity	Loss of natural and modified habitat due to vegetation clearing	• 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 violate rules and regulations; • The planned clearance area for the construction works shall be clearly identified and marked to avoid accidental clearing; • Disturbed areas shall be rehabilitated as soon as possible following construction activities; • Construction Contractor will establish biological resource management program and management plan to manage the construction activities to be conducted and monitor compliance with relevant permits and environmental regulations in order to prevent potential impacts to terrestrial ecology, in particular, vegetation and wildlife; and • In natural habitat areas to be cleared, microhabitat features such as hollow logs will be relocated to adjacent natural habitat areas rather than being destroyed where possible.	All construction areas	Design phase	Civil Engineers, Deputy Managing Director (EC)	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Terrestrial Biodiversity	Degradation of habitat	• The measures outlined in this document relating to hydrology, water quality, air quality and noise and vibration, will be implemented. • Construction and domestic waste will be appropriately stored and disposed of to avoid attracting native and alien species to the construction areas; • For areas in direct runoff path to a watercourse, sediment and erosion control devices will be installed prior to commencement of vegetation clearance or earthworks and maintained until vegetation replanting can occur to stabilise disturbed surfaces; • Monitoring of erosion and sediment control will be conducted to inspect the proper function of devices; • Oil, chemical and solid waste will be stored, and handled and disposed of by appropriately licensed waste management contractors; • Weed and pest management measures should be implemented in accordance with a Project weed and pest management plan to avoid introduction of weeds to natural and modified habitat areas; • Weed and pest management measures should be implemented in accordance with a Project weed and pest management plan to avoid introduction of weeds to natural and modified habitat areas.	All construction areas.	Throughout construction period.	CC, EM/EO	EM/EO
Terrestrial Biodiversity	Fauna mortality	• Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to minimise potential for fauna strike; • Commitment will be made to raise awareness of values of natural habitat areas to personnel and arrangements will be made for restriction of poaching and forest product collection; • Hunting wild animals will be strictly prohibited to apply for all staff;	Rules apply to all personnel in any location while working for the Project.	Throughout construction period.	CC, EM/EO	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
		•				
Terrestrial Biodiversity	Disturbance to fauna behaviour	• Construction vehicles and machinery will be maintained in accordance with industry standard to minimise unnecessary noise generation; • Traffic signs will be installed on all roads throughout construction areas depicting speed limits; • For construction and operation areas requiring night-time lighting, lights will be used only where necessary and will be directed toward the subject area and away from habitat areas where possible; and • Commitment will be made to raise awareness of values of natural habitat areas to construction work force and make arrangements for restriction of poaching.	All construction areas.	Throughout construction period.	CC, EM/EO	EM/EO
Terrestrial Biodiversity	Impacts to threatened species	• General biodiversity measures contribute to the conservation of threatened species. In addition: • If threatened flora species are identified within the Project Area, these will be specifically managed within the Biodiversity Action Plan and replanting or propagation may be appropriate. • The training and awareness program will highlight the threatened species with potential to occur in the Project Area to further discourage hunting.	All construction areas.	Throughout construction period.	CC, EM/EO	EM/EO
Terrestrial Biodiversity	Some residual impacts will not be able to be avoided through the measures outlined in this EMP. These impacts are to be offset.	• The recommended offset package outlined in the Biodiversity Offset Design Report (ERM 2013) will be implemented.	Offset areas designated in Biodiversity Offset Design Report (ERM 2013)	Beginning in design phase.	Deputy Managing Director (EC)	Deputy Managing Director (EC)
Aquatic Biodiversity	Degradation of habitat	• Water quality and hydrology measures will be implemented.	All construction areas, and specific measures for	Throughout construction period.	CC, EM/EO	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
			bridges.			
Aquatic Biodiversity	Mortality	• Fishing and using of illegal fishing gear anywhere along the river will be prohibited.	Rules apply to all personnel in any location while working for the Project.	Throughout construction period.	EM/EO	Deputy Managing Director (EC)
Land Use	Removal of productive land (temporary and permanent)	• Livestock in affected areas will be relocated, where necessary; • Productive land acquisition for the road alignment will be minimized as far as possible, and where unavoidable, compensation for the loss of property will be provided to the affected people; • A separate Resettlement Plan will be prepared to address land acquisition and compensation issues, and will be reviewed by the Provincial Resettlement Management and Living Conditions Restoration Committee.	Construction areas within productive or privately owned land.	Prior to commencement of construction in each area.	EM/EO	Deputy Managing Director (EC)
Land Use	Potential for resettlement of individual families or communities.	• In the unlikely event that resettlement is required, the provisions of the Technical Guidelines on Compensation and Resettlement in Development Projects of the Lao PDR concerning resettlement and compensation will be followed strictly.	Acquired land and resettlement site	Prior to construction	EM/EO	Deputy Managing Director (EC)
Economy and Livelihoods	Construction of the transmission line and associated infrastructure will provide employment opportunities to local people.	• NNP1PC will carefully manage labor conditions. • The construction contractor will hire local people during construction where local people have the required skills and experience. • Training in health and safety and technical areas will be provided to all personnel.	All construction areas.	Prior to and during construction.	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Damage to Property	Potential disturbance of/damage to property and community facilities.	• When constructing in the vicinity of irrigation and drainage channels, channels will be pegged and marked out to avoid unnecessary disturbance. • If irrigation/drainage channels are to be intersected by Project infrastructure, they will be reinstated in the final infrastructure design. For example, if interrupted by a tower pad irrigation channels will be re-routed around the pad; if intersected by an access road, pipes will be installed below ground to maintain flow. • The contractor will immediately repair and/or compensate for any damage caused by the project to properties and community facilities.	All construction areas.	As required.	CC	EM/EO
Community Health and Safety (Disease)	Possible increase in disease transmission.	• A public health education campaign will be provided, addressing: hygiene, disease prevention (including transmission pathways and symptoms of relevant diseases) and basic health promotion. The program will be designed and implemented in consultation with district and local health authorities. • Impregnated mosquito nets need will be provided to the local communities. Treatment programs and rapid diagnostic testing will be provided in cooperation with health authorities, including volunteer health workers. • Latrines will be provided for each household in the Project area so that villagers have access to clean and safe water as soon as possible and preferably prior to commencement of construction.	Villages and households	Prior to and during construction phase.	Deputy Managing Director (EC)	Deputy Managing Director (EC)
Community Health and Safety (Flood)	Naturally occurring floods may move loose construction equipment and materials, potentially causing accident or injury to the community, and damaging property.	• Construction materials and chemicals will be secured and locked down during flooding season.				

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Occupational Health and Safety (Accident and Injury)	Potential for accident and injury during construction.	• A Health and Safety program will be developed and implemented which includes an initial safety induction for all employees, on-going safety awareness and an incident reporting system. • First aid kits will be readily accessible by workers and trained first aid teams will be assigned to work sites.	All construction areas	Throughout construction period.	CC	EM/EO
Occupational Health and safety (Disease)	Health Risks due to lack of health and sanitation conditions through disposal of sewage on open land which may cause mosquito nuisance, water borne diseases, etc. Chances of spread of sexually transmittable diseases, including AIDS.	• Toilet facilities and sewage treatment systems will be installed at worker camps prior to use. • First aid equipment/facilities will be provided at worker camps and work areas. • Education and awareness programs will be provided addressing disease prevention and treatment. • Mosquito wire screen and net will be installed at high use areas, including offices, canteens and bedrooms. • Hygienic drinking water will be provided.	Worker camp and all construction areas	Throughout construction period.	CC	EM/EO
Health and Safety – community and personnel (UXO)	UXO events result in injury or death, and causes serious loss and destruction of property.	• A UXO survey will be undertaken following finalization of alignment, and UXO clearance will occur for the construction area. • All construction activities will occur within the UXO clearance boundary.	All construction areas	Prior to construction	Owner	GOL's representative
Health and Safety – community and personnel (Geology)	Landslide and rock movement may be induced, particularly along steep slopes around the construction site along riverbank, borrow areas, spoil disposal areas and quarry.	• The potential for and monitoring of landslides and rock movements around the Project site will be investigated during construction. • If there are any sections along the access road that may have landslide and rock movement problems, the construction contractor will address the problem before further construction. • Routine inspection of the construction areas will be undertaken.	Steep areas	Throughout construction period	CC, Owner	Owner

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Culture and Customs	Temporary migration of workers may influence local cultural and create social tension.	• The contractor will consult with local authorities to learn of any traditional practices and rules that need to be followed, and to coordinate in the enforcement of laws and regulations. • A code of conduct will be established and enforced to reduce the potential for conflict between local residents and migrant workers; • Any entertainment venues or recreational facilities in the vicinity of the project shall be operated strictly according to the local village values and traditions.	Applicable to all personnel while at worker camp and in villages.	Throughout construction period	CC, Owner	Owner
Physical Heritage	Increase in adverse impacts on cultural heritage and archaeological sites found in areas where access road is under construction.	• Construction activities will be undertaken in such manner as to avoid any physical effect on known sites of cultural or religious significance. • ESOs will be trained to identify potential sites or items of cultural significance. Construction workers will be trained in the appropriate reporting and communication procedures to be followed if they identify any potential sites or items and the importance of implementing these procedures • The Owner will employ a head of village who is familiar with cultural resources. • The following steps will be implemented in the event that previously unidentified artifacts are identified: i. The contractor shall immediately cease operations on road section where artifacts/archaeological finds are unearthed and immediately inform NNP1 Site Manager. ii. The Owner will consult the Head of Village and Culture and Tourism Administration Office to obtain advice regarding the next steps. • The contractor to recommence work only after the Culture and Tourism Office has provided official notification accordingly.	All construction areas.	Throughout construction period.	EM/EO	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Traffic and access	Hazards associated with the traffic movement in working areas during construction phase leading to property/equipment damage and injury to workers or nearby villagers.	• Transportation schedules will be arranged to avoid peak hours of road usage. • Traffic signs will be installed for all roads throughout construction areas. • Relevant traffic regulations will be implemented throughout construction areas. • Traffic speed regulation devices, such as speed bumps, and signage will be installed at sensitive locations including in the vicinity of villages, construction camps, at busy intersections or before the sharp bend, and in areas of high habitat value if necessary. • Prior to the movement of special loads on public roads, including hazardous materials or large items of including hazardous materials or large items of construction equipment, the ESMMU will be notified. If the ESMMU require additional measures, the reasonable and practical measures will be implemented to ensure that the risk of harm to the community and environment is minimized during transportation of special loads; • In cases where heavy loads are required to be transported, some segments of roads and bridges may be reinforced to withstand the load. • In the event that stringing conductors present a possible risk to traffic temporary barriers (such as bamboo scaffolds) will be constructed across the roads and rivers to protect the public and property.	All Project roads and public roads.	Throughout construction	CC	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Operation Phase						

Water Quality	The use of herbicides in RoW maintenance can lead to the release of herbicides into waterways via surface runoff.	• Vegetation management methods that minimize the application of herbicides will be used (refer to 'Vegetation Management' below); and
		• If the use of herbicides is required:
		  • Personnel will be trained on the safe and efficient application of herbicides;
		  • Herbicides will be applied in accordance with the manufacturer's directions and published reports on minimum effective dose;
		  • Herbicides will be applied using methods to avoid unintentional drift or runoff. For example, herbicides will not be applied on windy days.
		  • Herbicides will not be applied within 50 m of watercourses or drainage lines.
		• Herbicides will be stored and handles to minimize escape to the environment, including:
		  • Storing in a room with appropriate spill containment measures;
		  • Siting storerooms away from water resources and well heads; and
		  • Handling and disposing of storage containers as hazardous waste.
			RoW and herbicide storage locations.	Throughout maintenance period.	Maintenance Contractor	EM/EO

Air Quality	Air pollution due to burning of vegetation for RoW management.	• Vegetation will not be burnt.	All roads in Project site	Throughout operation period.	Maintenance Contractor	EM/EO
Noise	Noise pollution from transmission lines may disturb local residents and fauna.	• Where locating the RoW near human receptors and areas of natural habitat for noise-sensitive species is unavoidable, the use of noise barriers and noise cancelling acoustic devices will be investigated.	Transmission line within 1 km of natural habitat or villages.	Prior to operation.	Maintenance Contractor	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit

Biodiversity (Vegetation Management in RoW)	Degradation of habitat for RoW maintenance.	• The Project shall implement landscaping and re-vegetation using locally native species after completion of construction for any areas not required to be permanently cleared.
		• Vegetation management will aim to maintain low growing vegetation and only remove vegetation that may interfere with transmission line operation.
		• Trees greater than 3 m will be pruned.
		• Tall-growing tree species and invasive species will be selectively removed to encourage growth of low-growing native species.
		• If further ecological surveys identify endangered and critically endangered species that may breed in and around the RoW, maintenance activities will be scheduled to avoid breeding and nesting seasons for these species.
		• Clearing in riparian areas will be minimized. Vegetation removal within 10m of watercourse banks will be undertaken by hand to avoid the use of machinery in riparian areas.
		• The use of herbicides will be minimized by:
		  • Using mechanical weed control and pruning methods;
		  • Provide invasive species identification training to maintenance personnel to minimize application of unnecessary herbicides; and
		  • Using animals to graze areas where access needs to be maintains.
			RoW	Throughout maintenance period.	Maintenance Contractor	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Terrestrial Biodiversity	Fauna mortality	• Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to minimise potential for fauna strike. • Commitment will be made to raise awareness of values of natural habitat areas to personnel work force and arrangements will be made for restriction of poaching and forest product collection. • Transmission lines will be designed to minimise risk of electrocution, including maintaining a 1.5 m spacing between energised components and grounded hardware, or covering energised parts.	All roads in Project site, and training at induction and training location.	Throughout operation period	EM/EO	Deputy Managing Director (EC)
Terrestrial Biodiversity	Potential increased levels of hunting due to improved access to areas surrounding RoW.	• Strict rules against logging (other than required maintenance activities) and wildlife hunting and poaching will be imposed on all personnel engaged in or associated with the Project. Penalties will be 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. • Commitment will be made to raise awareness of values of natural habitat areas to construction and operation work force and arrangements will be made for restriction of poaching and forest product collection. • The Biodiversity Offset Plan will consider improved enforcement and security of offset areas.	Rules apply to all personnel in any location while working for the Project. Offset areas discussed in Biodiversity Offset Plan.	Throughout operation period.	EM/EO	Deputy Managing Director (EC)
Economy and Livelihoods	Ongoing maintenance of the RoW, particularly vegetation management, can provide employment to local residents.	• Local people will be employed for suitable roles wherever possible. • Appropriate health and safety measures will be undertaken to protect all Project personnel, as described in Section *4.3.8*.	RoW	Throughout maintenance period.	Maintenance contractor	EM/EO
Community Health and Safety	Aircraft collision, electromagnetic radiation, noise	• These impacts will be mitigated through appropriate siting of infrastructure. Refer to measures outlined for Design and Pre-Construction Phase.	Refer to measures outlined for Design and	Refer to measures outlined for Design and Pre-	Refer to measures outlined for Design and Pre-	Refer to measures outlined for Design and

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
			Pre-Construction Phase.	Construction Phase.	Construction Phase.	Pre-Construction Phase.
Community Health and Safety	Exposure to herbicides.	• The use of herbicides will be minimized. • If application of herbicides is unavoidable, application will not occur during windy or rainy weather. • The measures outlined under 'Vegetation Management' will be implemented. • Only herbicides that have been manufactured under license and approved by the appropriate authority in accordance with the Food and Agriculture Organization's International Code of Conduct on the Distribution and Use of Pesticides will be used.	RoW	Throughout maintenance period.	Maintenance contractor	EM/EO
Community Health and Safety	If vegetation within the RoW is uncontrolled, the transmission line could ignite a forest fire.	• Thinning and slashing will be scheduled to avoid the fire season. • Vegetative debris will be disposed of in locations that do not increase the fire risk. • Fuel breaks will be established to slow the progress of fires and allow firefighting access.	RoW	Throughout maintenance period.	Maintenance contractor	EM/EO
Community Health and Safety	Electrocution due to contact with high voltage electricity or items in contact with high voltage electricity (such as tools, vehicles or ladders).	• Signs and barriers will be installed to prevent access to high voltage areas. • Grounding conducting objects will be installed near transmission lines.	RoW	Throughout operation period.	Maintenance contractor	EM/EO

Occupational Health and Safety	Exposure to EMF at levels higher than those experienced by the general public.	• An EMF safety program will be developed prior to operation which:
		  • identifies potential levels of exposure;
		  • provides training for all workers;
		  • delineates zones appropriate for public access and those restricted to appropriately trained workers;
		  • defines measures to limit exposure time, such as through work rotation; and
			Transmission Line	Throughout operation period.	Operator	EM/EO

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
		• provides personal monitoring equipment for workers.				
Occupational Health and Safety	Electrocution due to contact with high voltage electricity or items in contact with high voltage electricity (such as tools, vehicles or ladders)	• Transmission lines will be deactivated and grounded prior to work on, or near, transmission lines. • Live work will only be conducted by appropriately trained workers.	Transmission Line	Throughout operation period.	Operator	EM/EO

Occupational Health and Safety	Working at height on towers.	• Fall protection measures will be implemented including:
		  • provision of appropriate fall protection equipment,
		  • training in use of equipment and climbing techniques, and
		  • rescue of fall-arrested workers.
		• All equipment, including hoisting equipment, power tools and tool bags, will be properly rated and maintained.
			Transmission Line	Throughout operation period.	Operator	EM/EO

Occupational Health and Safety	Exposure to herbicides and PCBs.	• Appropriate personal protective equipment (such as gloves and safety glasses) will be supplied to all personnel handling herbicides or potentially contaminated materials; • Training will be provided to all personnel in the appropriate application, hygiene and safety requirements for the use of herbicides.	RoW	Throughout operation period.	Operator	EM/EO
Rehabilitation Phase						
Hydrology	Changes to topography required for the construction phase can affect hydrology.	• Construction areas not required for operation or maintenance of the transmission line will be rehabilitated. • Rehabilitation areas will be graded to provide proper drainage and blend with natural contour with the land.	All construction areas.	Areas are to be rehabilitated as soon as they are no longer required for construction or operation.	CC, EM/EO	Deputy Managing Director (EC)

Environmental Aspect	Impact	Mitigation Measures	Location	Timeframe	Responsibility to implement	Responsibility to audit
Terrestrial Biodiversity	Loss or degradation of habitat	• Landscaping and re-vegetation will be undertaken after completion of construction using native species where possible, and based on advice provided by a suitably qualified botanist/ecologist; • Following grading, rehabilitation areas will be vegetated using plants native to the area, suitable for the site condition, and beneficial to wildlife. • Following abandonment, all yards, offices, and construction buildings, including concrete footings and slabs, will be removed from the site. • Where applicable, the following agencies will be consulted to determine the recommended plant species composition, seeding rates, and planting dates: Department of Natural Resources and Environment, Department of Agriculture and Rural Development. • Grasses, forbs, shrubs, and trees appropriate for site conditions and surrounding vegetation will be included in the plant list. Species chosen for a site will be matched for site drainage, climate, shading, resistance to erosion, soil type, slope, aspect, and vegetation management goals. Wetland and riparian species will be used in re-vegetating disturbed wetlands. Upland re-vegetation shall match the plant list to the site's soil type, topographic position, elevation, and surrounding natural communities.	All construction areas no longer required	Areas are to be rehabilitated as soon as they are no longer required for construction or operation.	CC, EM/EO	Deputy Managing Director (EC)

8.3 ENVIRONMENTAL MONITORING

Monitoring is an integral part of the environmental management system as it:

- verifies the implementation of environmental mitigation measures, in compliance with environmental management plans, contractual obligations and regulatory requirements;
- Identifies and measures impacts of Project activities;
- Identifies opportunities for corrective action.

The initial monitoring program based on the impacts and mitigation measures defined in this IEE is provided in *Table 8.3*. An updated monitoring program will be provided in the ESMMP-CP.

Monitoring in the construction period can be categorized in the following:

- At Contractor level, monitoring to ensure on a day to day basis that mitigation measures are fully implemented with construction activities, and that results observed comply with the contractual obligations and Contractor's SS-ESMMP;
- At Owner level, routine inspections to ensure that monitoring results provided by the Construction Contractor are corrected, to provide the necessary environmental coordination and interface with the Contractors, and to provide a comprehensive picture of the current environmental situation and efforts at site level.

8.3.1 Monitoring and Inspection by Construction Contractor

The Construction Contractor will employ suitably qualified inspectors, who will conduct routine inspections to evaluate compliance with commitments defined in the Construction Contractor's SSESMMP-CP.

Results of field observations, including documenting compliance or non-compliance, will be reported on standard forms to enable observations to be recorded in a consistent manner.. The information can be entered into the database that will be used to track the status of and allow analysis of non-compliance situations.

Monitoring activities will include verification of implementation of mitigation measures defined in the SS-ESMMP, as well as water quality, air quality, noise and vibration and biological monitoring. For ambient air, noise and water quality, sampling and analysis shall be carried out relying on certified equipment and/or laboratory.

8.3.2 Monitoring and Inspection by Owner

The Inspector or EO of the Owner will visit and inspect each of the construction sites at the frequency defined in the monitoring plan below. Information collected during each visit will be reported on a standard form, which provides a checklist of issues to control, depending on the degree of compliance or non-compliance observed. The Inspector or EO of the Owner may join inspection with Construction Contractor and relevant agencies e.g. GOL, and as agreed in order to observe and follow up any event or significant issues that have been reported. Visits to a site will be increased if the site presents a higher environmental risk potential.

Monitoring activities will include verification of implementation of mitigation measures defined in the ESMMP-CP, as well as water quality, air quality, noise and vibration and biological monitoring. For ambient air, noise and water quality, sampling and analysis shall be carried out relying on certified equipment and/or laboratory.

8.3.3 Internal Audit

Regular audits shall be carried out by internal auditors with the following experience:

- Expertise in environmental science and technology;
- Expertise in the technical and environmental aspects of construction phase of the project;
- Expertise in environmental law and regulation;
- Expertise in environmental management systems; and
- Expertise in auditing process.

The auditor will initiate scheduled audits of construction activities and the Construction Contractor's organization against the requirements established in the Contract Documents and the ESMMP-CP.

Internal Audits will be carried out every six months. Non-compliance identified during audits will be subject to corrective action.

8.3.4 External Audit

GOL's representative will regularly audit the Owner's management system and construction activities to verify compliance with contractual obligations. It is the responsibility of the Owner to provide available documentation, information and data requested by the auditor.

Non-compliance identified during audits will be subject to corrective action. The audit report will be submitted to the Owner for action.

Table 8.3 Environmental Monitoring Program

Environmental Aspect/Area to be concerned	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
				Implementing Unit	Monitoring Unit	
Design Phase						
Hydrology	Drainage will be designed to safely convey runoff from developed areas at non-erosive volumes and velocities.	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Hydrology	Bridge design to maintain hydrology	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Water Quality	Design to avoid works in watercourses, riparian areas and on steep slopes.	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Water Quality	Locate material stockpiles at least 30m away from steep slopes and watercourses.	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Water Quality	Provide for solid, liquid and hazardous waste storage and treatment in design of construction areas and worker camps.	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Hydrology	Flood Response Plan prepared to address the risk of flash flooding. This plan should be provided to all construction personnel.	Audit adequacy of Flood Response Plan	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Noise	Refine transmission line route to avoid villages and critical habitat for noise-sensitive species.	Confirm details in design specifications and contracts.	Once	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Biodiversity	A habitat/flora assessment will be undertaken within proposed transmission line route and proposed access roads.	Audit adequacy of assessment.	Once following assessment.	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Biodiversity	Design and layout plan to minimise tree cutting and protected area disturbance where possible.	Audit design and layout. Examine design and contract documents to confirm sufficient protection of biodiversity.	Once	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
Biodiversity	Transmission line design provides sufficient clearance to minimize risk of electrocution of birds and bats.	Audit design.	Once.	Deputy Managing Director (EC)	Deputy Managing Director (EC)	Project office
Biodiversity	Implement the recommended offset package outlined in the Biodiversity Offset Design Report (ERM 2013).	Verify progress of offset program.	Quarterly	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Land Use	Locations of infrastructure, including permanent infrastructure, will be selected to minimize the acquisition of productive land as far as practicable.	Verify that alternative alignments have been considered to minimize impact to productive land.	Once	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Land Use	A compensation process will be developed and compensation will be provided for the loss of property during the construction phase.	Verify that landowners have been compensated for loss of property and impacts to productivity.	Monthly until all compensation is paid.	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Community Health and Safety	Transmission lines and towers will be sited outside of known flight path envelopes where possible; and if installation is required in flight sensitive areas, buried lines will be used.	Verify that transmission lines are designed to avoid impacts to aircraft.	Once	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Community Health and Safety	Site transmission lines and other high voltage equipment away from residential properties and areas of high human occupancy (e.g. schools). Evaluate potential exposure levels and assess against the standards provided in Annex *B*.	Verify that transmission lines are located to produce exposure levels below those defined in Annex *B*.	Once	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Community Health and Safety	Preparation of flood response plan.	Verify flood response plan has been prepared.	Once prior to commencement of construction	Deputy Managing Director (EC),	Deputy Managing Director (EC),	Project office

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
				environmental consultant	environmental consultant	
Public Property	Powerlines will be sited in consultation with the community, and with due consideration of landscape views. Changes to property values due to powerline proximity will be assessed, and appropriate compensation will be provided.	Verify that suitable consultation has occurred and landholders have been compensated where necessary.	Once	Deputy Managing Director (EC), environmental consultant	Deputy Managing Director (EC), environmental consultant	Project office
Construction Phase						
Capacity of personnel	Provision of training and education.	Review training register to verify mandatory training has been attended.	Monthly	CC	EMO	Human Resources Office
Hydrology	Construction materials and equipment secured during flood season.	Visual verification that materials and equipment are secured.	Weekly during flood season.	CC	EMO	All construction areas.
Hydrology	Inform local people of changes to water levels due to in-stream works.	Construction contractor to record instances of changes to downstream water levels, and record contact with community representatives. Records to be verified.	Monthly.	CC	EMO	In stream works.
Hydrology	Earthworks undertaken to minimize changes to surface flows.	Visual verification of completed earthworks following rain events.	Once per construction area.	CC	EMO	All areas where earthworks are undertaken.
Water Quality (Erosion and Sediment)	Undertake clearing and earthworks in dry season.	Verification of construction schedule.	Monthly.	CC	EMO	All construction areas.
Water Quality (Erosion and Sediment)	Minimize period of soil exposure.	Verification of construction schedule.	Monthly.	CC	EMO	All construction areas.
Water Quality (Erosion and Sediment)	Installation of erosion and sediment control devices.	Visual verification.	Weekly	CC	EMO	All construction areas.

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
Water Quality (Erosion and Sediment)	Appropriate location of stockpile materials.	Visual verification.	Weekly	CC	EMO	All construction areas.
Water Quality (Erosion and Sediment)	Water quality monitoring.	Measurement of parameters defined in Annex *B*.	Monthly	CC	EMO	Water quality monitoring locations (to be defined following definition of final alignment).
Water Quality (Erosion and Sediment)	During works in riparian areas: avoid vegetation clearing, and if unavoidable, cut vegetation near or at ground level; machinery to operate from stream bank, not channel; and any diversion infrastructure must be clean.	Visual verification.	Once at each area of in-stream/riparian work.	CC	EMO	Watercourses.
Water Quality (Erosion and Sediment)	Stockpile management measures, including stabilization, drainage, righting and sediment traps.	Visual verification of stockpile stabilization, distance from watercourses and drainage paths and installation of sediment traps.	Monthly	CC	EMO	Stockpiles
Water Quality (Effluent)	Installation of wastewater treatment systems and sediment retention ponds. Provision of spill response kit.	Visual verification that systems are installed and in good working order, and that spill response kit is available. .	Monthly	CC	EMO	All construction areas.
Water Quality (Effluent)	Installation of solid and septic waste management systems. Installation of sediment and retention ponds.	Visual verification that systems are installed and in good working order	Monthly	CC	EMO	All construction areas.
Water Quality (Effluent)	Monitoring of effluent water quality.	Monitoring of parameters listed in Annex *B*.	Monthly	CC	EMO	All construction areas.
Water Quality (Hazardous	Appropriate storage and disposal of hazardous materials. Appropriate spills	Visual verification of appropriate storage and disposal. Verification that	Monthly	CC	EMO	All construction areas.

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
Materials)	clean up.	there are no unattended spills or leaks.				
Air quality	Daily monitoring of dust levels.	Visual assessment of dust level and implementation of further dust suppression if required.	Daily	CC	EMO	All cleared/exposed work areas.
Air quality	Dust suppression, including restricting vehicle movement to designated access routes; covering all loads; watering exposed surfaces during windy conditions; vehicle speed limits; cleaning of vehicles; avoiding blasting on windy days.	Visual verification that mitigation measures are implemented.	Weekly	CC	EMO	All cleared/exposed work areas.
Air quality	Vehicles switched off when stopped. PPE for emission protection provided to all workers working in activities generating emissions.	Verification of sample of vehicles and work areas.	Weekly	CC	EMO	Throughout construction area.
Air quality and Noise and Vibration	Regular maintenance of vehicles and equipment.	Review of vehicle and equipment log books to verify maintenance.	Quarterly	CC	EMO	All cleared/exposed work areas.
Noise and Vibration	Use of sound dampening equipment. Hearing protection available to personnel.	Visual verification of use of appropriate sound dampening equipment on machinery and use of hearing protection by all personnel in areas with noise over 80dB.	Monthly	CC	EMO	Throughout construction area.
Noise and Vibration	High noise activities carried out between 6am and 7pm, and not during schools days.	Verify monthly based on daily reports.	Monthly	CC	EMO	Throughout construction area.
Terrestrial Biodiversity	Vegetation clearing areas clearly marked. Microhabitat features relocated. Weed and pest management measures.	Visual verification of demarcation of clearing areas, and restriction of clearing to within defined area. Visual verification of relocation of microhabitat feastures, and	Weekly	CC	EMO	Throughout construction area.

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
		implementation of weed and pest management measures.				
Terrestrial Biodiversity	Delivery of training and awareness.	Discussion with sample of personnel to determine level of understanding of biodiversity values and management measures.	Monthly	CC	EMO	Throughout construction area.
Land Use	Compensation provided for loss of land and reduction in productivity of land.	Review of compensation cases to identify progress.	Monthly until all cases finalized.	EMO	EMO	Affected land.
Economy and Livelihoods	Employment of local people.	Verification of the number of local people employed, and identification of additional local employment opportuntiies.	Quarterly.	CC	EMO	NA
Damage to Property	Irrigation and drainage channels pegged and marked when working in vicinity.	Visual verification.	Weekly.	CC	EMO	Drainage channels in construction area.
Damage to Property	Irrigation and drainage channels reinstated in final design.	Visual verification.	Once, at completion of construction around each drainage channel.	CC	EMO	Drainage channels in construction area.
Community Health and Safety (Disease)	Delivery of public health campaign. Provision of mosquito nets, latrines and malaria treatment programs.	Review of implementation of public health program.	Monthly	EMO	EMO	Villages
Community Health and Safety (Flood)	Construction materials and chemicals will be secured and locked down during flooding season.	Visual verification of secured items.	Weekly during rainy season.	CC	EMO	All construction areas.
Occupational Health and Safety (Accident and Injury)	A Health and Safety program will be developed and implemented which includes an initial safety induction for all employees, on-going safety awareness and	Verify implementation of Health and Safety program.	Monthly	CC	EMO	All Project areas.

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
	an incident reporting system.					
Occupational Health and Safety (Accident and Injury)	First aid kits will be readily accessible by workers and trained first aid teams will be assigned to work sites.	Visual verification of availability of first aid kits.	Monthly	CC	EMO	All Project areas.
Occupational Health and safety (Disease)	Toilet facilities and sewage treatment systems will be installed at worker camps prior to use. Mosquito wire screen and net will be installed at high use areas, including offices, canteens and bedrooms.	Verification of provision of toilet facilities, sewage systems, mosquito screens.	Once at establishment of worker camp.	CC	EMO	Worker camps.
Occupational Health and safety (Disease)	Clean drinking water will be provided.	Monitor drinking water quality.	Monthly	EMO	EMO	Worker camps.
Occupational Health and safety (Disease)	Education and awareness programs will be provided addressing disease prevention and treatment.	Verification of delivery of education and awareness program.	Monthly	EMO	EMO	Worker camps.
Health and Safety – community and personnel (UXO)	A UXO survey will be undertaken following finalization of alignment, and UXO clearance will occur for the construction area. All construction activities will occur within the UXO clearance boundary.	Verification of UXO clearance.	Once, prior to commencement of construction.	EMO	EMO	All Project areas.
Health and Safety – community and personnel (Geology)	Monitoring of potential of landslides and rock movement.	Inspection of stability of steep slopes within, and in vicinity of construction areas by a qualified engineer.	Quarterly, and monthly during rainy season.	EMO	EMO	Steep slopes.
Culture and Customs	A code of conduct will be established and enforced to reduce the potential for conflict between local residents and	Supervisors to monitor employee behavior throughout construction period.	Ongoing	CC	EMO	All Project areas.

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
	migrant workers.					
Physical Heritage	Cease work if previously unidentified artifacts are identified.	Review cases of artifact detection and verify that action was taken in accordance with chance finds procedure.	Quarterly	CC	EMO	All Construction areas.
Traffic and access	Abide by traffic rules; appropriate road barriers applied to separate public traffic from construction areas.	Visual verification of driver behavior and road safety devices.	Monthly	CC	EMO	All Construction areas.
Operation Phase						
Water Quality	Herbicide application to minimize unintentional drift or runoff to watercourses.	Visual verification that herbicides are applied in accordance with mitigation measures defined in EMP.	Once during each maintenance period	EMO	EMO	RoW
Water Quality	Storage of herbicides with sufficient containment to avoid release to the environment.	Visual verification that herbicide storage prevents release to the environment.	Quarterly	EMO	EMO	Herbicide storage areas.
Noise	Where locating the RoW near human receptors and areas of natural habitat for noise-sensitive species is unavoidable, the use of noise barriers and noise cancelling acoustic devices will be investigated.	Monitoring of noise level at nearest residences, and a sample of natural habitat areas.	Quarterly.	EMO	EMO	Villages and natural habitat monitoring locations.
Biodiversity	Vegetation trimming will be restricted to that required to safely operate the transmission line. Use of herbicides minimised. Speed limits of 40 km/hr enforced.	Verify that mechanical and manual methods of vegetation management are being utilised where practicable, and that vegetation trimming is minimized.	At each vegetation management event.	EMO	EMO	RoW
Biodiversity	Training and awareness program delivered.	Discussion with a sample of personnel to determine level of understanding.	Quarterly	EMO	EMO	RoW
Community Health	Only herbicides that have been	Verify type of herbicides used.	Quarterly.	EMO	EMO	Herbicide

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
and Safety	manufactured under license and approved by the appropriate authority in accordance with the Food and Agriculture Organization's International Code of Conduct on the Distribution and Use of Pesticides will be used.					storage areas.
Community Health and Safety	Management of vegetation to limit fire risk.	Visual verification that: • Vegetation is not encroaching RoW and does not exceed 4.5 m height; • Fuel breaks are maintained; • Vegetative debris is disposed of in a location/manner that does not increase fire risk.	Quarterly	EMO	EMO	RoW
Community Health and Safety	Signs and barriers will be installed to prevent access to high voltage areas. Grounding conducting objects will be installed near transmission lines.	Visual verification of installation of signs and barriers, and grounding conducting objects.	Quarterly	EMO	EMO	RoW
Occupational Health and Safety	Implementation of fall protection measures.	Visual verification of the use of fall protection measures, and use of properly rated and maintained equipment.	Quarterly	EMO	EMO	RoW
Occupational Health and Safety	Appropriate personal protective equipment (such as gloves and safety glasses) will be supplied to all personnel handling herbicides or potentially contaminated materials; Training will be provided to all personnel in the appropriate application, hygiene and safety requirements for the use of herbicides.	Visual verification of use of personal protective equipment.	At each maintenance period.	EMO	EMO	RoW
Rehabilitation Phase						

Environmental Aspect/Area to be	Mitigation Measures	Monitoring method	Monitoring frequency	Responsible Unit		Location
Hydrology	Rehabilitation areas will be graded to provide proper drainage and blend with natural contour with the land	Visual verification of proper contouring and drainage.	Once, following completion of rehabilitation.	EMO	EMO	RoW
Biodiversity	Re-vegetation after completion of construction using locally native species.	Visual verification of tower sites following construction.	Once, or weekly until achieved, at each tower site following construction.	EMO	EMO	Tower sites

9 INDICATIVE BUDGET FOR IMPLEMENTATION OF THE EMP

The budget provided in *Table 9-1* covers the implementation of, and compliance with, NNP1PC's environmental obligations for transmission line construction and operation. The budget includes environmental monitoring undertaken by NNP1PC (both internally and outsourced). The budget is indicative only, and NNP1PC may fund any additional measures required from changes to the ECC, EMP, ESMMP-CP and ESMMP-OP; or other measures required to prevent or mitigate impacts to the environment which for any reason were not included in the initial budget.

Implementation of environmental controls during construction is the responsibility of the construction contractor. A budget for environmental measures implemented by the construction contractor will be provided in the contractor's EMP.

Table 9.1 Indicative EMP budget (Figures in US$)

Items	Tasks	Expenses	Labour
Implementation of EMP			
Design Phase			
Hydrology	Drainage Control Bridge Design Flood Response Plan	$8,000	$10,000
Biodiversity	Habitat Protection	$15,000	$18,000
Construction Phase			
Capacity of Personnel	Environmental Induction Training Preparation of Posters and Leaflets Provision of PPE	$5000	$20,000
Hydrology	Securing of hazardous materials Re-contouring of Quarries and barrow pits	$5000	$20,000
Water Quality and Erosion	Sediment and Erosion Control Controls for preventing spillage and clean-up of hazardous materials Septic Tank installation Design for Management of rubbish and waste	$35,000	$60,000
Air quality	Watering of exposed soil surfaces Washing and cleaning of vehicles	$30,000	$15,000
Noise and Vibration	Inspections of vehicles Provision of PPE	$5,000	$5000
Geology	Monitoring of landslides	$1000	$5000

Items	Tasks	Expenses	Labour
UXO	UXO Clearance	$15,000	$35,000
Hazardous management	Storage and handling of hazardous waste	$5000	$5000
Terrestrial Biodiversity	Training and Awareness Inspection of vehicles Wildlife protection procedure Speed signage Marking of habitats for retention	$10,000	$18,000
Cultural heritage and archaeology	Training and Awareness Employment of Head of Village Inspections for artifacts	$5000	$10,000
Health and safety	Construction of toilet facilities Sewage Treatment Awareness Program Mosquito Control Drinking Water First Aid equipment	$35,000	$15,000
Traffic and access	Education and Awareness Traffic signs	$15,000	$10,000
Operation Phase			
Air Quality	Road watering	$25,000	$5000
Terrestrial Biodiversity	Education and awareness on fauna strike Inspection of vehicles for fauna trafficking	$4000	$7500
Rehabilitation Phase			
Topography and Hydrology	Rehabilitation of disturbed areas Removal of all equipment and buildings	$150,000	$10,000
Terrestrial Biodiversity	Replanting of disturbed areas with native species	$15,000	$10,000
	SUB TOTAL	**$165,000.00**	**$20,000.00**
Environmental Monitoring Program (Calculated over the life of the project)			
Design Phase			
Hydrology	Confirm details of design specifications	$1000	$10,000
Terrestrial Biodiversity	Audit Design layout		$2500
Construction Phase			0
Capacity of Personnel	Review training register during weekly site audit		$15,000
Hydrology	Audit of Flood Plan during weekly site audit		$15,000

Items	Tasks	Expenses	Labour
Water Quality	Audit of planning documentation Water quality monitoring Audit of sediment and erosion control measures	$18,000	$15,000
Air quality	Audit of dust control measures during weekly site audit	$5000	$5,000
Noise and Vibration	Noise control monitoring	$5000	$15,000
Geology	Geologist/engineer inspection		$5000
UXO	Audit of UXO clearance		$5000
Hazardous management	Audit of hazardous materials storage and waste		$5000
Terrestrial & Aquatic Biodiversity	Audit of clearance works Confirm vehicle inspections		$15,000
Health and safety	Audit hygiene and PPE adherence by all personnel		$15,000
Traffic and access	Audit use of signage and traffic controls		$15,000
Operation Phase			0
Air Quality	Daily dust audit		$25,000
Terrestrial and aquatic Biodiversity	Audit of clearance works Confirm vehicle inspections		$25,000
Rehabilitation Phase			0
Topography and Hydrology	Audit of slope stability by geologist/engineer		$5000
Terrestrial Biodiversity	Audit of vegetation establishment and removal of plant and equipment/buildings/waste		$20,000
	SUB TOTAL	**$29,000**	**$212,500.00**
	TOTAL	**$419,000**	**$463,000**

10 CONCLUSION AND RECOMMENDATION

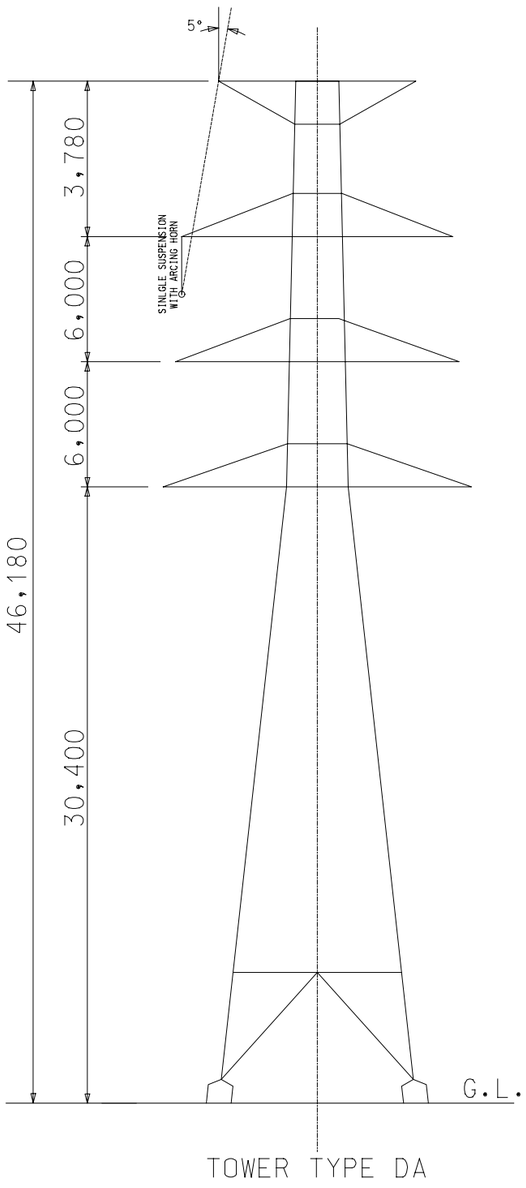
This IEE was prepared based on preliminary route alignment and assessment of alternatives, and has been assessed using information collected during biodiversity and social assessment for the NNP1 Project as well as other desktop sources.

This document provides a description of the baseline social and environmental conditions, a discussion of potential impacts and measures to minimize and mitigate those impacts. The document also introduces the Grievance Redress Mechanism and Consultation Process.

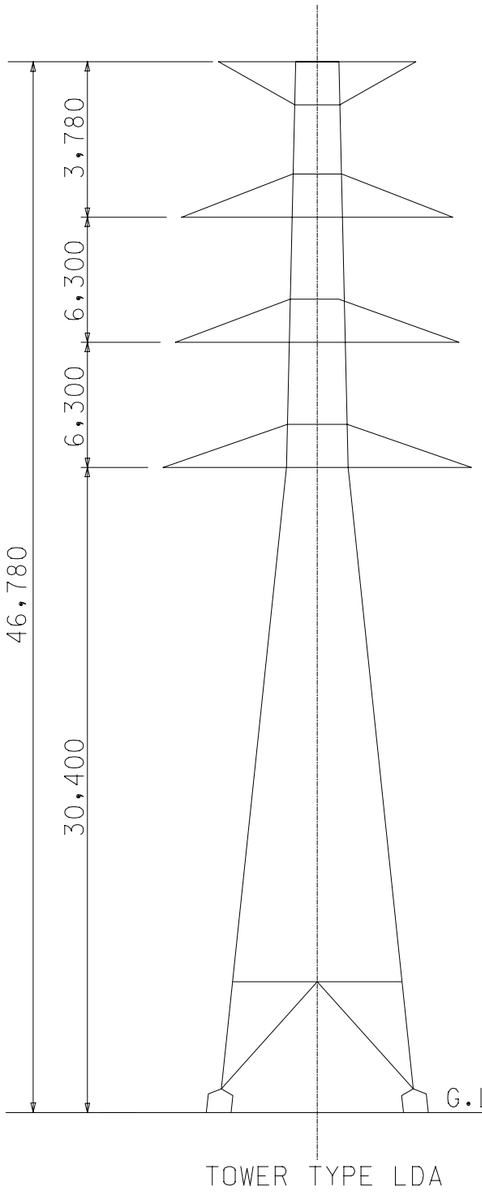
The IEE identified risks to the environment and local communities, including impacts to biodiversity, water quality, traffic and community health and safety. Management actions outlined in this document will be refined and developed further into the appropriate ESMMP-CP documentation that will be implemented to avoid and minimize the identified impacts. In the case of biodiversity, including threatened species, some impacts may be unavoidable and these will be offset through the approach provided in the BODR.

Annex A

Plans of Transmission Tower

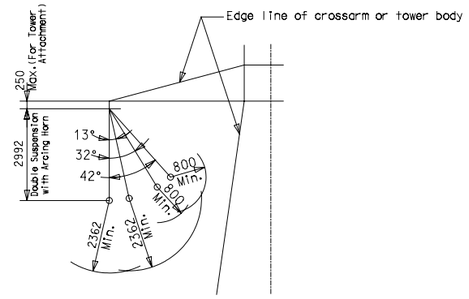


TOWER TYPE DA

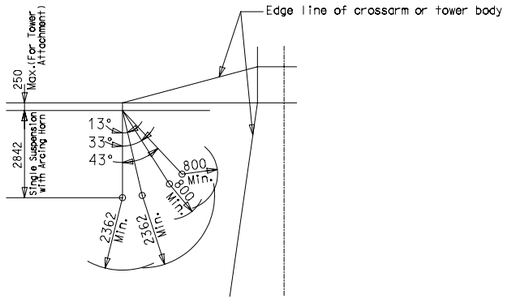


TOWER TYPE LDA

TOWER CONFIGURATION



Double Suspension String
(2X16 discs)
with Arcing Horn



Single Suspension String
(16 discs)
with Arcing Horn

ELECTRICAL CLEARANCE DIAGRAM

SAG AND ELECTRICAL CLEARANCE DATA

1. Sags of conductor and OHG.wire for normal span 430 m shall be as fellows
   a. Conductor : 1272 MCM ACSR/GA 33.91 mm diameter
      Sag at 25°C with wind pressure 69.2 kg/sq.m = 17.45 m
      at everyday temperature 25°C = 16.81 m
      at Max. Operating temperature 75°C = 18.77 m
   b. Overhead ground wire : 3/8" High Strength galv.steel.
      Sag at 25°C with wind pressure 69.2 kg/sq.m = 14.13 m
      at everyday temperature 25°C = 12.61 m
      at Max. temperature 40°C = 13.02 m
   c. Overhead ground wire : 70 sq.mm OPGW (10.5mm diameter)
      Sag at 25°C with wind pressure 69.2 kg/sq.m = 14.22 m
      at everyday temperature 25°C = 12.61 m
      at Max. temperature 40°C = 13.08 m
2. Tower design shall provide at least the following electrical clearances.

Insulator swing angle	Min. clearance- m
for single suspension	
0° to 13°	2.362 m
13° to 43°	0.80 m
for double suspension	
0° to 13°	2.362 m
13° to 43°	0.80 m

3. Overhead ground wire shall provide 5° protective zone (on conductor of single suspension string with arcing horn)
4. Tower application for tower type DA and LDA

	Tower Type DA	Tower Type LDA
Ruling span	430 m	430 m
Wind span	430 m	650 m
Weight span	550 m	1300 m
Line angle	0°-1°	0°-1°

5. Ground clearance and crossing clearance

Ground Clearance

Above street and highways, suburb and urban area	10.00 m
Above roads in rural districts	8.40 m
Above ground in areas accessible to pedestrains only	8.40 m
Crossing navigable river (above maximum water surface)	11.50 m

Crossing clearance

Telecommunication line	5.2 m
Supply line up to 33 kV and shield wire	3.50 m
Power lines 115 kV	4.30 m
Power lines 230 kV	5.80 m

NOTES

1. Clearance dimensions are minimum from surface of steel (not from member gage or working lines) to the nearest point on the conductor or hardware.
2. All dimensions are in millimeter except as noted.
3. All cable attachment device shall be supplied with tower, minimum proof loads shall be equal to those of hardware.

REV.NO.	JOB NO.	JOB DESCRIPTION	DRAWN	DESIGNED	VERIFIED	VALIDATED	RECOMMENDED	CONCURRED	APPROVED	DATE

THE KANSAI ELECTRIC POWER CO.,INC.
ELECTRICITY GENERATING AUTHORITY OF THAILAND
ROJANA INDUSTRIAL PARK PUBLIC COMPANY LIMITED

NAM NGIEP 1 HYDROPOWER PROJECT

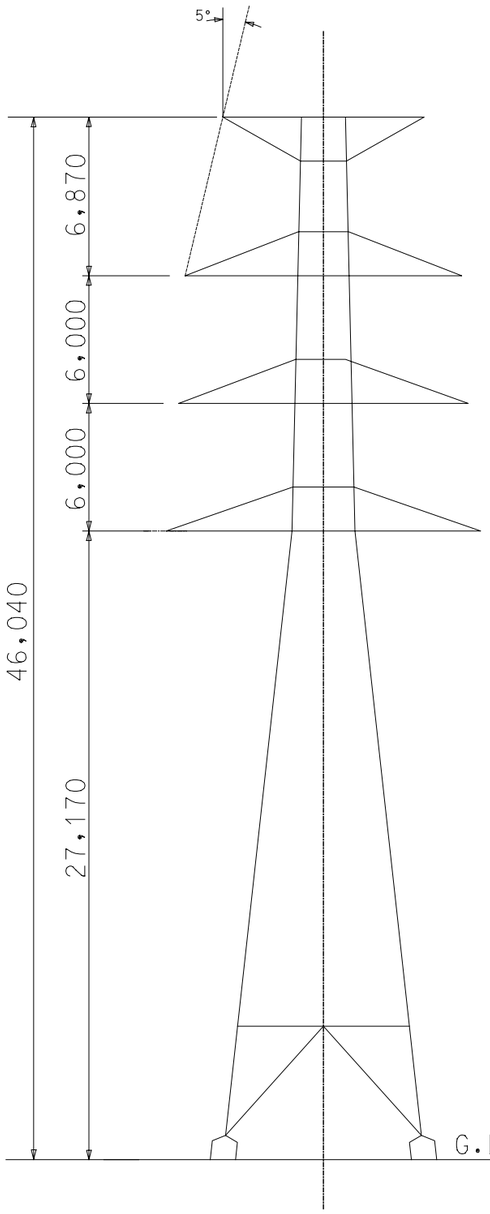
DRAWN	Sujanya K.	VALIDATED	
DESIGNED	Sujanya K.	RECOMMENDED	
VERIFIED	P. Pittak	CONCURRED	
APPROVED		DATE	

230 kV TRANSMISSION LINE

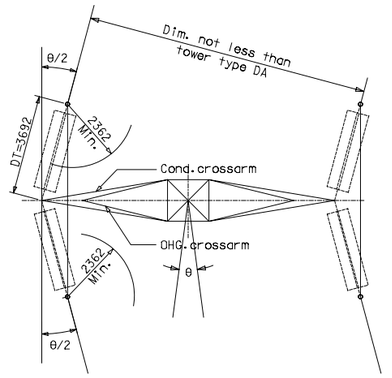
ELECTRICAL AND GROUND CLEARANCE FOR TOWER TYPE DA AND LDA

JOB NO.	REPLACING DWG.NO.	DWG.NO.	REV.
NNP1		NNP1-E-002	0

Filename : NNP1-E-002
Date July 24, 2007

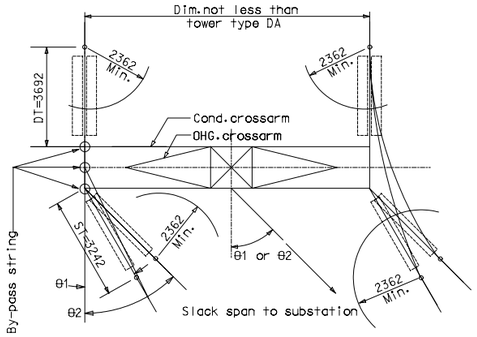


TOWER TYPE
DB, DC, DD, DE, AND DDE



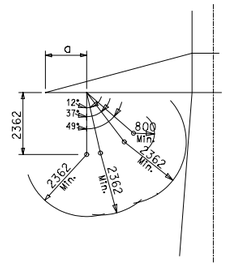
0°≤ θ ≤ 15° without by-pass string for both sides
0°≤ θ ≤ 30° without by-pass string for both sides

TYPICAL CROSSARM FOR TOWER TYPE DB & DC

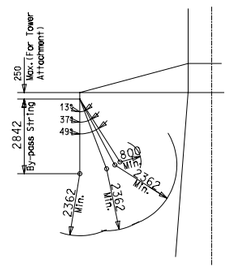


0°≤ θ1 ≤ 30° with one by-pass string for outer angle
30°< θ2 ≤ 45°with two by-pass string for outer angle

TYPICAL CROSSARM FOR TOWER TYPE DDE

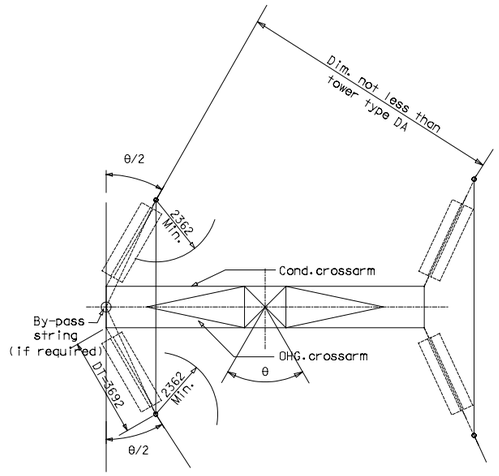


JUMPER LOOP



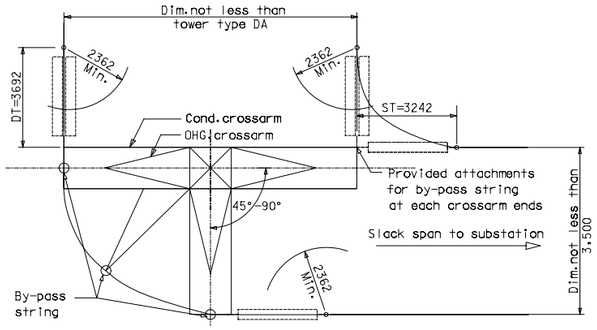
BY-PASS STRING

Tower type	Min.dim. a
DB	482
DC	956
DD	956
DE	956



0°≤ θ ≤ 30° without by-pass string for both sides
30°< θ ≤ 90°with one by-pass string for outer angle

TYPICAL CROSSARM FOR TOWER TYPE DD & DE



TYPICAL CROSSARM FOR TOWER TYPE DDE

TOWER APPLICATION TABLE

TOWER TYPE	APPLICATION	LINE ANGLE (DEGREE)	WIND SPAN (m)	WEIGHT SPAN (m)
DB	TENSION	0°-15°	440	550
DC	TENSION	0°-30°	440	550
DD	TENSION	0°-60°	440	550
DE	TENSION	0°-90°	440	550
DDE	DEADEND	0°(COMPLETE DEADEND)	220	300
		0°-90°(DEADEND WITH SLACK SPAN)	330	450

NOTES

1. Clearance dimensions are minimum from surface of steel (not from member gage or working lines) to the nearest point on the conductor or hardware.
2. All dimensions are in millimeter except as noted.
3. Conductor size : 1272 MCM ACSR/GA
   Shield wire : 3/8" GSW HS and 70 sq.mm (10.5 diameter)
4. Ruling span : 430 m.
5. All cable attachment device shall be supplied with tower, minimum proof loads shall be equal to those of hardware

REV.NO.	JOB NO.	JOB DESCRIPTION	DRAWN	DESIGNED	VERIFIED	VALIDATED	RECOMMENDED	CONCURRED	APPROVED	DATE

THE KANSAI ELECTRIC POWER CO.,INC.
ELECTRICITY GENERATING AUTHORITY OF THAILAND
ROJANA INDUSTRIAL PARK PUBLIC COMPANY LIMITED

NAM NGIEP 1 HYDROPOWER PROJECT

DRAWN	Sujanya K.	VALIDATED	
DESIGNED	Sujanya K.	RECOMMENDED	
VERIFIED		CONCURRED	
APPROVED		DATE	

230 kV TRANSMISSION LINE

ELECTRICAL AND GROUND CLEARANCE FOR TOWER TYPE DB, DC, DD, DE & DDE

JOB NO.	REPLACING DWG.NO.	DWG.NO.	REV.
NNP1		NNP1-E-003	0

Filename : NNP1-E-003
Date July 26,2007

Annex B

Environmental Standards

DRINKING WATER QUALITY STANDARDS

Lao PDR current standards for drinking water of the Lao PDR are provided below for reference.

Table B.1 Bacteriological Parameter

Parameters	*Units*	*Concentration*
Faecal Coliform	*MPN/100ml*	*0*
Total Coliform	*MPN/100ml*	*<2.2*
Entero virus	*MPN/100ml*	*0*

Source: Refer to CA - Annex C– Appendix 2 Standard, 1.8 Drinking Water Quality Standards, Bacteriological Parameters

Table B.2 Physical-Chemical Parameters

Parameters	Symbol	Unit	Maximum Concentration
Aluminium	Al^{3+}	mg/l	0.2
Ammonia	NH_3	mg/l	1.5
Chloride	Cl^-	mg/l	250
Copper	Cu^{2+}	mg/l	2.0
Iron	Fe^{2+} and Fe^{3+}	mg/l	<1
Manganese	Mn^{2+}	mg/l	0.5
Sodium	Na^+	mg/l	250
Sulphate	SO_4^{2-}	mg/l	250
Hydrogen Sulphide	H_2S	mg/l	0.1
Conductivity	EC	µS/cm	<1,000
Total dissolved solids	TDS	mg/l	600
Sodium Chloride	NaCl	mg/l	300-350
pH	pH	-	8.5
Temperature	T	^0C	35
Hardness	-	mg/l	300

Parameters	Symbol	Unit	Maximum Concentration
Turbidity	-	NTU	<10
Taste and Odour	-	-	Acceptable
Colour	-	TCU	5
Residual Chlorine (if Chlorine disinfection is used)	Cl_2	mg/l	<0.2

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.8 Drinking Water Quality Standards, Physical-Chemical Parameters.

Table B.3 Health Significant Chemical Parameters

Parameters	Symbol	Unit	Maximum Concentration
Antimony	Sb^{3+}	mg/l	0.005
Arsenic	As^{3+}	mg/l	0.01-0.05
Barium	Ba^{2+}	mg/l	0.7
Boron	B	mg/l	0.50
Cadmium	Cd^{2+}	mg/l	0.003
Chromium	Cr	mg/l	0.05
Cyanide	CN^-	mg/l	0.07
Fluoride	F^-	mg/l	1.5
Lead	Pb	mg/l	0.01
Mercury	Hg	mg/l	0.001
Nitrate	NO^-_3	mg/l	50
Nitrite	NO^-_2	mg/l	3
Selenium	Se	mg/l	0.01

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.8 Drinking Water Quality Standards, Health Significant Chemical Parameters

Table B.4 Priority Parameters

Parameters	Symbol	Unit	Maximum Concentration
Iron	Fe	mg/l	<1
Manganese	Mn	mg/l	<0.5
Arsenic	As	mg/l	<0.05
Fluoride	F^-	mg/l	<1.5
Nitrate	NO_3^-	mg/l	50
Nitrite	NO_2^-	mg/l	3
Nitrite Nitrogen	NO_2^-N	mg/l	1
pH	pH	-	6.5-8.5
Coliform	-	MPN/100ml	0
Conductivity	EC	µS/cm	1000
Residual Chlorine (if Chlorine disinfection is used)	Cl_2	mg/l	0.2
Total Hardness	-	mg/l	<300
Turbidity	-	NTU	<10
Taste and Odour	-	-	Acceptable

Source: Refer to CA - Annex C – Appendix 2 Standard, 1.8 Drinking Water Quality Standards, Priority Parameters

GROUNDWATER QUALITY STANDARDS

Lao PDR current standards for groundwater are provided below for reference.

Table B.5 Volatile Organic Compound

No.	Substances	Unit	Maximum Concentration
1	Benzene	mg/l	0.005
2	Carbon Tetrachloride	mg/l	0.005
3	1,2-Dichloroethane	mg/l	0.005
4	1,1-Dichloroethylene	mg/l	0.007
5	Cis-1,2-Dichloroethylene	mg/l	0.070

No.	Substances	Unit	Maximum Concentration
6	Trans-1,2-Dichloroethylene	mg/l	0.1
7	Dichloromethane	mg/l	0.005
8	Ethylbenzene	mg/l	0.7
9	Styrene	mg/l	0.1
10	Tetrachloroethylene	mg/l	0.005
11	Toluene	mg/l	1
12	Trichloroethylene	mg/l	0.005
13	1,1,1 Trichloroethane	mg/l	0.2
14	1,1,2 Trichloroethane	mg/l	0.005
15	Total Xylenes	mg/l	10

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.9 Groundwater Quality Standards

Table B.6 Heavy Metals

No.	Substances	Unit	Maximum Concentration
1	Cadmium	mg/l	0.003
2	Hexavalent Chromium	mg/l	0.05
3	Copper	mg/l	1
4	Lead	mg/l	0.01
5	Manganese	mg/l	0.5
6	Nickel	mg/l	0.02
7	Zinc	mg/l	5
8	Arsenic	mg/l	0.01
9	Selenium	mg/l	0.01
10	Mercury	mg/l	0.001

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.9 Groundwater Quality Standards

Table B.7 Pesticides

No.	Substances	Unit	Maximum Concentration
1	Chlordane	mg/l	0.0002
2	Dieldrin	mg/l	0.00003
3	Heptachlor	mg/l	0.0004
4	Heptachlor Epoxide	mg/l	0.0002
5	DDT	mg/l	0.002
6	2,4-D	mg/l	0.03
7	Atrazine	mg/l	0.003
8	Lindane	mg/l	0.0002
9	Pentachlorophenol	mg/l	0.001

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.9 Groundwater Quality Standards

Table B.8 Other Parameters

No.	Substances	Unit	Maximum Concentration
1	Benzo[a]pyrene	mg/l	0.0002
2	Cyanide	mg/l	0.2
3	Polychlorinated biphenyls	mg/l	0.0005
4	Vinyl Chloride	mg/l	0.002

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.9 Groundwater Quality Standards

GROUNDWATER QUALITY STANDARDS FOR DRINKING PURPOSES

Lao PDR's current standards for groundwater for drinking purposes are provided below for reference.

Table B.9 Physical Parameters

Characteristics	Parameters	Symbol	Unit	Permitted Standard Value	
				Suitable	Maximum
Physical	Colour	-	Platinum-	5	15

Characteristics	Parameters	Symbol	Unit	Permitted Standard Value	
			Cobalt (Pt-Co)		
	Turbidity	-	JTU	5	20
	Total solids	TS	mg/l	≤600	1,200

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.10 Groundwater Standards for Drinking Purposes

Table B.10 Chemical Parameters

Characteristics	Parameters	Symbol	Unit	Permitted Standard Value	
				Suitable	Maximum
Chemical	Acidity	pH	-	7.0-8.5	6.5-9.2
	Iron	Fe(ii), Fe(iii)	mg/l	≤0.5	1
	Manganese	Mn^{2+}	mg/l	≤0.3	0.5
	Copper	Cu^{2+}	mg/l	≤1.0	1.5
	Zinc	Zn^{2+}	mg/l	≤5.0	15
	Sulphate	SO_4^{2-}	mg/l	≤200	250
	Chloride	Cl^-	mg/l	≤250	600
	Fluoride	F^-	mg/l	≤0.7	1
	Nitrate	NO_3^-	mg/l	≤15	45
	Total Hardness as $CaCO_3$	Total $CaCO_3$	mg/l	≤300	500
	Non-carbonate hardness as $CaCO_3$	Non $CaCO_3$	mg/l	≤200	250
	Arsenic	As^{3+}, As^{5+}	mg/l	None	0.05
	Cyanide	CN^-	mg/l	None	0.1
	Lead	Pb^{2+}	mg/l	None	0.05
	Mercury	Hg	mg/l	None	0.001
	Cadmium	Cd^{3+}	mg/l	None	0.01
	Selenium	Se(iv)	mg/l	None	0.01

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.10 Groundwater Standards for Drinking Purposes

Table B.11 Bacteria Parameters

Characteristics	Parameters	Symbol	Unit	Permitted Standard Value	
				Suitable	Maximum
Bacteria	Coliform bacteria	Coliform	MPN/100 ml	<2.2	<2.2
	E. coli bacteria	E. coli	MPN/100 ml	None	None
	Standard plate count	-	Colonies/ml	≤500	-

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.10 Groundwater Standards for Drinking Purposes

AMBIENT SURFACE WATER QUALITY STANDARDS

Deviation from these standards will only be allowed with the prior written approval of MONRE on a case by case basis, where the Company is able to demonstrate to MONRE's reasonable satisfaction that such deviation is caused by the inherent nature of the Nam Ngiep river or by the initial impoundment of the reservoir during the appropriate period as approved by MONRE. In applying for MONRE's approval, the Company shall clearly specify and justify all parameters, the proposed temporary standards for such parameters and the period during which such temporary standards are proposed to be in force together with appropriate monitoring plans and proposed steps promptly to address and resolve any failure to meet temporary standards. For the avoidance of doubt, the Company remains at all times responsible for Adverse Impacts related to approve deviations from the Ambient Water Quality Standards caused by the initial impoundment.

Table B.12 Ambient Surface Water Quality Parameter

Parameters	Units	Standard
pH		5-9
Dissolved Oxygen	mg/l	>6.0
BOD_5	mg/l	1.5
COD	mg/l	5.0
Nitrogen as nitrate ($N\text{-}NO_3$)	mg/l	5.0
Nitrogen as ammonia ($N\text{-}NH_3$)	mg/l	0.2

Parameters	Units	Standard
Sulfate	mg/l	500
Total coliform bacteria	MPN/ml	5,000
Total faecal coliform	MPN/ml	1,000
Phenols	mg/l	0.005
Arsenic (As)	mg/l	0.01
Cadmium (Cd) $CaCO_3 \leq 100$ mg/l	mg/l	0.005
Cadmium (Cd) $CaCO_3 \geq 100$ mg/l	mg/l	0.05
Chromium (VI) (Cr^{6+})	mg/l	0.05
Copper (Cu)	mg/l	0.1
Cyanide	mg/l	0.005
Lead (Pb)	mg/l	0.05
Mercury (Hg)	mg/l	0.002
Nickel (Ni)	mg/l	0.1
Zinc (Zn)	mg/l	1.0
Manganese (Mn)	mg/l	1.0
Alpha ¬Radioactivity	Becquerel/l	0.1
Beta ¬ Radioactivity	Becquerel/l	1.0
Total Organochlorine	mg/l	0.05
DDT	mg/l	1.0
Alpha-BHC	mg/l	0.02
Dieldrin	mg/l	0.1
Aldrin	mg/l	0.1
Heptachlor and Heptachlor Epoxide	mg/l	0.2
Endrin	mg/l	0

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.11 Ambient Surface Water Quality Standards

EFFLUENT STANDARDS

The Company is responsible for compliance with applicable effluent standards. This applies to all effluents and runoff from project activities, facilities, installations as well as discharges from resettlement sanitation and drainage.

Selected standards are listed below. All other parameters shall comply with the Lao National Standards and IFC Guidelines whichever is stricter.

Deviation from these standards will only be allowed:

1. with the prior written approval of MONRE, and in circumstances where the Company and its contractors have applied an appropriate waste water treatment system used by international construction contractors in Lao PDR and applicable to the construction site or
2. if the water from any project activities does not have an adverse effect on the existing water quality or
3. to the extent that the deviations are present as a result of the existing water quality.

Table B.13 Effluent Standards

Parameters	Units	Guidelines
pH		**6-9**
Biochemical Oxygen Demand -BOD	mg/l	**30**
Chemical Oxygen Demand -COD	mg/l	**125**
Total suspended solids	mg/l	**50**
Oils and grease	mg/l	**10**
Phenol	mg/l	**0.5**
Cyanide	mg/l	**0.1**
Ammonia -N	mg/l	**10**
Total Nitrogen	mg/l	**10**
Total phosphorus	mg/l	**2**
Residual chlorine	mg/l	**0.2**
Total coliforms	MPN/100ml	**<400**
Temperature increase	°C	**<3**
Arsenic	mg/l	**0.1**

Parameters	Units	Guidelines
Cadmium	mg/l	**0.05**
Chromium	mg/l	**0.1**
Copper	mg/I	**0.3**
Fluoride	mg/l	**20**
Iron	mg/l	**2**
Lead	mg/l	**0.2**
Mercury	mg/l	**0.002**
Nickel	mg/l	**0.5**
Selenium	mg/l	**0.1**
Silver	mg/I	**0.5**
Sulfides	mg/l	**1**
Zinc	mg/l	**0.5**
Total Toxic metals	mg/l	**5-10**

Source: Refer to CA - Annex *C* – Appendix 2 Standard, 1.13 Effluent Standards

NOISE STANDARDS

Noise emission and ambient noise levels shall be in compliance with the Lao National Environmental Standard for noise as provided below for reference.

Table B.14 Noise Standards

Standards Method of Measurement	Standards Method of Measurement
Maximum Sound Level (L_{max}) should not exceed 115 dB(A)	Maximum Sound Level (L_{max}) should not exceed 115 dB(A)

Source: Refer to Agreement on the National Environmental Standards of Lao PDR, 2009

Table B.15 Noise Standards for Other Places

Type of Area	Standard Value in dB(A)		
	6.00-18.00	18.00-22.00	22.00-6.00
Quiet areas: hospitals, libraries, treatment places, kindergarten and schools	50	45	40
Residential areas: hotels and houses	55	55	45
Commercial and service areas	70	70	50
Small industrial factories located in residential areas	70	70	50

Source: Refer to Agreement on the National Environmental Standards of Lao PDR, 2009

AIR STANDARDS

Air emission and ambient air levels shall be in compliance with the Lao National Environmental Standard for ambient air quality standard as provided below for reference.

Table B.16 Ambient Air Quality Standards

Parameters	Symbol	Average Time Unit: mg/m³					Method of Measurement
		Hour			1 month	1 year	
		1 hr	8hr	24 hr			
Carbon monoxide	CO	30	10.26	-	-	-	Non dispersive infrared detection

Parameters	Symbol	Average Time Unit: mg/m³					Method of Measurement
Nitrogen dioxide	NO_2	0.32	-	-	-	-	Chemiluminescene method
Sulphur dioxide	SO_2	0.78	-	0.30	-	0.10	UV Fluorescence (1hr, 24hr, 1yr) or Pararosaniline (1hr, 4hr)
Total suspended Particulate	TSP	-	-	0.12	-	0.05	Gravimetric
Particulate Matter less than 10 microns	PM-10	-	-	0.12	-	0.05	Gravimetric or Beta Ray or Taper Element Oscillating Microbalance or Dichotomous
Ozone	O_3	0.20	-	-	-	-	Chemiluminescence or UV Absorption Phoptometry
Lead	Pb	-	-	-	1.5	-	Atomic Absorption Spectrometer

Source: Refer to Agreement on the National Environmental Standards of Lao PDR, 2009

VIBRATION STANDARD

The vibration standard was not mentioned in the Lao PDR national standard and international standard guideline. Therefore, to compare the results of measuring in construction activities of the Project such as blasting plant and quarry, the guideline for vibration standards from Mining and Quarry in Thailand is proposed in Table A3.8.1.

Table B.17 Vibration from Mining and Quarry Standard

Frequency (Hertz)	Velocity (mm/s)	Displacement (mm)
1	Not Exceed 4.7	Not Exceed 0.75
2	Not Exceed 9.4	Not Exceed 0.75
3	Not Exceed 12.7	Not Exceed 0.67
4	Not Exceed 12.7	Not Exceed 0.51
5	Not Exceed 12.7	Not Exceed 0.40
6	Not Exceed 12.7	Not Exceed 0.34
7	Not Exceed 12.7	Not Exceed 0.29
8	Not Exceed 12.7	Not Exceed 0.25
9	Not Exceed 12.7	Not Exceed 0.23

Frequency (Hertz)	Velocity (mm/s)	Displacement (mm)
10	Not Exceed 12.7	Not Exceed 0.20
11	Not Exceed 13.8	Not Exceed 0.20
12	Not Exceed 15.1	Not Exceed 0.20
13	Not Exceed 16.3	Not Exceed 0.20
14	Not Exceed 17.6	Not Exceed 0.20
15	Not Exceed 18.8	Not Exceed 0.20
16	Not Exceed 20.1	Not Exceed 0.20
17	Not Exceed 21.4	Not Exceed 0.20
18	Not Exceed 22.6	Not Exceed 0.20
19	Not Exceed 23.9	Not Exceed 0.20
20	Not Exceed 25.1	Not Exceed 0.20
21	Not Exceed 26.4	Not Exceed 0.20
22	Not Exceed 27.6	Not Exceed 0.20
23	Not Exceed 28.9	Not Exceed 0.20
24	Not Exceed 30.2	Not Exceed 0.20
25	Not Exceed 31.4	Not Exceed 0.20
26	Not Exceed 32.7	Not Exceed 0.20
27	Not Exceed 33.9	Not Exceed 0.20
28	Not Exceed 35.2	Not Exceed 0.20
29	Not Exceed 36.4	Not Exceed 0.20
30	Not Exceed 37.7	Not Exceed 0.20
31	Not Exceed 39.0	Not Exceed 0.20
32	Not Exceed 40.2	Not Exceed 0.20
33	Not Exceed 41.5	Not Exceed 0.20
34	Not Exceed 42.7	Not Exceed 0.20
35	Not Exceed 44.0	Not Exceed 0.20
36	Not Exceed 45.2	Not Exceed 0.20
37	Not Exceed 46.5	Not Exceed 0.20

Frequency (Hertz)	Velocity (mm/s)	Displacement (mm)
38	Not Exceed 47.8	Not Exceed 0.20
39	Not Exceed 49.0	Not Exceed 0.20
40	Not Exceed 50.8	Not Exceed 0.20

Note: Pollution Control Department (PCD), Ministry of National Resources and Environment, Thailand.

ELECTRIC AND MAGNETIC FIELD EXPOSURE LIMITS

Table B.18 Exposure Limits for General Public Exposure to Electric and Magnetic Fields

Frequency	Electric Field (V/m)	Mangetic Field (μT)
50 Hz	5000	100
60 Hz	4150	83

Source: International Commission of Non-Ionizing Radiation Protection, cited in World Bank Group (2007) *Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution.*

Table B.19 Occupational Exposure Limits for Electric and Magnetic Fields

Frequency	Electric Field (V/m)	Mangetic Field (μT)
50 Hz	10,000	500
60 Hz	8300	415

Source: International Commission of Non-Ionizing Radiation Protection, cited in World Bank Group (2007) *Environmental, Health and Safety Guidelines for Electric Power Transmission and Distribution.*

Annex C

Transmission Line Biodiversity Assessment Report

FINAL REPORT

Nam Ngiep One Power Company Limited

NNP1 Transmission Line Biodiversity Assessment
Report

May 2014

Reference: 0229866

Environmental Resources Management Australia
Level 1, 60 Leichhardt Street
Spring Hill, QLD 4000
Telephone +61 7 3839 8393
Facsimile +61 7 3839 8381
www.erm.com

CONTENTS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The Nam Ngiep Hydropower Project (NNP1) in northern Lao is currently undertaking investigations to support an approval to construct and operate a hydropower facility on the Nam Ngiep River. As a component of the Project a transmission line is required to transmit electrical power from the Main Dam site to the Nabong collector substation near Vientiane Capital, in order to benefit from the NNP1.

This report provides a biodiversity assessment specific to the proposed transmission line such that the route can be refined and finalised for construction. The proposed route is approximately 125 km in length with a 'right of way' (RoW) requirement of 35 m. For the purposes of assessment the RoW for the entire length of the route has been considered to allow for interpretation of biodiversity values that may be associated with the disturbance area. It is acknowledged that transmission lines comprise isolated towers connected via aerial line and as such the entire RoW may not be required to be disturbed. By considering the entire RoW, recommendations can be made to avoid sensitive areas.

The Asian Development Bank has requested information specific to the biodiversity values of the transmission line that consider the ADB Safeguard Policy Statement and International Finance Corporation performance Standard 6 guidance. This report uses available data sources from desktop review, field reconnaissance, village interview and spatial analysis to describe the biodiversity values in accordance with the standard. Primarily this involves the identification and assessment of habitats (natural and modified) that may be impacted by the transmission line.

Biodiversity values of the transmission line were identified relating to the land cover of the region, condition of the vegetated areas, and flora and fauna species. The outcomes of the assessment identified six flora species, nine mammals, eight birds, two reptiles, five fish species and a number migratory fish species as candidates for assessment against the IFC critical habitat criteria. Candidates included IUCN listed species, nationally listed species and migratory species. Through investigation and consultation with species specialists information was compiled and assessed against the critical habitat criteria. The assessment identified that the transmission line Project Area is unlikely to be associated with habitat considered to be critical habitat for these priority biodiversity values and potential impacts can be managed.

An impact assessment was undertaken for the biodiversity values identified for the Project Area. The key threats to biodiversity as a result of the transmission line relate to permanent loss of habitat, disturbance and displacement of species, creation of barriers to fauna movement, degradation of habitat due to edge effects and fragmentation, and fauna mortality. In general the significance of these impacts to biodiversity and priority biodiversity values was considered to be minor or negligible. The exception related to the potential loss of natural habitat that is suitable for IUCN listed and nationally listed species. Although the Project Area is not considered critical habitat for these species, potential habitat will be permanently removed to facilitate the construction of the transmission towers and access roads.

The mitigation hierarchy recognises a preference for avoiding environmental impacts and as such an alternative route was considered to investigate the potential to reduce or avoid the extent of the permanent biodiversity impact. The outcomes of the analysis of alternatives identified that the alternative option alignment avoids a preserved area, is likely to be lower cost and disturbed less natural habitat area, and asuch is deemed the preferred option.

Disturbance to habitat in modified and natural habitat areas has potential to have impacts on the local biodiversity and downstream biodiversity as well as impacts to priority biodiversity values. The biodiversity impact assessment (Section 5) identified potential impacts to both modified and natural habitats however the modified habitat types were not identified to play a significant role in habitat suitability for priority biodiversity values.

Primarily, a Biodiversity Action Plan (BAP) will be developed that will document a strategy for refining the mitigation and management approach to conservation of biodiversity values, including key objectives, specific measures for the IUCN listed threatened species with potential to occur in the Project Area, performance indicators and responsible parties. Management measures specific to managing the natural environment will be also incorporated into the Project EMMP.

Direct disturbance to habitats will be minimised where possible however this impact assessment has identified an unavoidable loss of approximately 117 ha of natural habitat and 216 ha of modified habitat. A Biodiversity Offset Design Report has been developed for the entire NNP1 Project that provides the methodology and approach to the design and implementation of biodiversity offsets as the compensatory measure for residual impact to habitats. The report incorporates the transmission line as part of the NNP1 Project and will include the residual impact to natural habitats and priority biodiversity values identified within this biodiversity assessment.

1 INTRODUCTION

1.1 PURPOSE OF THIS REPORT

The Asian Development Bank (ADB) has requested information on the biodiversity values of the transmission line for the Nam Ngiep Hydropower Project (NNP1). The purpose of this report is to provide an assessment of biodiversity values for the transmission line component of NNP1 (the Project) considering the ADBs Safeguard Policy Statement (SPS) and International Finance Corporation Performance Standard 6 guidance.

ERM understand that the ADB will consider this biodiversity assessment of the transmission line to determine if there will be impacts on critical habitat, and determine appropriate safeguard provisions to protect natural habitats and endangered species during construction and operation of the infrastructure.

ERM have prepared the following assessment based on information collected from field reconnaissance, existing biodiversity reports relevant to the area, spatial data on the biodiversity values of the route, assessment of alternative routes and advice from the ADB.

Overall, the report aims to:

- Develop an understanding of the biodiversity values of the site, focussing on the potential for priority biodiversity values;
- Further investigate the priority biodiversity values in terms of the critical habitat criteria defined by the International Finance Corporation;
- Assess the level of impact of the transmission line on the identified biodiversity values, priority and otherwise;
- Develop mitigation and management strategy to manage any potential significant impacts identified.

1.2 EXISTING REPORTS

This report has been prepared using information from the following key information sources:

- Environmental Research Institute (ERI) 2012 Environmental Impact Assessment – Nam Ngiep 1 Hydropower Project; and
- ERM 2013 Biodiversity Baseline Assessment Nam Ngiep Hydropower Project.

1.3 REFERENCE MATERIALS

ERM has used the following key reference materials when undertaking the revised EIA:

- International Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living. Natural Resources (January 2012), and guidance note;
- International Finance Corporate Environmental, Health and Safety Guidelines: Electrical Power Transmission and Distribution (April 2007);
- Asian Development Bank Safeguard Policy Statement (January 2010);
- Asian Development Bank Environmental Safeguards A Good Practice Sourcebook – Draft Working Document (November 2012).

1.4 PROJECT AREA

The transmission alignment is approximately 125 km in length with a required 35 m wide 'right of way' (RoW) to be established. For the purposes of this assessment the Project Area is defined as the area potentially directly impacted by the construction and operation of the transmission line. This includes the temporary and permanent disturbance footprints of the RoW.

The Project Area includes areas to be cleared of vegetation for construction pads and permanent infrastructure, as well as areas within the RoW that will require vegetation suppression to maintain safe clearance to the transmission line. *Table 1-1* provides estimates of the temporary and permanent disturbance footprint within the Project Area.

Table 1.1 Approximate dimensions and footprints of Project components

Project Component	Temporary Footprint		Permanent Footprint	
	Area (ha)	*Comment*	*Area (ha)*	*Comment*
Total RoW	437.5	35 m width 125 km length	437.5	35 m width 125 km length
• Access road within RoW (dirt or grassed surface)	38.5	5 m width 77 km length[1]	62.5	5 m width 125 km length[1]
• Towers (temporary dirt, permanent hardstand)	101.9	100 m length per tower 35 m width per tower 291 towers	2.4	9 m length per tower 9 m width per tower 291 towers
• Worker camp	72.8	65 m length per tower 35 m width per tower 291 towers	0	Temporary only
• Remaining RoW (vegetation suppressed to 3 m)	224.3	Total RoW footprint, minus cleared areas	372.6	Total RoW footprint, minus cleared areas
Total cleared footprint	213.2		64.9	
Total vegetation suppression	224.3		372.6	

footprint				
Total footprint	437.5		437.5	

1. Temporary length is 77 km due to approximately 48 km cleared for construction zones. In practice, length of access road within RoW will be lower, as RoW will not be used for access in steep or mountainous areas, or in areas where access is currently sufficient.

1.5 ASSESSMENT APPROACH

In order to characterise the biodiversity values and assess the potential impacts to biodiversity values associated with the transmission line, information has been collated from field reconnaissance, available literature, spatial data and species profiles. This approach allows for an approximate footprint to be described and biodiversity values that may be directly impacted identified, while considering the resolution of the spatial datasets. All area calculations for land cover and vegetation conditions should be considered upper estimates and have been derived for the purposes of identifying biodiversity values associated with the Project Area rather than detailed disturbance footprint areas. As described in the following sections, ground truthing will be required to provide more accurate information and a broad indication of the accuracy of the spatial layers at the Project scale.

In accordance with the ADB sourcebook (Section V) the objectives of the biodiversity impact assessment are to: identify and quantify the potential project impacts; design measures to avoid, minimise or mitigate potential adverse impacts; and identify likely residual impacts. To achieve this a five step process was undertaken. This included:

- **Screening** to determine the biodiversity features that require studying (*Section 2*);
- **Scoping** to determine which direct and indirect biological impacts are likely to be significant in order to determine the focus issues of the impact assessment (*Section 3*);
- **Baseline Studies** to define the values of the habitats that will be affected on the Project Area and in the area of influence (*Section 4*);
- **Impact Analysis** to assess impacts identified during scoping and baseline studies to determine the significance of the impacts (*Section 5*);
- **Mitigation Measures** are developed to avoid or reduce adverse impacts to biodiversity with a priority given to impacts on features with significant biodiversity values (*Section 6*); and
- **Biodiversity Offsets** are determined to compensate for unavoidable residual harm caused to biodiversity (*Section 6.4*).

The vegetation within the Project Area and surrounds is described in terms of modified and natural habitats in accordance with the ADB sourcebook and IFC PS6. Desktop sources and available data provided information specific to IUCN Red List critically endangered and endangered species that are known or may occur within the Project Area such that a determination of critical habitat status can be made.

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
- Access Road (Main Dam)
- Proposed Access Road (Transmission Line)
- Proposed Transmission Line

N
0 10 20 30Km
1:600,000

Basemap: ESRI World Imagery
Datum: WGS84

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

Client:	Nam Ngiep Power Company Ltd.		
Drawing No:	0185065b_TL_BIODASSES_G001_R0.mxd		
Date:	17/01/2014	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 1.1 - Project Area

Nam Ngiep 1 Hydropower Project
Transmission Line Biodiversity Assessment

Environmental Resources Management ANZ

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

ERM

2 SCREENING FOR BIODIVERSITY VALUES

2.1 REGIONAL BIODIVERSITY VALUES

Terrestrial ecoregions are natural ecological communities with shared species, dynamics and environmental conditions and offer a useful way of understanding the biodiversity within each area (ADB & UNEP, 2004). Central Lao PDR straddles two ecoregions; namely the Luang Prabang Montane Rainforest (Eco-region IM0121) and the Northern Annamites Rain Forests (Eco-region IM0136). Ecoregions are natural ecological communities with shared species, dynamics and environmental conditions and offer a useful way of understanding the biodiversity within each area (ADB & UNEP, 2004).

The Luang Prabang Montane Rainforests ecoregion comprises areas largely above 800 m in north-central Lao PDR. It is globally recognised for its diversity in bird species (some 540 different species of birds have been recorded) 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 eco-region but this is thought to be due to the lack of biological surveys conducted here (WWF, 2003b). Large tracts of untouched and inaccessible forest within the eco-region are known to shelter several large mammals, including tigers, Asian elephants, wild dogs, Himalayan (or Asiatic) black bears, Francois' leaf monkeys, and guars. Their continued existence is however under threat through habitat loss and hunting/ poaching (WWF, 2003b).

The Northern Annamites Rain Forest ecoregion runs along the border between Lao PDR and Vietnam, southwards from the southern edge of the Project Area. The area is characterised by large areas of limestone karst topography; higher elevations produce cooler temperatures and distinct conditions for plant growth. It is globally recognised for its species diversity and in particular the number of new large or mid-sized mammals that have been (and still expected to be) discovered there in recent years. Of the 134 mammals known from the ecoregion, three are near endemic and four are endemic to the region. Each new survey reveals more new species of mammals, birds, fishes, reptiles, butterflies and plants. Vascular plant levels of endemism are high (WWF, 2003b).

The Annamites Rain Forest eco-region has also been categorised by the WWF as one of the Global 200 most important biogeographic regions, on the basis of its species richness, endemism and global rarity of the major habitat type. The Global 200 eco-regions represent the areas of highest conservation importance.

2.2 *PROJECT AREA BIODIVERSITY VALUES*

Key features of the Project Area are where the transmission line passes through the Huay Ngua PPA in the Bolikhamxay Province, crosses the Nam Ngiep River and traverses nearby the Phou Khao Khouy National Protected Area (NPA).

The Huay Ngua PPA was established in 2010 and is located to the east of the Nam Ngiep River between Borikham and Hat Kham. The preserved area is approximately 5,430 ha. There are five villages with a total population of 4,302 made up of Laoloum, Laosoung and Keummou ethnic groups. The groups are located in scattered settlements living near highland rice fields and rivers. The villagers use local terrestrial and aquatic biodiversity however dependence varies (Provincial Conservation Division, 2010).

The Huay Ngua PPA is an important part of a wildlife corridor between PKK and along the Nam Ngiep River. The area is considered significant for aquatic and terrestrial wildlife habitat (Provincial Conservation Division, 2010) as well as providing a research site of Province Agriculture and Forestry School. The Huay Ngua PPA currently does not have any formal management arrangements in place to facilitate its management. A management committee under Central, Provisional or District levels of government has not been established. A Management Plan for the Huay Ngua PPA has been prepared but it has not been implemented as no funding currently exists to pay for the management actions it contains. The priority actions to manage the Huay Ngua PPA included in the plan are related to:

- raising community awareness to increase participation in sustainable uses;
- improving community livelihoods in and around the Huay Ngua PPA to assist in management of natural resources;
- law enforcement and patrolling;
- biodiversity research and monitoring; and
- development of ecotourism opportunities.

The forest and wildlife is considered a high value resource with increasing demand in Lao PDR and neighbouring countries. The Huay Ngua PPA is abundant in these resources. Some fauna species have been impacted by hunting and trapping for local and regional market and there is harvesting for rosewood and agar wood (*Aguilaria cassna*) (Provincial Conservation Division, 2010).

The Nam Ngiep River 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 Pakxon. The Project Area crosses the river in the lower catchment near the Mekong River

confluence. The terrain is predominately flat and slopes gradually towards the Mekong River.

The Phou Khao Khouy NPA is a protected are near Vientiane that spans 2000 km and encompasses a range of landscapes from sandstone cliffs and river gorges to rugged mountain slopes. The area is dominated by natural habitat and a number of IUCN Red List species are considered to occur in the area. The Project Area does not intersect this national protected area rather traverses the foothills that are associated with the region.

Forest resources have played an important role in the economics of the surrounding province contributing to almost 30% of the total province economy in 2000. Although production of forest products is important for the province, environmental values remain important and the forest is considered a place for production and collection of food for the rural population as well as a source of traditional medicine (Provincial Conservation Division, 2010).

Both of these conservation significant areas are currently being considered as candidate offset sites for the NNP1 project.

2.3 BASELINE BIODIVERSITY ASSESSMENT

2.3.1 Overview

The baseline biodiversity values of the transmission line have been determined using a number of information sources including:

- Geospatial datasets including aerial photography and vegetation mapping;
- Desktop literature and other sources;
- Field survey undertaken for the NNP1 Project components; and
- Field reconnaissance visit to identify key biodiversity areas for consideration in refining the alignment.

These sources provide description of vegetation communities, habitats and species that occur in the region surrounding the Project Area, and therefore have potential to occur within the Project Area. The data collated for the purposes of this report can be categorised into two types:

Direct: Species recorded during biodiversity field surveys of NNP1 Project components undertaken during the 2013 are considered direct counts. In general the location and details of this data has been recorded and a higher level or certainty can be inferred.

Indirect: Species reported from village surveys or within reports using a more regional study area are considered indirect records. These data sources provide a valuable understanding of the biodiversity of the locality and region

however should be afforded further analysis or applicability considered. Data obtained from village surveys can contain errors in some instances, especially when considering identification of species with more challenging diagnostic features.

The reliability of the records has been considered throughout the report and the category of any species records are denoted throughout.

2.3.2 Direct Biodiversity Data Sources

Direct biodiversity data sources that inform this biodiversity assessment are outlined in *Table 2-1* and described further below.

Table 2.1 Summary of Direct Biodiversity Data Sources

Surey Team	Date	Location	Methods
Thailand Institute of Scientific and Technological Research (TISTR)	March and July 2013	• Huay Ngua PPA • Proposed Resettlement Area	• Forest and vegetation survey • Terrestrial fauna survey • Aquatic biota survey
National University of Laos	November 2013	• Proposed Access Road Corridor	• Forest and vegetation survey

Thailand Institute of Scientific and Technological Research Biodiversity Survey (2013)

As part of the NNP1 Project biodiversity baseline assessment field investigations were undertaken in four key areas in the region. Data from the surveys in areas relevant to the proposed transmission line route has been considered in the assessment. This included survey:

- within Huay Ngua PPA (intersected by the proposed route); and
- at the proposed Resettlement Area of the Project on the west bank of the Nam Ngiep River.

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 TISTR team as a subcontractor to ERM were engaged to undertake survey design, field survey and deliver a field survey biodiversity report.

Surveys were undertaken by teams targeting separate taxa: vegetation (team of 7 people), terrestrial wildlife (team of 6 people) and aquatic biota (team of 5 people). The locations of the relevant survey sites associated with the transmission line options are shown in *Figure 2.1*.

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

Forest and Vegetation Survey

The forest survey team surveyed for species diversity along trails and in sampling plots. Unknown plants were collected and three duplicates of leave with flowers or fruits for further analysis in the laboratory. Botanists recorded necessary information i.e. morphology, habit, colour of flowers and ecology, georeferenced location, and compiled photographic records.

Across the survey the sampling plots consisted of three types of temporary plots;

- A circular sample plot with a radius of 17.85 meters (or 0.1 ha);
- Square plots of 5x5 meters (25 square meters or 0.0025 ha); and
- Square plots of 2x2 meters (4 square meters or 0.0004 ha).

Analyses of the data collected included specialised laboratory investigations to establish identification of voucher specimens.

Terrestrial Fauna Survey

The terrestrial fauna survey aimed to describe the baseline wildlife diversity of the NNP1 Project Area impact zones for the purposes of assessing the potential Project impacts to terrestrial wildlife. Survey and sampling work involved developing an inventory of wildlife species (amphibians, reptiles, birds, and mammals).

One survey station was located in Huay Ngua PPA. The inventory of each fauna group was collected through direct and indirect counts.

Direct counts were carried out to determine numbers of amphibians, reptiles, birds, and mammals by sightings during the field surveys at the survey station. Observations and records of animal signs such as tracks, nets, burrows, droppings, hair and feathers, were also recorded. Details of the techniques used for each group include:

- Amphibians and reptiles: species searches were undertaken in habitats such as under logs, rocks, bark as well as digging in the buttress of trees. At night, spotlighting was used to detect nocturnal species along rivers, around poundages, and within tree canopies.
- Birds: were directly observed using binoculars during day time. Some species of birds were identified using call identification during the morning or evening, when they are the most active. Birds were also caught using mist-nets under tree canopies or cross the creeks these were identified, photographed, and released.

- Mammals: were observed from their signs such as tracks, scats, scratches on trees, burrows, etc. small mammals, were captured using live-traps or Sherman's traps. Bats were surveyed at night using mist-net and harp traps placed under tree canopies or cross creeks. Some species of mammals were identified from local hunters.

For all wildlife species the habitats were recorded. In the case of unidentified individuals these were collected and preserved and later analysed at the laboratory in the Natural History Museum-Nation Science Museum, Prathum Thani, Thailand.

Indirect counts were used to obtain supplementary information on fauna by interviewing local residents who lived in or near by the area. Some local villagers may hunt animals for food or for sale. Local households as well as local markets were also sampled.

Relative abundance of wildlife was calculated from numbers obtained in the direct and indirect counts, species were assigned as abundant, common, and less common using a calculation formulated by Pettingil (1969).

Aquatic Biota Survey

Aquatic biota sampling was conducted at different locations in Nam Ngiep, Nam Xan, Huay Ngua PPA and the Houay Soup resettlement area. Two survey stations were located in the Nam Ngiep River associated with the Project Area. Techniques included:

- collection of phytoplankton and zooplankton species using multiple plankton net surveys at each location, followed by preservation, identification and laboratory analysis at TISTR;

- collection of benthos at multiple replicate sites using an Ekmann dredge, followed by identification and abundance counts at the TISTR laboratories; and,

- capture and identification of fish species within the main rivers and their tributaries using the help of local fishermen using multi-mesh gillnets, electrofishing, cast nets, gun and hook, as well as discussions with fishermen and other information sources.

2.3.3 Indirect Biodiversity Data Sources

Desktop Review

Desktop review was undertaken to collate and assess other data sources. The desktop review included an assessment of:

- Online reports relating to the Project Area and biodiversity of Lao PDR;

- Threatened species profiles and online species distribution information; and

- Published literature relating to threatened species and Lao PDR biodiversity.

Information collated through desktop review was used to provide additional background information relating to the biodiversity values associated with the PPA and potentially the Project Area. Specific to the PPA, species identified within the Houy Ngua Provincial Preserved Area Management Plan (MP) 2011-2015 by the Provincial Agriculture and Forestry Office of Bolikhamxay (PAFO) (December 2010) have been considered to have potential to occur in the Project Area (indirect data). The management plan reports species based on some field survey and village interview results.

Geospatial Analysis

Geospatial analysis was undertaken to assist in understanding the biodiversity values in the Project Area. Primarily this was based on interpretation of a variety of spatial layers provided by DFRM and Rapideye Imagery.

In order to further understand the biodiversity values represented within the Project Area, remote sensing analysis was undertaken to map the variation in vegetation condition. Rapideye Imagery was used to identify the normalised difference vegetation index (NDVI) across the Project Area. NDVI is a remote sensing indicator that provides a measure of vegetation density and condition by indicating the photosynthetic capacity of the land surface cover.

The imagery outputs provide a NDVI in grid formation (5m x 5m) across the Project Area. Condition classes (for a range of NDVI) were defined and applied to each forest type. These condition classes are shown in *Table 2-2* and were used to refine land cover calculations. Area within the Impacted NDVI range were removed from habitat area calculations.

Table 2.2 Condition Class NDVI Range

Condition	NDVI Range
Benchmark	0.8 to 1.0
High	0.6 to 0.8
Moderate	0.4 to 0.6
Low	0 to 0.4
Impacted	-ve to 0

Limitations and Benefits

For this Project NDVI has been used as a remote sensing tool to indicate vegetation condition. As with all remote sensing techniques there are limitations associated and all information has not been ground-truthed. The outcomes of this assessment should be interpreted on a regional scale and note that the data is based on image capture at one specific time. Similarly, as

discussed NDVI is an indicator of photosynthetic capacity of the surface and does not distinguish between vegetation communities.

The inherent benefit of utilising NDVI relates to the remote sensing accessibility of information from areas that may be difficult to access on the ground or when considering larger areas for a local and regional context. The index allows for comparison of vegetation photosynthetic capacity along the length of the corridor in the context of the surrounding landscape.

The NDVI and land cover calculations are based on 5 metre square pixels. The RapidEye satellite imagery provided was at 5 metre square pixels and this same level of accuracy was used in generating the NDVI and land cover calculations presented in this report.

Social and Cultural Surveys

The preparation of the initial IEE (ERIC 2012) involved desktop review and site surveys to gain information on the social and cultural values of natural reosurces within the Project Area. Desktop review included assessment of landuses based on LandSat imagery in an 80 m wide study area along the proposed RoW alignment to determine land uses within the RoW. The field survey included verficiation of this mapping throughout the RoW.

270000 280000 290000 300000 310000 320000 330000 340000 350000 360000

2070000 2060000 2050000 2040000 2030000 2020000 2010000

Legend

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

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Access Road (Main Dam)
- Proposed Access Road (Transmission Line)
- Proposed Transmission Line

Biodiversity Survey Locations:

- Forest Survey Location
- Aquatic Survey Location
- Wildlife Survey Location

N

0 2.5 5 7.5Km

1:250,000

Basemap: ESRI World Imagery
Datum: WGS84

Xiengmi
Longxan
Nam Leuk reservoir
Phou Khao Khouay National Protected Area
Papek
Nam Mang 3 Reservoir
Nakhai
Nangommay
Ban Natan
Xienglaena
Veunthan
Somsamay
Palai
Nakhao
Donsangphai
Phao
Hai
Dongneng
Na
Thabok
Mekong River
Pakxan
Ban Hatsaykham
Ban Hat Gniun
Ban Thahuea
Phou Ngou Provincial Protected Area
Ban Sisavath
Huay Ngua Provincial Protected Area

Client:	Nam Ngiep Power Company Ltd.		**Figure 2.1 - Biodiversity Survey Locations**
Drawing No:	0185065b_TL_BIODASSES_G002_R0.mxd		
Date:	17/01/2014	Drawing Size: A3	Nam Ngiep 1 Hydropower Project Transmission Line Biodiversity Assessment
Drawn By:	TC	Reviewed By: DN	

Environmental Resources Management ANZ
Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

3 SCOPING OF PROJECT IMPACTS ON BIODIVERSITY VALUES

3.1 BACKGROUND

This Section documents the scoping of potential project impacts on biodiversity values in accordance with the requirements of IFC PS6. It considers:

- type of activities; including the nature of the Project impacts based on the Project lifecycle (pre-construction and construction of project facilities, and operation activities);
- impacts and threats to biodiversity values (in terms of *direct* or *indirect* impacts); and
- spatial extent of the impacts (area and condition of habitats); and
- permanence of the impacts (temporal nature of impacts or cumulative impacts).

3.2 SCOPING

3.2.1 *Project Activities*

The main activities associated with the construction of the transmission line include:

- Clearing of vegetation construction of towers and access tracks;
- Vegetation trimming for the RoW;
- Earthworks for installation of the transmission towers;
- Construction of towers and stringing;
- Transport of materials;
- Operation of large machinery;
- Construction of temporary stockyards, works camps and mobile offices;
- Storage of hazardous materials and refuelling;
- Rehabilitation of RoW areas not required to be permanently cleared; and
- Operation of worker camp.

The main activities associated with the operation of the transmission line are:

- Maintenance of the RoW, including repairs to transmission lines, and trimming vegetation;
- Vehicle travel along access tracks within and outside of the RoW for maintenance activities;
- Presence of permanent infrastructure, including towers, conductors and permanent access roads; and
- Transmission of electricity.

3.2.2 Nature Of Impacts

Table 3-1 summarises the nature of impacts to biodiversity values related to the activities. These terms are used in the scoping of project impacts on biodiversity values and relate to the identified threats from the activities.

Table 3.1 Nature of impacts on biodiversity values

Term	Description
Direct Impacts	Direct physical displacement or impact from the Project on a species' habitat or lifecycle.
Indirect Impacts	A secondary impact resulting from a direct impact from the Project on a species' habitat or lifecycle.
Spatial Impacts	Impacts on species' habitats or lifecycle including: isolation of populations or individuals; impacts on species endemism; impacts on the heterogeneity of species; environmental gradients; edaphic interfaces (derived from soil toils); connectivity between habitats and climate change adaptation importance.
Temporal Impacts	• Temporary Impact means a reversible impact on a species' habitat or lifecycle; and • Permanent Impact means an irreversible impact on a species' habitat or lifecycle.
Cumulative Impacts	Impacts from the total of all impacts on a species' habitat or lifecycle.

3.2.3 Threats to Biodiversity Values

Table 3-2 defines the threats to biodiversity values related to the activities. These threats to biodiversity are derived from IFC 6 and relate to the activities that are likely to occur during Project construction and post construction phases.

Table 3.2 Threats to biodiversity values

Term	Description
Permanent Loss	Permanent loss of habitat or species due to permanent or temporary site activities for the Project
Disturbance and displacement	Disturbance to, or displacement/exclusion of a species from foraging habitat due to construction and operational activities.

Term	Description
Barrier creation	Creation of barriers to the movements of animals with limited powers of dispersal.
Fragmentation	Fragmentation of habitat, or permanent /temporary severance of wildlife corridors between isolated habitats of importance for biodiversity.
Edge Effects	Disturbance or damage to adjacent habitat and species caused by movement of vehicles and personnel, potential mobilisation of sediment, artificial lighting, dust, spillage of fuels and chemicals, emissions and noise, and subsidence.
Alien Species	Introduction or spreading of alien species during the construction works.
Pollution	Contamination of the environment that has a direct or indirect impact on a species either through exposure to harmful substances.
Mortality	Mortality of individual fauna species as a result of vehicle or machinery strike or falling debris during clearing activities. Mortality of avian and bat species as a result of collision or electrocution.

4 BASELINE BIODIVERSITY VALUES OF THE PROJECT AREA

4.1 OVERVIEW

As of January 2014, targetted ecological surveys have not been undertaken within the Project Area. A review of ecological surveys of the other NNP1 project components, and secondary data of protected areas, has been undertaken to identify the biodiversity values of the region and to identify the IUCN Red Listed species and National Restricted species with potential to occur in and around the Project Area. The findings of this review will inform additional ecological surveys to be undertaken prior to construction.

The following Section summarises the key biodiversity values identified from the secondary data sources, ecological surveys of other NNP1 project components (TISTR 2013), and geospatial analysis. Where appropriate the values are quantified or discussed in terms of the Project Area (RoW) however the biodiversity values of the surrounds are also considered.

4.2 TERRESTRIAL BIODIVERSITY VALUES

4.2.1 Vegetation

Land Cover

The Lao landscape has historically been dominated by dense forest and, despite more recent clearance, retains significantly more forest coverage than neighbouring countries Thailand, Vietnam and China (Yunnan Province) (Duckworth *et al*., 1999). The original forests of the Northern-Central Highlands, where the Project Area is located, were predominantly dry evergreen and mixed deciduous forests. However, shifting cultivation has removed much of the original forest and large areas of grassland, bamboo and other secondary vegetation are now present. Non-timber forest products (NTFPs) such as leaves, shoots, flowers, fruits and bark are used extensively by the Lao people and are of great importance both as a food source and also medicinally and culturally.

Land cover type mapping based on DFRM 2010 forest mapping identifies the dominant landcover types within the Project Area to be deciduous forest and old fallow land, with smaller portions of young fallow land and rice paddies. The land cover types mapped within the Project Area are presented in *Table 4-1* , based on the 35 m wide RoW, and shown in *Figure 4.1*.

Table 4.1 Land cover types within the Project Area

Type (code)	Description	Total within Project Area (ha)
Natural Habitat		**151**
Deciduous forest (DF)	Deciduous forest occurs when deciduous tree species represent more than 50% of the stand. The forest storeys are not as dense as those of evergreen type. Most often bamboo occurs in this type of forest. Deciduous Forest includes both Upper and Lower deciduous forest types and this definition is based on relative altitude, forest occurring above 200 m is classified as Upper Mixed deciduous Forest and deciduous forest occurring at an altitude 200 m and below is classified as Lower Deciduous Forest.	139
Evergreen forest (EF)	Area dominated by trees where 75% or more of the tree species maintain their leaves all year. Canopy is never without green foliage.	<1
Bamboo (B)	Bamboo area where the over storey has a crown cover less than 5%.	9
Scrub, Heath (SR)	This is an area covered with scrub and stunted trees. The soil is shallow and rocky.	1
Swamp (SW)	Areas where the soil is saturated with water. The soil may basically be fertile but the lack of oxygen limits its agricultue or forest capacity. The swamp could have high ecological or environmental value and the flora and fauna may be rich.	<1
Modified Habitat		**247**
Agriculture Plantation (AP)		12
Old fallow land (OFL)	Land that has been ploughed and tilled and left un-seeded during a growing season.	133
Young fallow land (YFL)	Land that has been recently ploughed and tilled and left un-seeded during a growing season.	57
Rice paddy (RP)	Areas permanently being used for rice cultivation.	43
Slash and burn (SB)	Slash-and-burn is a description of land that has been subjected to an agricultural technique which involves cutting and burning of forests or woodlands to create fields.	2
Unclassified		**8**
Water (W)	The land cover class Water includes rivers, water reservoirs (i.e. ponds and dams for irrigation and hydro power) and lakes. Water reservoirs and lakes with an area of 0.5 ha and rivers should be at least 10m wide to be classified as Water.	2
Shadow (SH)*	Shadow indicates limitations in the dataset from shadows and cloud contained in the aerial imagery.	2
Cloud (CL)*	Cloud indicates limitations in the dataset from shadows and cloud contained in the aerial imagery.	3
Other Land (O)		<1
Rock (R)		<1

270000 280000 290000 300000 310000 320000 330000 340000 350000 360000

2070000 2060000 2050000 2040000 2030000 2020000 2010000

Legend

- Nam Ngiep Catchment Boundary
- City, Town or Village
- Lao PDR Boundary

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Proposed Access Road (Transmission Line)
- Proposed Transmission Line (Eastern Alignment)
- Proposed Transmission Line (Western Alignment)

Land Cover:

- 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

N

0 2.5 5 7.5Km

1:250,000

Basemap: ESRI World Imagery
Land Cover: DFRM
Datum: WGS84

Xiengmi
Ban Hat Gniun
Ban Thahuea
Ban Hatsaykham
Longxan
Ban Sisavath
Ban Nonsomboun
Mekong River
Pakxan
Thabok
Papek
Na
Nakhai
Nangommay
Ban Natan
Xienglaena
Hai
Veunthan
Somsamay
Palai
Nakhao
Donsangphai
Phao
Dongneng

Client:	Nam Ngiep Power Company Ltd.		
Drawing No:	0185065b_TL_BIODASSES_G003_R0.mxd		
Date:	17/01/2014	Drawing Size: A3	
Drawn By:	TC	Reviewed By: DN	

Figure 4.1 - Land Cover

Nam Ngiep 1 Hydropower Project
Transmission Line Biodiversity Assessment

Environmental Resources Management ANZ

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

ERM

Vegetation Condition

Vegetation condition based on the NDVI data within the Project Area is divided into four categories. NDVI data identified that:

- The majority of land (94%) is moderate or low condition;
- 5% of the Project Area is high condition, and this is mostly concentrated in the northern segment, from south of Huay Ngua PPA to the Main Dam;
- Approximately two thirds of the Project Area is in moderate condition, and this is evenly distributed throughout the Project Area; and
- Approximately a third of the Project Area is low condition, and this is primarily concentrated in the Pakxan region in the south east.

The representation of these categories within the Project Area is summarised in *Table 4-2* and shown *Figure 4.2*.

Table 4.2 Vegetation Condition in the Project Area

Condition Category (NDVI range)	Area within Project Area (ha)
Impacted (- to 0)	6
Low (0 to 0.4)	129
Moderate (0.4 to 0.6)	251
High (0.6 to 0.8)	22

270000 280000 290000 300000 310000 320000 330000 340000 350000 360000

2070000 2060000 2050000 2040000 2030000 2020000 2010000

Legend

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

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Re-regulation Dam
- Re-settlement Area
- Access Road (Main Dam)
- Proposed Access Road (Transmission Line)
- Transmission Line (Eastern Proposed Alignment)
- Transmission Line (Western Proposed Alignment)

Condition Class:

- High
- Moderate
- Low
- Impacted

N

0 2.5 5 7.5Km

1:250,000

Basemap: ESRI World Imagery
Datum: WGS84

Xiengmi
Longxan
Ban Hat Gniun
Ban Thahuea
Ban Hatsaykham
Phou Ngou Provincial Protected Area
Ban Sisavath
Huay Ngua Provincial Protected Area
reservoir
Phou Khao Khouay National Protected Area
Pakxan
Thabok
Papek
Nam Mang 3 Reservoir
Na
Nakhai
Nangommay
Ban Natan
Xienglaena
Mekong River
Hai
Veunthan
Somsamay
Palai
Phao
Donsangphai
Nakhao
Dongneng

Client:	Nam Ngiep Power Company Ltd.		
Drawing No:	0185065b_TL_BIODASSES_G004_R0.mxd		
Date:	17/01/2014	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 4.2 - Condition Class (NDVI)

Nam Ngiep 1 Hydropower Project
Transmission Line Biodiversity Assessment

Environmental Resources Management ANZ

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

ERM

4.2.2 *Flora Species*

The following sections outline the flora species, diversity and condition identified for Huay Ngua PPA, the resettlement area, the NNP1 Access Road and Phou Khao Kouay NPA.

Huay Ngua PPA

Sampling undertaken during 2013 surveys by TISTR recorded 451 species of vascular plants in the Huay Ngua PPA sampling locations and 410 at the resettlement area sampling locations on the west bank of the Nam Ngiep River. Huay Ngua PPA vegetation is dominated by mixed deciduous forest with some areas of mixed evergreen forest and secondary growth of mixed deciduous forest. Canopy cover was recorded at approximately 60-70 per cent.

Resettlement Area

Resettlement area vegetation is dominated by secondary growth of mixed deciduous forest. Canopy cover was recorded at approximately 40% (TISTR 2013).

NNP1 Access Road

The botanical inventory collected within the disturbance footprint by NUL identified 139 species of vascular plants (Phengsintham 2013) that included one Bryophyta species, nine Pteridophyta species, 102 Dicotyledones species, 25 monocotyledons species and three mushroom species (NUL 2013).

Phou Khao Kouay NPA

The central portion of Phou Khao Kouay NPA contains the lower basins of the Nam Leuk and Nam Mang. This area is predominantly upper dry evergreen forest. This forest has plant families and genera typical for other parts of Southeast Asia, such as the genera Dipterocarpus and Shorea. Mixed deciduous forest is found on lighter, shallow soils. Large stands of coniferous forest, usually monospecific stands of *Pinus merkusii*, grow on shallow, nutrient deficient, sandy soils, particularly in the western portion of the park, where it occurs in association with extensive, fire-climax grasslands.

The dominant species recorded by TISTR in each canopy strata are summarised in *Table 4-3*.

Table 4.3 Dominant Flora Species in survey sites

Canopy class	Dominant species
Resettlement Site Secondary Growth of Mixed Deciduous Forest	
Top canopy (~15m)	*Taliparitimacrophyllum, Peltophorum dasyrachis, Macaanga denticulata, Lepisanthes rubiginosa, Cratoxylum formosum, Aporosa villosa, Chaetocarpus castanocarpus, Maesa ramentacea, Irvingia malayana, Lagerstoemia calyculata.*

Canopy class	Dominant species
Lower canopy (<10m)	Densely covered by seedlings of original forest type, shrubs, climbers and herbs such as *Cleistanthus papyraceus*, *Ardisia helferiana*, *Chionanthus velutinus*, *Connarus semidecandrus, and Amomum biflorum*. The typical species of bamboo found in the area is *Gigantochloa albociliata.*
Access Road (Huay Ngua PPA) Mixed Deciduous Forest	
Top canopy (20-35m)	*Anisoptera costata, Lagerstroemia calyculata, Shorea roxburghii, Irvingia malayana, Alstonia glaucescens, Schima wallichii, Vitex pinnata, Stereospermum fimbriatum*
Middle canopy (10-20m)	*Acronychia pedunculata*, *Peltophorum dasyrachis*, *Nauclea orientalis*, *Microcos tomentosa*, *Mallotus paniculatus*, *Gonocaryum lobbianum, Cratoxylum formosum*
Lower canopy (<10m)	*Croton cascarillicdes*, *Breynia glauca*, *Ardisia helferiana*, *Glycosmis pentaphylla*, *Melicope pteleifolia*, *Allophylus cobbe*, *Salacia chinensis*

IUCN Listed Species

A total of 11 plant species listed under the IUCN Red List were recorded during vegetation surveys of the Re-settlement area and Huay Ngua PPA in 2013, the NUL vegetation ground-truthing survey and desktop review of PKK. The species are considered the subject species for the transmission line Project Aea. The IUCN listed species are shown in *Table 4-4* and include:

- one species listed as critically endangered;
- five species listed as endangered; and
- five species listed as vulnerable.

Table 4.4 IUCN Listed Flora Species Reported

Scientific Names	Status	Huay Ngua PPA (TISTR)	Phou Khao Khouy NPA (Indirect)	Re-settlement Site (TISTR)
Dipterocarpus turbinatus	CR	✓		
Afzelia xylocarpa	EN	✓		✓
Anisoptera costata	EN	✓	✓	
Dalbergia oliveri	EN	✓		✓
Dipterocarpus alatus	EN	✓	✓	
Shorea roxburghii	EN	✓		✓
Cycas pectinata	VU	✓		
Dalbergia cochinchinensis	VU	✓		
Hopea odorata	VU	✓		✓
Syzygium vestitum	VU	✓		
Ternstroemia wallichian	VU	✓		

4.2.3 Fauna Species

Huay Ngua PPA

A total of 38 terrestrial species of fauna from 19 families, and 31 genera were recorded from the field surveys in 2013 surveys in Huay Ngua PPA by TISTR. Species diversity of animals recorded in this area was low in comparison to other areas surveyed nearby however this is expected to be due to the lack of secondary data, all records were obtained by direct observation during the TISTR field surveys.

The Huay Ngua Provincial Preserved Area Management Plan reports (indirect data) fauna species occurring within the PPA to include wild pig, munjac, clouded leopard (*Pardofelis nebulosa*), civet, flying squirrel as well as Green peafowl (*Pavo muticus*), Hill myna (*Gracula religiosa*), Red junglefowl (*Gallus gallus*) and the Siamese fireback (*Lophura diardi*).

Overall, the TISTR surveys and indirect data reported:

- Nine amphibian species;
- Fifty-nine bird species;
- Twenty-seven mammal species;
- Nine reptile species; and
- Thirty-nine fish species (including twelve species considered to be migratory).

Resettlement Area

Field surveys of the Resettlement area in 2013 found that the area is 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.

Restricted Species

Species listed as Restricted under the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF includes wild animals and fish which are rare, endangered, high conservation value, and special significance to the economy and national environment.

The 2013 surveys of the Resettlement area and Huay Ngua PPA by TISTR in 2013 (direct data) and indirect data sources identified the following species listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF that may also occur within the transmission line RoW:

- Two mammal species;

- Six bird species;
- One reptile;
- One fish;
- No amphibians.

These species are considered subject species for the transmission line Project Area.

Table 4.5 No. 0360/MAF Restricted Fauna Species Reported

Common Name	Scientific Name	Direct Data	Indirect Data	No. 0360/MAF Status
Mammals				
Leopard	*Panthera pardus*		✓	Restricted
Asiatic golden cat	*Pardofelis temminckii*		✓	Restricted
Bengal slow loris	*Nycticebus bengalensis*		✓	Restricted
Birds				
Great hornbill	*Buceros bicornis*		✓	Restricted
Greater coucal	*Centropus sinensis*	✓	✓	Restricted
Siamese fireback	*Lophura diardi*		✓	Restricted
Silver pheasant	*Lophura nycthemera*		✓	Restricted
Grey peacock-pheasant	*Polyplectron bicalcaratum*		✓	Restricted
Red-breasted parakeet	*Psittacula alexandri*	✓	✓	Restricted
Reptiles				
Reticulated python	*Broghammerus reticulatus*		✓	Restricted
Fish				
	Wallago leeri		✓	Restricted

IUCN Listed Species

Three IUCN Red Listed critically endangered, endangered or vulnerable fauna species were recorded within the Huay Ngua PPA area during 2013 surveys by TISTR while 16 additional species listed as critically endangered, endangered or vulnerable on the IUCN Red List that may occur within the Huay Ngua PPA were identified. Information regarding the PKK identified a number of IUCN Red List species to occur within the national protected area, including ten mammal species (1 critically endangered, 4 endangered and 5 vulnerable).

Table 4.6 IUCN Listed Fauna Species Recorded/Reported

Common Name	Scientific Name	Direct Data	Indirect Data	IUCN Status
Mammals				
Northern white-	*Nomascus leucogenys*		✓	CR

Common Name	Scientific Name	Direct Data	Indirect Data	IUCN Status
cheeked gibbon				
Asian wild dog, dhole	*Cuon alpinus*		✓	EN
Asian elephant	*Elephas maximus*		✓	EN
Sunda pangolin	*Manis javanica*		✓	EN
Fishing cat	*Prionailurus viverrinus*		✓*	EN
Phayre's leaf monkey	*Trachypithecus phayrei*		✓	EN
Asian small-clawed otter	*Aonyx cinerea*		✓	VU
Gaur	*Bos gaurus*		✓	VU
Malayan sun bear	*Helarctos malayanus*		✓	VU
Northern pig-tailed macaque	*Macaca leonina*		✓	VU
Clouded leopard	*Neofelis nebulosa*		✓	VU
Bengal slow loris	*Nycticebus bengalensis*		✓	VU
Sambar deer	*Rusa unicolor*			VU
Himalayan black bear	*Ursus thibetanus*		✓	VU
Large spotted civet	*Viverra megaspila*		✓	VU
Birds				
White-winged duck	*Cairina scutulata*		✓*	EN
Green peafowl	*Pavo muticus*		✓	EN
Imperial eagle	*Aquila heliaca*		✓	VU
Reptiles				
Big-headed turtle	*Platysternon megacephalum*		✓	EN
Southeast Asian softshell turtle	*Amyda cartilaginea*		✓	VU
Snail-eating turtle	*Malayemys subtrijuga*		✓	VU
Impressed tortoise	*Manouria impressa*		✓	VU
Indo-Chinese spitting cobra	*Naja siamensis*		✓	VU
Fish				
Giant barb	*Catlocarpio siamensis*		✓	CR
Striped catfish	*Pangasianodon hypophthalmus*		✓	EN
Yellow tail brook barb	*Poropuntius deauratus*	✓*		EN
Thicklipped barb	*Probarbus labeamajor*		✓	EN
Bandan sharp-mouth barb	*Scaphognathops bandanensis*	✓		VU
Jaguar loach	*Yasuhikotakia splendida*	✓		VU

CR = Critically endangered, EN = Endangered, VU = Vulnerable

*Specialist consultation identified potential for unreliable record

4.3 SOCIAL AND CULTURAL VALUES

The initial IEE identified that approximately a third of land in the study area was deforested/degraded land used for swidden agriculture or shifting cultivation. Approximately 6% of land supported paddy fields, tree plantations and gardens (ERIC 2012).

The initial IEE identified that all of the 20 villages studied had buddist temples and monasteries, and many villages had spirit sites *(phi muang, phi thien, phi mau)* (ERIC 2012). The people in this area value the temples as significant local cultural and traditional features (ERIC 2012). The intial IEE identified that temples were approximately 2 km from the proposed RoW (ERIC 2012).

4.4 *PRIORITY BIODIVERSITY VALUES*

IFC PS6 provides guidance on the identification of habitat values of an area through the definition of modified and natural habitats, as well as critical habitats. These categories provide a mechanism to rank areas of importance across the site. Similarly, species categorised as critically endangered, endangered and vulnerable are considered to be at a heightened risk of extinction and are awarded an elevated level of consideration under the IFC Performance Standards.

IFC PS6 identifies that the relative importance with respect to conserving a biodiversity value can be determined by its status in terms of irreplaceability in the landscape and vulnerability in being able to persist. These factors have been included in the presentation of species specific information for the purposes of critical habitat determination. *Irreplaceability* refers to the number of spatial options remaining where conservation of a value can occur. *Vulnerability* is a temporal limitation whereby threats to a value in a location increase the exposure to conservation risk.

Modified Habitat

Modified habitat is altered natural habitat, often formed by the removal of native species for harvesting, land conversion and/or introduction of alien flora and fauna species (ADB, 2012).

Land cover mapping for the Project Area identified a number of vegetated cover classes. The agriculture plantation, old fallow land, young fallow land, rice paddy and slash and burn classes are considered to be modified habitats. *Figure 4.1* shows the distribution of these modified land uses within the Project Area.

Natural Habitat

Natural habitat is an environment where the biological communities are largely formed by native plant and animal species and where human activity has not modified the areas primary ecological functions (ADB, 2012).

Land cover mapping for the Project Area identified a number of vegetation cover classes. The deciduous forest, evergreen forest, bamboo, scrub/heath and swamp classes are considered to be natural habitats for the purposes of this assessment. *Figure 4.1* shows the distribution of the natural habitat land uses within the Project Area.

Critical Habitat

One of the key provisions of IFC PS 6 is the identification of 'Critical Habitat'. IFC PS6 defines critical habitats as areas with high biodiversity value, including (but not limited to) habitat of significant importance to critically endangered and/or endangered species. For this Project, threatened species

with potential to occur have been considered as candidates for determination of critical habitat.

Specifically, critical habitat criteria form the basis of the determination (IFC PS6 Guidance Note). The criteria include:

- Criterion 1: Critically endangered and or endangered species (Tier 1 and Tier 2 sub-criteria for habitat for these species);
- Criterion 2: Endemic and/or restricted-range species (Tier 1 and Tier 2 sub-criteria for habitat for these species);
- Criterion 3: Migratory and/or congregatory species (Tier 1 and Tier 2 sub-criteria for habitat for these species);
- Criterion 4: Highly threatened and/or unique ecosystems;
- Criterion 5: Key evolutionary processes.

Assessment of the Project Area has not identified any highly threatened and/or unique ecosystems, or key evolutionary processes. As such the assessment focusses on the relevance of Criterion 1-3. Each of the candidate species has been assessed for the critical habitat determination criteria 1-3 using direct and indirect data sources.

The species information was collated and analysed against the relevant critical habitat criteria (*Annex D*). A summary of the analysis is provided below. The species screened against the determination criteria and quantitative thresholds include IUCN listed species, species listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF and species considered to be migratory.

Table 4.7 Candidate Species Critical Habitat Assessment Summary

Species	Criteria	Record		Likely Critical Habitat	Comment
		Direct	In-direct		
Afzelia xylocarpa	1	✓		No	Project area not of significant importance for the species.
Anisoptera costata	1	✓		NA	Not native to Lao PDR.
Dalbergia oliveri	1	✓		NA	Not native to Lao PDR.
Dipterocarpus alatus	1	✓		NA	Not native to Lao PDR.
Dipterocarpus turbinatus	1	✓		No	Project area not of significant importance for the species.
Shorea roxburghii White meranti	1	✓		No	Project area not of significant importance for the species.
Cuon alpinus Dhole	1		✓	No	Project area not of significant importance for the species.
Elephus maximus Asian elephant	1		✓	No	Project area not of significant importance for the species.
Manis javanica Sunda pangolin	1		✓	No	Key threat will require management.
Nomascus leucogenys Northern white-cheeked gibbon	1	✓		No	Project area not of significant importance for the species.
Nycticebus bengalensis Bengal slow loris	1		✓	No	Project area not of significant importance for the species.
Panthera pardus Leopard	1		✓	No	Key threat will require management.
Pardofelis temminckii Asiatic golden cat	1		✓	No	Project area not of significant importance for the species.
Prionailurus viverrinus Fishing cat	1		✓	No	Project area not of significant importance for the species.
Trachypithecus phayrei Phayre's leaf monkey	1		✓	No	Project area not of significant importance for the species.
Buceros bircornis Great hornbill	1		✓	No	Project area not of significant importance for the species.
Cairina scutulata White winged duck	1		✓	No	Project area not of significant importance for the species.
Centropus sinensis Greater coucal	1	✓		No	Project area not of significant importance for the species.
Lophura diardi Siamese fireback	1		✓	No	Project area not of significant importance for the species.
Lophura nycthemera Silver pheasant	1		✓	No	Project area not of significant importance for the species.
Pavo muticus Green peafowl	1		✓	No	Project area not of significant importance for the species.
Polyplectron bicalcaratum Grey peacock pheasant	1		✓	No	Project area not of significant importance for the species.
Psittacula alexandri Red-breasted parakeet	1		✓	No	Project area not of significant importance for the species.
Broghammerus reticulatus Reticulated python	1		✓	No	Project area not of significant importance for the species.

Species	Criteria	Record		Likely Critical Habitat	Comment
		Direct	In-direct		
Platysternon megacephalum Big-headed turtle	1		✓	No	Project area not of significant importance for the species.
Catlocarpio siamensis Giant barb	1,3		✓	No	Project area not of significant importance for the species.
Pangasianodon hypophthalmus Striped catfish	1,3		✓	No	Project area not of significant importance for the species.
Poropuntius deauratius Yellow tail brook barb	1	✓		No	Species misidentification. Project area not of significant importance for the species.
Probarbus labeamajor Thicklipped barb	1,2,3		✓	No	Project area not of significant importance for the species.
Wallago leeri	2		✓	No	Project area not of significant importance for the species.
Migratory fish species	3	✓		No	Project area not of significant importance for the species.
r = species included at request					

Habitat Summary

A summary of the area of each habitat type within the Project Area in accordance with IFC PS6 definitions is provided in *Table 4-8*.

Table 4.8 Area of Habitat Types within the Project Area

Habitat Type	Estimate within Project Area (ha)*
Natural Habitat	151
Modified Habitat	247
Other	8
*Estimate derived from land cover mapping.	

5 BIODIVERSITY IMPACT ASSESSMENT

5.1 APPROACH

The assessment of impacts was undertaken using a standardised impact assessment (Mitigation Hierarchy) approach that follows key steps:

1. **Evaluate** the significance of the impacts by considering the magnitude of the impacts (nature, scale and duration) and the nature of the receptor (*sensitivity*) (*Table 5-1* and *Table 5-2* outline the significance criteria matrix);
2. **Mitigate** any potential impacts evaluated as *Moderate* or *Major* and determine alternatives for any impacts evaluated as *Critical* (*Section 6.1*); and
3. Identify the **Residual** biodiversity values impacted to determine if potential significant impact remains after mitigation (*Section 6.3*);
4. Identify the requirements for **Biodiversity Offsetting** (*Section 6.4*).

5.1.1 *Significance Criteria*

The Project impacts identified have been assessed for their significance against each potentially occurring habitat and species according to the criteria provided in *Table 5-1* and *Table 5-2.*

Table 5.1 Habitat Impact Assessment – Significance Criteria

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

Table 5.2 Assessment of risks to Species

Species Sensitivity/Value		Magnitude of Effect			
		Negligible	**Small**	**Medium**	**Large**
Low	Species which are included on the IUCN Red List of Threatened Species as Least Concern (LC) (IUCN 2011).	Not significant	Not significant	Minor	Moderate
Medium	Species included on the IUCN Red List of Threatened Species as Vulnerable (VU), Near Threatened (NT) or Data Deficient (DD) (IUCN 2011). Species protected under national legislation. Nationally restricted range species. Nationally important number of migratory or congregatory species.	Not significant	Minor	Moderate	Major
High	Species included on the IUCN Red List of Threatened Species as Critically Endangered (CR) or Endangered (EN) (IUCN 2011). Species having a globally Restricted Range (ie plants endemic to a site or found globally at fewer than 10 sites, fauna having a distribution range (or globally breeding range for bird species) less than 50,000 km^2. Internationally important numbers of migratory or congregatory species. Key evolutionary species.	Not significant	Moderate	Major	Critical
Magnitude of Effect Definition					
Negligible	*Effect is within the normal range of variation.*				
Small	*Affects a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself*				
Medium	*Affects a sufficient proportion of a species population that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.*				
Large	*Affects an entire population or species at sufficient scale to cause a substantial decline in abundance and/or change in distribution beyond with natural recruitment (reproduction, immigration from unaffected areas) may not return that population or species, or any population or species dependent upon it, to its former level within several generations, or when there is no possibility of recovery.*				

5.2 *ASSESSMENT OF IMPACTS TO BIODIVERSITY VALUES FROM ACTIVITIES*

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, and dust;
- Creation of a barrier to fauna movement;
- Fragmentation of habitat;
- Edge effects;
- 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;
- Mortality as a result of vehicle strike; and
- Mortality of avian and bat species as a result of collision or electrocution.

The Project Area and adjacent areas contain biodiversity and conservation values.

Table 5.3 Assessment of Impacts to Natural and Modified Habitats

Impact	Description	Comment	Sensitivity	Magnitude	Significance
Temporary loss of habitat	Temporary disturbance of habitat in areas required to facilitate construction. Temporary disturbance will mainly be associated with construction areas surrounding tower pads, any required access tracks to tower locations, and temporary stockyards, workers camps and mobile offices.	Construction activities will require clearing of vegetation for tower pads, access tracks, and temporary infrastructure such as worker camps and mobile offices. The habitat types within the proposed RoW are common and widespread within the region (Low sensitivity) and the loss will be limited to that necessary for construction. The areas to be temporarily disturbed are considered unlikely to impact the viability or functioning of adjacent ecosystems (Small magnitude). Where possible topsoil will be managed locally and natural regeneration or rehabilitation using native species will be undertaken in areas not required for the operation of the Project. For access road waterway crossings, water exclusion dams may be required during construction leading to a loss of habitat locally and restriction of movement by aquatic species.	Low	Small	**Negligible**
Permanent loss or modification of habitat	Permanent loss of 65 ha of habitat, and modification of 373 ha of habitat within the corridor footprint.	The Project Area is approximately 438 ha, with the area of natural habitat within mapped as approximately 151 ha. The Project will require permanent clearing of approximately 65 ha of vegetation for tower pads and access tracks within the RoW. The remaining area, approximately 373 ha, will require require selective removal of tall growing species (>3m height). Tower locations have not yet been defined, however based on a ratio of 37% of vegetation as natural habitat, it is expected that 24 ha of natural habitat would be permanently removed, and 138 ha of natural habitat would be permanently modified. In the context of the surrounding area, the habitats are representative of the larger catchment and not considered unique. A diversity of flora and fauna species were reported to occur in the Huay Ngua PPA (based on ecological surveys or village surveys), including IUCN listed species (sensitivity medium) in the disturbance area and the habitat for these populations will be locally reduced. Similarly, in the context of the extent of the PPA the removal is not likely to	Medium	Small	**Minor**

Impact	Description	Comment	Sensitivity	Magnitude	Significance
		threaten the long-term viability of the habitat and biodiversity (magnitude small). Habitat for threatened species is specifically assessed in *Table 5-4*.			
Temporary disturbance to fauna behaviours	Disturbance and displacement of resident fauna due to noise, light and/or vibration as a result of construction activities (excavation, drilling, blasting, clearing, operation of camps, plant and vehicle movement).	Noise and light disturbances have the potential to influence fauna breeding, roosting or foraging behaviour of native fauna. The consequences of these influences are dependent on the extent of disturbance but in extreme cases these factors can influence local populations if breeding and communication is inhibited. Excessive noise can impede fauna communication and deter the use of habitats nearby. Similarly, introducing light sources has the potential to deter foraging and dispersal activities of nocturnal species.	Low	Small	**Negligible**
Permanent disturbance to fauna behaviours	Disturbance and displacement of resident fauna due to noise as a result of electricity transmission, and noise and light as a result of maintenance activities.	Noise and light disturbances have the potential to influence fauna breeding, roosting or foraging behaviour. The consequences of these influences are dependent on the extent of disturbance but in extreme cases these factors can influence local populations. Excessive noise can impede fauna communication and deter the use of habitats nearby. Similarly, introducing light sources has the potential to deter foraging and dispersal activities of nocturnal species.	Low	Small	**Negligible**
Barrier to movement and habitat fragmentation	Barrier to terrestrial fauna movement and habitat fragmentation	The RoW will not be fenced, and limited infrastructure will exist at ground level (towers only). Vegetation to 3 m high will be retained, which will maintain shelter at ground level and as such facilitate he maintenance of fauna movement. The RoW may interrupt the continuity of forest habitat, as vegetation heights will be limited to below 3 m, however the maintenance of vegetation in the understorey and midstorey is likely to continue to allow arboreal species to move throught the landscape.	Low	Small	**Negligible**

Impact	Description	Comment	Sensitivity	Magnitude	Significance
	Barrier to aquatic fauna movement and habitat fragmentation	Although the transmission line includes numerous watercourse crossings transmission line construction is not expected to involve instream works, as conductors will be strung from outside watercourses. The Project may, however, required the construction of access roads which could involve watercourse crossings. The construction design and activities will consider the requirement to maintain flow within the watercourses. A number of IUCN listed species and other native species have been identified within the NNP1 project components that are migratory (sensitivity medium). These species have potential to occur within watercourses that may be affected by access roads required for transmission line construction. Bridge and other crossing infrastructure will be designed to maintain existing flows such that there is not barrier to movement in the long term (magnitude small).	Medium	Small	**Minor**
Edge effects	Vegetation clearing required the Project will generate newly disturbed forest edges around the margins of access roads, transmission towers and associated infrastructure.	Edge effects are an indirect impact of land clearing. Where vegetation clearing occurs, adjacent vegetation and habitats are exposed to increased noise, light, dust and wind environment as well as increased competition from predators and invasive species. In extreme cases some of these effects have potential to alter the habitat characteristics of the ecotone and influence suitability for native flora and fauna. 'New' habitat edges will be created where clearing occurs adjacent existing cleared areas as well as in previously undisturbed areas. In general, the habitats that may be impacted are common and widespread within the region (low sensitivity) and the impact is not likely to impact the viability/function of adjacent habitats (small magnitude).	Low		**Negligible**
Degradation of habitat	Introduction of alien species and competition with native communities	Invasive or alien species have the potential to be introduced or spread throughout the Project Area through increased movement of people, vehicles, machinery, vegetation and soil. An increase in the prevalence of weeds or other pests has the potential to reduce the quality of habitat for some native flora and fauna, including threatened species (sensitivity medium). Invasive flora species can rapidly germinate in disturbed areas whereby affecting the ability of native	Medium	Small	**Minor**

Impact	Description	Comment	Sensitivity	Magnitude	Significance
		vegetation communities to re-establish. Alien animals also have the potential to be introduced or increased in abundance. These animals may adversely impact native fauna as a result of increased competition for resources, predation or habitat degradation. Vehicle movement and activities which introduce a risk of invasion will be focussed along access tracks, tower locations and areas requiring vegetation management within the RoW (magnitude small).			
	Accidental release of hazardous substances stored or used during construction and operation phases.	The Project components include the storage and handling of hazardous materials, including refuelling. Accidental release or spill of these materials can be toxic to flora and fauna locally and downstream if substances are released into the aquatic environment. During operation, maintenance of vegetation in the RoW may involve the use of herbicides. Use of herbicides could have unintended impacts on non-target vegetation if personnel are not appropriately trained in the proper use of herbicides. The waterways of the region experience substantial flows and as such it is likely that an accidental spill can be diluted such that impacts are localised (magnitude small) however the catchment provides habitat for nationally and globally listed species (sensitivity medium).	Medium	Small	**Minor**
	Indirect impacts, including dust emissions, polluted runoff, edge effect and noise impacts..	A range of Project activities have the potential to lead to indirect impacts to native flora, fauna and habitats. In general this includes dust and runoff impacts during construction as well as longer term edge effects and noise impacts of the operation of the facilities. During construction, land preparation has the potential to generate dust which may settle on vegetation adjacent to the construction area. Excessive dust deposition on flora may act to suppress growth through limiting photosynthesis and the dusted foliage may also become unpalatable to foraging fauna. The construction activities will be temporary and short lived, and dust generation is likely to be localised to active work areas. Rainfall will generally remove dust			**Minor**

Impact	Description	Comment	Sensitivity	Magnitude	Significance
		from foliage. Land preparation will create exposed bare earth areas that are vulnerable to erosion (wind and/or runoff) until infrastructure construction or replanting is completed to stabilise the surface. Erosive processes transport and deposit sediment to downstream habitats (both aquatic and terrestrial). The indirect impact has potential to degrade downstream habitat areas or change habitat characteristics, and as such influencing suitability for native flora and fauna communities. Use of herbicides in RoW maintenance may have indirect impacts to terrestrial and acquatic habitats outside the RoW via release to non-target areas in run-off or wind. The waterways in the region experience substantial flows and as such it is likely that an accidental spill can be diluted such that impacts are localised (magnitude small) however the catchment provides habitat for nationally and globally listed species (sensitivity medium).			
Fauna mortality		Fauna mortality can occur during vegetation clearing activities in the event individuals are struck by vehicles and machinery. Animals that are unable to disperse during clearing activities are vulnerable to being injured or destroyed through interaction with machinery or falling debris. Fauna mortality is most likely to occur during the construction phase, when vegetation is completely removed, however may also occur during vegetation management in the RoW throughout the operation phase, for example if nests are located within trimmed vegetation. It is likely that most individuals will disperse (sensitivity low) from clearing locations into adjacent habitats however some less mobile species may experience a localised reduction (magnitude small) in abundance during this period, such as amphibians, reptiles and small mammals. Fauna mortality can also occur as a result of hunting, poaching and collection for trade. The upgrade of the access road and construction or new access pathways	Low	Small	**Negligible**

Impact	Description	Comment	Sensitivity	Magnitude	Significance
		will improve access to the region, thud increasing the opportunity for these activities. Hunting, poaching and collection are threats identified for many of the species highlighted in this report. During operation, mortality of avifauna (birds and bats) may occur due to collision with the transmission line and electrocution. Avian collisions could occur in large numbers if lines are located in daily flyways, or if avifauna are travelling during low light conditions.			

Table 5.4 Assessment of Impacts on Conservation Significant Biodiversity Values

Value	Impacts	Sensitivity	Magnitude	Significance
IUCN Listed Critically Endangered and Endangered Species Habitat (terrestrial)	Forest suitable for the endangered IUCN listed flora and fauna species (sensitivity high) is within the Project Area. An assessment of critical habitat status in accordance with the IFC PS6 and ADB Sourcebook guideline identified it is unlikely the Project Area contains critical habitat. The plant species habitat preferences include the natural habitats represented within the Project Area and surrounds. The Project Area contains 151 ha of natural habitat. Mammal species that may occur in the Project Area include the Asian elephant. The deciduous forest areas of the Project Area are potential habitat for this species (140 ha). The Asian elephant is a highly mobile species and a herd is known to occur near Na. The alignment has been designed to avoid this population and the conservation area maintained by the local village.	High	Small	**Moderate**
IUCN Listed Vulnerable and nationally listed Restricted species Habitat (terrestrial)	Habitat suitable for vulnerable IUCN listed species will be directly impacted by the Project. This area is dominated by natural habitat in particular deciduous forest. The Project Area contains 151 ha of natural habitat. The plant species habitat preferences include the natural habitats represented within the Project Area and surrounds. Desktop review identified the mammal species that may be impacted include the gaur, Malayan sun bear, clouded leopard, Sambar deer, Himalayan black bear and large spotted civet. The disturbance area is supports natural habitat, including deciduous forest of which most of these species may inhabit. The majority of the mammal species are highly mobile and it is unlikely that home ranges are contained within the disturbance area. Bird species that may be impacted include the white-winged duck, green peafowl and imperial eagle. Habitat availability in the wider catchment is well represented and the impact area is limited in the context of the locality.	Medium	Medium	**Moderate**

Value	Impacts	Sensitivity	Magnitude	Significance
IUCN Listed Critically Endangered and Endangered Species Habitat (aquatic)	Watercourse crossings may be required to facilitate access to the transmission line. The design and construction of watercourse crossings will manage the maintenance of flow and sediment and erosion control to limit impacts to upstream and downstream habitats. The big headed turtle may utilise some areas of aquatic habitat within the Project Area. Little is known about the population of the species however preferred habitat includes narrow fast flowing, cool, rocky mountain brooks and streams. The area of this habitat to be impacted will be limited to watercourse crossing locations. The impact to this species should it occur is not considered to be substantial. The giant barb and striped catfish may move through the habitats within the Project Area however the magnitude of impact is considered to be negligible given the small area of impact and other management measures utilised to maintain flow and limit impacts upstream and downstream.	High	Negligible	**Not Significant**
IUCN Listed Vulnerable species habitat, nationally listed Restricted species habitat, endemic and migratory species habitat (aquatic)	Watercourse crossings may be required to facilitate access to the transmission line. The design and construction of watercourse crossings will manage the maintenance of flow and sediment and erosion control to limit impacts to upstream and downstream habitats. A number of IUCN listed species and migratory species have potential to occur within watercourses that the Project Area intersects (sensitivity medium). Bridge and other crossing infrastructure will be designed to maintain existing flows such that there is not barrier to movement in the long term (magnitude small).	Medium	Small	**Minor**

5.3 ANALYSIS OF ALTERNATIVES OPTION

The mitigation hierarchy of avoid, minimise, mitigate and compensate, recognises the preference to avoidance mechanisms in managing environmental impacts. In accordance with these principles a preliminary study of re-routing outside Huay Ngua PPA was considered.

In this section, the base alignment considered in this biodiversity assessment, and described in Section *1.4* is referred to as the Eastern Alignment. The alternative considered avoids Huay Ngua PPA by remaining on the west bank of the Nam Ngiep River and is referred to as the Western Alignment. For the purposes of route comparison, the two alignments can be broken down into five different segments (as shown in *Figure 5.1*), each with its own considerations for route selection.

The Western Alignment rejoins the Eastern Alignment south of Huay Ngua PPA. The Western Alignment is in a steeper and more remote area than the Eastern Alignment, and development of this alignment would require the construction of an access roads totalling approximately 8 km. Vegetation areas discussed below include the areas of clearing required for the access road. *Figure 5.1* shows the route investigated.

Field reconnaissance in January 2014 by a team of engineer and environmental consutlants was undertaken to further refine the alternative options, the outcomes of which have been assessed in this section.

5.3.1 *Alternative Routes Biodiversity Values*

Vegetation and Habitats

Review of land cover mapping based on DFRM 2010 forest mapping identified habitat types and condition of each of the five segments for the two route alternatives, as indicated in *Table 5-5.* A summary of the comparative biodiversity values of each segment are discussed as follows:

- **Segment 1** – The Eastern Alignment traverses slightly less natural habitat than the Western Alignment, and the Eastern Alignment traverses less High and Moderate condition land. However, the Western Route does traverse some Impacted condition land. Both Alignments are equally preferable in terms of vegetation and habitat for Segment 1.

- **Segment 2** – The Eastern Alignment traverses considerably (4.17 ha) more natural habitat type compared to the Western Alignment. The Western Alignment does traverse slightly (2.98 ha) more High condition land, however it also avoids the Huay Ngua PPA and is therefore the preferable option.

- **Segment 3** – Both Alignments traverse similar areas of natural, modified, and unclassified habitat types. The Western Alignment traverses slightly (0.09 ha) less High condition land. Both Alignments are equally preferable for Segment 3 with respect to vegetation and habitats.

- **Segment 4** – The Western Alignment traverses considerably (11.88 ha) less natural habitat compared with the Eastern Alignment, and also traverses less High condition land and significantly less Moderate condition land. The Western Alignment is preferable for Segment 4 based on analysis of vegetation and habitats.

- **Segment 5** – Both Alignments traverse similar habitat types and conditions for Segment 5, and are equally preferable based on analysis of vegetation and habitat.

Overall, the Western Alignment avoids 12 ha of natural habitat (predominately deciduous forest). Review of NDVI mapping also identifies that the Western Alignment contains a higher proportion of low condition vegetation (39%) in comparison to the Eastern Alignment (32%).

The land cover types mapped within each alignment are summarised in *Table 5-5*. Vegetation condition for each alignment is summarised in *Table 5-6*.

Table 5.5 The Summary of Land Cover

	Habitat type (ha)			**Condition (ha)**				**Other**
Segment	*Natural*	*Modified*	*Unclassified*	*Impacted*	*Low*	*Moderate*	*High*	
1a	13.41	10.24	-	-	3.41	13.14	7.10	
1b	13.46	12.92	0.17	0.14	2.75	15.65	8.02	
2a	29.11	6.41	0.36	0.44	1.57	24.89	8.98	
2b	24.94	6.34	2.31	0.01	2.53	19.09	11.96	Avoids PPA
3a	8.52	17.50	0.10	0.06	1.90	20.86	3.29	
3b	8.57	17.48	0.08	0.06	1.78	21.11	3.20	
4a	77.00	177.33	6.53	2.47	89.68	165.60	3.12	
4b	65.12	183.33	3.94	3.73	120.84	125.41	2.41	
5a	32.48	51.82	1.58	3.06	40.90	41.93	0.01	
5b	32.73	51.56	1.59	3.09	41.10	41.69	0.01	

A, to equal eastern alignment

B, to equal western alignment

Table 5.6 Comparison of Vegetation Condition

Condition Category (NDVI range)	**Eastern Alignment (ha)**	**Western Alignment (ha)**	**Change in Western Alignment (ha)**
Impacted (- to 0)	8	7	+ <1
Low (0 to 0.4)	129	159	+ 30
Moderate (0.4 to 0.6)	251	212	- 39
High (0.6 to 0.8)	22	25	+ 4

Condition Category (NDVI range)	Eastern Alignment (ha)	Western Alignment (ha)	Change in Western Alignment (ha)

270000 280000 290000 300000 310000 320000 330000 340000 350000 360000

2070000 2060000 2050000 2040000 2030000 2020000 2010000

Legend

- Nam Ngiep Catchment Boundary
- City, Town or Village
- Lao PDR Boundary

Nam Ngiep 1 Hydropower Project:

- Inundation Area
- Proposed Access Road (Transmission Line)
- Proposed Transmission Line (Eastern Alignment)
- Proposed Transmission Line (Western Alignment)

Land Cover:

- 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

N

0 2.5 5 7.5Km

1:250,000

Basemap: ESRI World Imagery
Land Cover: DFRM
Datum: WGS84

Xiengmi
Ban Hat Gniun
Ban Thahuea
Ban Hatsaykham
Longxan
Ban Sisavath
Ban Nonsomboun
Mekong River
Pakxan
Thabok
Papek
Na
Nakhai
Nangommay
Ban Natan
Xienglaena
Hai
Veunthan
Somsamay
Palai
Nakhao
Donsangphai
Phao
Dongneng

Client:	Nam Ngiep Power Company Ltd.		
Drawing No:	0185065b_TL_BIODASSES_G003_R0.mxd		
Date:	17/01/2014	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 5.1 - Alternative Route Options Land Cover Types

Nam Ngiep 1 Hydropower Project
Transmission Line Biodiversity Assessment

Environmental Resources Management ANZ

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

ERM

5.3.2 *Route Options – Other Factors*

The Alternative Road was checked by site reconnaissance on 2 and 3 October 2013, and again on 11 and 12 January 2013. A comparison of specifications for each plan is shown in *Table 5-7*.

Table 5.7 Specifications of Proposed Road and Alternative Route

	Eastern Alignment	Western Alignment
Length/Cost	Approximately 125 km Mitigation cost to be considered	Approximately 124 km Equivalent cost to Eastern Alignment
Construction/ Operation	Aligned in intermountain area with moderate slope, and accessibility with some distance from existing access road	Aligned in intermountain area with steep slope, and difficult accessibility away from the existing access road
Facility reliability	A certain distance from Nam Ngiep River High reliability due to alignment located in intermountain area with moderate slope	To avoid the flooded area because of close to Nam Ngiep River To avoid possible landslide area due to rather steep slope
Environment	Impacts on Huay Ngua PPA with longer length Tree cutting and bush clearance are required. Traverses more natural habitat than Western Alignment.	No impacts on Huay Ngua PPA Tree cutting and bush clearance are required. Traverses less natural habitat and more low condition vegetation than the Eastern Alignment.
Social	No residential area	No residential area
		Preferred

5.3.3 *Conclusions of Alternative Scenarios*

Based on the preliminary assessment of route alternatives, including two site reconnaissance visits and desktop review of vegetation mapping, the Western Alignment is considered the preferred option for the transmission line. This is due to the Western Alignment:

- Avoiding Huay Ngua PPA;
- Impacting a smaller area of natural habitat, based on desktop data; and
- Having similar costs as the Eastern Alignment.

Development of the Western Alignment will require further refinement of the route and infrastructure design. In particular:

- Location of towers close to the Nam Ngiep River will need to be higher than expected flood elevation; and
- Access road for maintenance to the right bank must be considered; and
- Ground-truthing of the alignment such that tower locations can avoid natural habitats where possible.

6 MITIGATING IMPACTS ON BIODIVERSITY VALUES

6.1 OVERVIEW

This Chapter provides measures to mitigate impacts based on the preferred alignment, the Western Alignment (including the associated access road). The biodiversity impact assessment presented for the Eastern Alignment in *Section 5* remains relevant for the Western Alignment, and is changed only by the updated vegetation covers provided in *Section 5.3*.

The Western Alignment has a total Project Area (WA Project Area) of 442 ha, which is dominated by mapped deciduous forest and old fallow land, with smaller areas of rice paddies and young fallow land. The biodiversity impact assessment (*Section 5*) identified potential impacts to both modified and natural habitats. The selection of the Western Alignment has reduced the area of direct impact on natural habitats, however the loss or modification of some habitat is unavoidable. As such, compensatory measures will be required for the impact of the direct loss of natural habitat.

Primarily, a Biodiversity Action Plan (BAP) will be developed to document a strategy for refining the mitigation and management approach to conservation of biodiversity values, including key objectives, specific measures for the IUCN listed threatened species with potential to occur in the Project Area, performance indicators and responsible parties.

This report has identified habitat for a number of IUCN and nationally listed species within the Project Area. An assessment against critical habitat criteria suggests it is unlikely that the Project contains any areas considered to be critical habitat. Although a disturbance to critical habitat is unlikely, measures to manage impacts to potential habitat will be developed.

The plan will provide the strategy to develop and implement mitigation measures as well as the strategy to achieve a suitable offset for the biodiversity values that will be permanently lost.

This Section provides information likely to be incorporated in the BAP. Due to the relatively small area to be impacted the management measures below provide a sound basis upon which to document more detailed measures and responsibilities.

6.2 MITIGATION MEASURES

Disturbance to habitat in modified and natural habitat areas has potential to impact local biodiversity and priority biodiversity values. Mitigation measures can be implemented to manage the disturbance so that biodiversity values are not significantly impacted or impacts are reduced by the application of the mitigation hierarchy (avoid, minimise, mitigate and, in some cases, compensate).

Management measures specific to managing the natural environment will be incorporated into the Project ESMMP and these will include (but not be limited to) those identified in *Table 6-1*. These general environmental management measures will assist in reducing the potential for degradation of habitat, behaviour disturbance and fauna mortality for native species. Management relating to priority biodiversity values will be developed through the implementation of the BAP. *Table 6-2* identifies measures specific to the priority species that have been identified with potential to occur for inclusion in the BAP and further development.

Table 6.1 Mitigation and Management Measures

Nature of Impact	Overview of Measures
Loss of habitat	• 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; • Further ecological assessments will be undertaken within the selected route option, and the alignment will be further refined based on the assessments to minimise tree cutting and refine the location of towers; • 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 violate rules and regulations; • The planned clearance area for the construction works shall be clearly identified and marked to avoid accidental clearing; • Cleared vegetation shall be stockpiled in accordance with a site Vegetation Management Plan in previously disturbed areas only; • All topsoil will be saved and used for site revegetation; • Disturbed areas shall be rehabilitated as soon as possible following construction activities; • Within the RoW, vegetation trimming will be restricted to that required to safely operate the transmission line. Groundcover and midstorey vegetation will be retained wherever practicable. • Construction Contractor will establish biological resource management program and management plan to manage the construction activities to be conducted and monitor compliance with relevant permits and environmental regulations in order to prevent potential impacts to terrestrial ecology, in particular, vegetation and wildlife; and • In natural habitat areas to be cleared, microhabitat features such as hollow logs will be relocated to adjacent natural habitat areas rather than being destroyed where possible.
Disturbance to fauna behaviour	• Construction vehicles and machinery will be maintained in accordance with industry standard to minimise unnecessary noise generation; • Traffic signs will be installed on all roads throughout construction areas depicting speed limits; • For construction and operation areas requiring night-time lighting, lights will be used only where necessary and will be directed toward the subject area and away from habitat areas where possible; and • Commitment will be made to raise awareness of values of natural habitat areas to construction work force and make arrangements for

Nature of Impact	Overview of Measures
	restriction of poaching.
Barrier to movement and habitat fragmentation	• The Project shall implement landscaping and re-vegetation after completion of construction in suitable areas; • Monitoring and maintenance of revegetated areas will be undertaken to manage effectiveness.
Edge effects	• Dust suppression techniques will be utilised during construction, to control the dispersion of dust created by clearing lands; • The Project shall implement landscaping and re-vegetation after completion of construction using native species where possible; • To avoid/minimize releasing sediment load into the river, erosion control measures will be implemented and maintained e.g. using silt fence and temporary re-vegetation to minimize sediment transport from steep slope releasing to the waterways; and • Weed and pest management measures should be implemented in accordance with a Project weed and pest management plan to avoid introduction of weeds to natural and modified habitat areas.
Degradation of habitat	• Construction and domestic waste will be appropriately stored and disposed of to avoid attracting native and alien species to the construction areas; • For areas in direct runoff path to a watercourse, sediment and erosion control devices will be installed prior to commencement of vegetation clearance or earthworks and maintained until vegetation replanting can occur to stabilise disturbed surfaces; • Monitoring of erosion and sediment control will be conducted to inspect the proper function of devices; • Oil, chemical and solid waste will be stored, and handled and disposed of by appropriately licenced waste management contractors; • Weed and pest management measures should be implemented in accordance with a Project weed and pest management plan to avoid introduction of weeds to natural and modified habitat areas; • Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to limit noise and dust generation; • Construction materials and chemicals will be appropriately secured and locked down during flood season to avoid accidental release to the natural environment; • Emergency response plan and procedures will be prepared and implemented for both construction and operation activities of the Project. This will include emergency drills and education of Project workers; • Vegetation management during the operation phase will minimise the use of herbicides by using mechanical pruning methods and providing appropriate training to maintenance personnel.
Fauna mortality	• Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to minimise potential for fauna strike; • Commitment will be made to raise awareness of values of natural habitat areas to construction and operation work force and arrangements will be made for restriction of poaching and forest product collection; • Hunting wild animals will be strictly prohibited to apply for all staff; • UXO clearance and certification will be implemented for the whole construction area; and • Construction activities will only be commenced within the UXO clearance boundary. • Final route alignment will avoid any identified areas of critical habitat

Nature of Impact	Overview of Measures
	for bird and bat species; • Transmission lines will be designed to minimise risk of electrocution, including maintaining a 1.5 m spacing between energised components and grounded hardware, or covering energised parts.

Table 6.2 Summary of Priority Biodiversity Values Management Measures

Value/Species	Key threats	Specific management measures
IUCN listed flora species	Values for carpentry/timber or medicinal purposes	• Survey identified the presence of IUCN listed flora species within the disturbance corridor. These species are listed under IUCN will need to be specifically managed within the Biodiversity Action Plan and Biodiversity Offset Areas and replanting or propagation may be appropriate • Weed management measures should be implemented in accordance with a Project weed and pest management plan to avoid introduction of weeds to natural and modified habitat areas • Investigate opportunity for replanting the listed species including seed collection and propagation for relocation to offset locations • Prohibit the use of IUCN listed species for fire wood or construction material
Asian elephant	Hunting Habitat loss and degradation	• Raise awareness of the species to discourage poaching and contribute to management of human-elephant conflict through education of construction team members and local villagers • Restrict access to the elephant conservation area near Na village by construction teams and vehicles • Install appropriate elephant exclusion fencing at the elephant conservation area near Na village • Rehabilitation of any disturbed areas as soon as practical after clearing • Compensatory measures for unavoidable habitat loss
Leopard, Asiatic golden cat, Dhole	Hunting Illegal trade (for some)	• Raise awareness of the species to discourage poaching and contribute to management through education of construction team members and local villagers • Raise awareness of values of natural habitat areas to construction work force and importance of prey species to the lifecycle to restrict poaching of forage resources where possible • Rehabilitation of any disturbed areas as soon as practical after clearing • Compensatory measures for unavoidable habitat loss
Fishing cat	Wetland destruction and degradation	• Rehabilitation of any disturbed areas as soon as practical after clearing • Establish watershed management to assist in maintain the quality of existing catchment habitats • Compensatory measures for unavoidable habitat loss or enhancement of wetland habitats
Sunda pangolin,	Hunting	• Raise awareness of the species to discourage

Value/Species	Key threats	Specific management measures
Bengal slow loris	Exploitation for medicine (for some)	poaching and contribute to management through education of construction team members and local villagers • Rehabilitation of any disturbed areas as soon as practical after clearing • Pre-clearing survey for presence of individuals prior to tree felling • Compensatory measures for unavoidable habitat loss
Northern white-cheeked gibbon, Phayre's leaf monkey	Hunting	• Raise awareness of the species to discourage poaching and contribute to management through education of construction team members and local villagers • Rehabilitation of any disturbed areas as soon as practical after clearing • Pre-clearing survey for presence of individuals prior to tree felling • Compensatory measures for unavoidable habitat loss
Great hornbill, White winged duck, Greater coucal, Red-breasted parakeet	Hunting	• Raise awareness of the protection of the species to trade (live birds and feathers) through education of construction team members • Rehabilitation of any disturbed areas as soon as practical after clearing • Compensatory measures for unavoidable habitat loss
Green peafowl, Grey peacock pheasant, Silver pheasant, Siamese fireback	Habitat conversion	• Rehabilitation of any disturbed areas as soon as practical after clearing • Compensatory measures for unavoidable habitat loss
Reticulated python	Trade	• Raise awareness of the species to discourage poaching and contribute to management through education of construction team members and local villagers • Rehabilitation of any disturbed areas as soon as practical after clearing • Compensatory measures for unavoidable habitat loss
Big-headed turtle	Hunting	• Rehabilitation of any disturbed areas as soon as practical after clearing • Raise awareness of the protection of the species from hunting/foraging by construction teams • Pre-clearing survey for presence of individuals prior to tree felling • Compensatory measures for unavoidable habitat loss (see Section *6.4*) including watershed management to assist in maintain the quality of existing catchment habitats • Compensatory measures for unavoidable habitat loss
IUCN listed and migratory fish	Overharvest Habitat	• Maintain appropriate downstream flows through suitable watercourse crossing

Value/Species	Key threats	Specific management measures
species	fragmentation and degradation Changes in water quality and flow	structure design • Limit impacts to water quality through appropriate sediment and erosion control during construction • Raise awareness of the protection of the species to discourage overfishing of the species where possible • Establish watershed management to assist in maintain the quality of existing catchment habitats

6.3 *RESIDUAL IMPACTS ON BIODIVERSITY VALUES*

Mitigation and management approaches have been considered to avoid, minimise and mitigate potential impacts to biodiversity as a result of Project activities. In general, many of the indirect impacts to biodiversity values can be minimised, such as behavioural disturbances, degradation of habitats, edge effects and barriers to terrestrial fauna movement. The next step of the mitigation hierarchy necessitates consideration biodiversity offsets for residual impacts.

The residual impacts identified relate to unavoidable footprint of 437.5 ha, including permanent clearing of 64.9 ha. Direct disturbance to habitats will be minimised where possible however this impact assessment has identified an unavoidable loss or modification of approximately 138 ha[1] of natural habitat. The Project is likely to involve the clearing of approximately 40 ha of modified habitat. *Table 6-3* summarises the breakdown of land cover types that will be permanently removed or altered.

Table 6.3 Land cover types within the WA Project Area

Land cover Type	Total Within Project Area (ha)	Estimated area to be cleared (ha)[1]	Estimated area to be suppressed (ha)[1]
Natural Habitat	**138**	**22**	**117**
Deciduous Forest	122	19	103
Evergreen Forest	1	0	1
Scrub, Heath	2	0	2
Swamp	7	1	6
Bamboo	6	1	5
Modified Habitat	**256**	**40**	**216**

[1] As discussed this is an upper estimate.

Land cover Type	Total Within Project Area (ha)	Estimated area to be cleared (ha)[1]	Estimated area to be suppressed (ha)[1]
Agriculture Plantation	7	1	6
Old Fallow Land	124	19	105
Rice Paddy	53	8	45
Slash and Burn	4	1	3
Young Fallow Land	68	11	57
Other Land	**8**	**1**	**6**
Cloud	4	1	3
Other Land	<1	0	0
Rock	<1	0	0
Shadow	<1	0	1
Water	2	0	2
Total Area	**402**	**63**	**339**

1. Tower locations have not yet been defined, and as such locations of clearing are unknown. Estimated areas of clearing and vegetation suppression are based on the areas of clearing required for towers and access roads, and the proportions of land cover types within the Project Area.

6.4 OFFSETS

The Biodiversity Offset Design Report provides an analysis of the approach to offset identified residual biodiversity values in accordance with the Business and Biodiversity Offset Program (BBOP) documents:

- Biodiversity Offset Design Handbook (BBOP 2012a); and
- *Resource Paper: No Net Loss and Loss-Gain Calculations in Biodiversity Offsets* (BBOP 2012b).

The Biodiversity Offset Design Report includes the:

- methodology and approach to the design of the biodiversity offset (including loss/gain calculations);
- recommended biodiversity offset package (including locations and supplementary environmental contributions);
- proposed delivery mechanisms for the biodiversity offset;
- framework for operational management plans, stakeholder participation programs, monitoring and evaluation arrangements, governance roles and requisite capacities;

- recommended budgets and financial arrangements; and
- analysis of benefit mechanisms and potential compensation requirements.

The impacted habitats and species for the transmission line have been considered in the assessment of biodiversity offsets for the entire project. This means that offsets required for the transmission line will be in addition to the offsets required for the inundation area, access road and associated facilities.

7 *RECOMMENDATIONS*

The impact assessment evaluated potential impacts relating to a permanent loss of natural habitat, including for critically endangered and endangered IUCN listed species as a Moderate Impact. All other potential impacts are considered to be Negligible or Minor Impact.

Mitigation and minimisation of potential Project impacts identified a number of mechanisms to reduce impacts to biodiversity as a result of the Project. This included avoidance measures (alternative alignment) as well as management measures limit direct impacts and minimise indirect impacts.

In accordance with IFC PS6, an assessment of impact to critical habitat for IUCN listed species was undertaken. The outcomes identified that it is unlikely that the Project Area is critical habitat for the candidate species identified.

Other key recommendations of this assessment include preparation and implementation of both a construction and operation Environmental Management Plan. The management plan should include:

- Measures to avoid introduction and spread of weeds or pest animal species to the local area;
- Measures to manage existing weed populations if encountered during construction;
- Measures to minimise the risk of fauna mortality;
- Emergency spills response procedures;
- Details of education and awareness programs for the workforce relating to threatened species, native species and natural habitat values; and
- Rehabilitation and regeneration procedures.

To accompany the management plan, monitoring procedures should also be developed. Monitoring programs recommended include water quality monitoring and weed monitoring. The monitoring programs should incorporate:

- Monitoring method;
- Equipment required;
- Frequency of monitoring;
- Data analysis or benchmarks for compliance; and
- Reporting requirements.

Compensatory measures will be required to offset the residual impacts that cannot be avoided. The Offset Plan will incorporate the required management and monitoring procedures specific to compensatory measures that are designed and implemented for the Project.

8 REFERENCES

Allen, D. 2011a. *Clarias batrachus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Allen, D. 2011b. *Oxyeleotris marmorata*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Ashton, P. 1998a. *Dipterocarpus alatus*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 21 August 2013.

Ashton, P. 1998b. *Dipterocarpus turbinatus*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 21 August 2013.

Ashton, P. 1998c. *Anisoptera costata*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 12 September 2013.

Asian Development Bank and UNEP. 2004. Greater Mekong Subregion Atlas of the Environment, Asian Development Bank and United Nations Environment Program's Regional Resource Center for Asia and the Pacific, 2004.

Asian Development Bank. 2009. Safeguard Policy Statement, Asian Development Bank Policy Paper

Asian Development Bank. 2012. Environment Safeguards: A Good Practice Sourcebook: Draft Working Document

Baird, I. 2011a. *Probarbus labeamajor*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 12 September 2013.

Baird, I. 2011b. *Yasuhikotakia splendida*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.ord. Downloaded on 20 November 2013.

Baird, I. 2012. *Sikukia gudgeri*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

BirdLife International. 2012b. *Pavo muticus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 12 September 2013.

BirdLife International. 2012c. *Cairina scutulata*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013.

Choudhury, A., Lahiri Choudhurym D.K., Desai, A., Duckworth, J.W., Easa, P.S., Johnsingh, A.J.T., Fernando, P., Hedges, S., Gunawardena, M., Kurt, F., Karanth, U., Lister, A., Menon, V., Riddle, H., Rubel, A. and Wikramanayake, E. (IUCN SSC Asian Elephant Specialist Group) 2008. *Elephas maximus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 03 September 2013.

Dey, S.C. 2010. *Xenentodon cancila*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Duckworth, J.W., Pattanavibool, A. Newton, P. & Nguyen Van Nhuan 2008. *Manis javanica*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 11 June 2013.

Hogan, Z. 2011. *Catlocarpio siamensis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 12 September 2013.

Huckstorf, V. and Freyof, J. 2011. *Poropuntius deauratius*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org. Downloaded 20 November 2013.

IFC. 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living. Natural Resources. January 1, 2012

MRC. 2005a. Key Mekong fish species – migration paths. *Catlocarpio siamensis*. http://ns1.mrcmekong.org/programmes/fisheries/mig_catlocarpio.htm. Accessed 20 November 2013.

MRC. 2005b. Key Mekong fish species – migrationpaths. *Barbodes gonionotus*. http://ns1.mrcmekong.org/programmes/fisheries/mig_barbodes.htm. Accessed 20 November 2013.

Mukherjee, S., Sanderson, J., Duckworth, W., Melisch, R., Khan, J., Wilting, A., Sunarto, S. and Howard, J.G. 2010. *Prionailurus viverrinus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 03 September 2013.

Ng, H.H. 2012a. *Acantopsis choirorhynchos*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Ng, H.H. 2012b. *Mystus singaringan*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Ng, H.H. 2012c. *Pseudomystus siamensis*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Nghia, N.H. 1998a. *Afzelia xylocarpa*. In: IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 26 August 2013.

Nghia, N.H. 1998b. *Dalbergia oliveri*. In: IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 26 August 2013.

Nghia, N.H. 1998c. *Anisoptera costata*. In: IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 11 September 2013.

Poulsen, A.F. and Valbo-Jorgensen, J. (editors). 2000. Fish migrations and spawning habits in the Mekong Mainstream – a survey using local knowledge. AMFC Technical Report. Mekong River Commission.

Provincial Conservation Division, 2010. Houy Ngua Provincial Preserved Area Management Plan 2011-2015. Provincial Agriculture and Forestry Office of Bolikhamxay December 2010.

Rayamajhi, A., Jha, B.R. and Sharma, C. 2010. *Mastacembelus armatus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Thinh, D.V., Van, N.S. and Nguyen, T.H.T. 2012. *Barbonymus gonionotus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Vidthayanon, C. and Hogan, Z. 2011. *Pangasianodon hypophthalmnus*. In IUCN 2012. IUCN Red Lost of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 12 September 2013.

Vidthayanon, C. 2012. *Luciosoma bleekeri*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Vidthayanon, C. 2012b. *Mastacembelus favus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Vidthayanon, C. 2012c. *Mystacoleucus atridorsalis*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.WWF. 2003a. WWF Ecoregions, Worldwide Fund for Nature. Available at http://www.worldwildlife.org/science/ecoregions.cfm

WWF. 2003b. Luang Prabang montane rain forests (IM0121), Worldwide Fund for Nature. Available at: http://www.worldwildlife.org/wildworld/profiles/terrestrial/im/im0121_full.html

Annex A

Species Specialist Input

Table D1 Species Specialist Input

Specialist	Relevant Species	Comment
Pheng Phengsintham (National University of Laos)	Flora species	Provided ground truthing and specialist comment
Ajay Desai (Asian Elephant Specialist Group)	Asian elephant	Provided comment and contacts
Kham khoun Khounboline (WWF Greater Mekong)	Asian elephant	Provided specialist comment
Daniel Challender (Pangolin Specialist Group)	Sunda pangolin	Provided alternative contact
Dr Christine Breitenmoser (IUCN Cat Specialist Group)	Cats	Provided alternative contact
Anthony Rylands (IUCN/SSC Primate Specialist Group)	Phayre's leaf monkey, Northern white cheeked gibbon	Provided alternative contact
Carola Borries (Research Associate Professor)	Phayre's leaf monkey	Provided alternative contact
Dr Benjamin Rawson (IUCN/SSC Primate Specialist Group)	Northern white cheeked gibbon	Provided specialist comment
Dr Phiavanh Phiapalath (IUCN/SSC Primate Specialist Group)	Phayre's leaf monkey, Northern white cheeked gibbon	Provided ground truthing and specialist comment
Dr Will Duckworth (Independent Researcher)	All mammals, birds and some reptiles	Provided specialist comment
Dr Peter Paul van Dijkp (Tortoise and Freshwater Turtle Specialist Group)	Big headed turtle	Provided specialist comment
Richard Hearne (IUCN SSC Duck Specialist Group)	White-winged duck	No advice
Baz Hughes (Wildfowl and Wetlands Trust)	White-winged duck	No advice
Professor Gordon McGregor Reid	Fish species	Provided contacts
Dr Maurice Kottelat	Fish species	Provided specialist comment

Annex B

TISTR Flora Survey Results

Family Name	Scientific Name	Resettlement Area	Huay Ngua	Status
AMARANTHACEAE	*Alternanthera sessilis* (L.) DC.	X	X	LC
AMARANTHACEAE	*Mangifera indica* L.	X		DD
APOCYNACEAE	*Alstonia scholaris* (L.) R.Br.	X	X	LC
ARACEAE	*Colocasia esculenta* (L.) Schott	X	X	LC
ARACEAE	*Cryptocoryne crispatula* Engl.			LC
ARACEAE	*Lasia spinosa* Thwaites	X	X	LC
CELASTRACEAE	*Eclipta angustata* Umemota & H.Koyama	X	X	LC
COMMELINACEAE	*Commelina benghalensis* L.	X	X	LC
COMMELINACEAE	*Floscopa scandens* Lour.	X	X	LC
CONVOLVULACEAE	*Aniseia martinicensis* (Jacq.) Choisy	X	X	LC
CYCADACEAE	*Cycas pectinata* Buch.-Ham.		X	VU
CYPERACEAE	*Actinoscirpus grossus* (L.f.) Goetgh. & D.A.Simpson	X	X	LC
CYPERACEAE	*Cyperus difformis* L.	X	X	LC
CYPERACEAE	*Cyperus digitatus* Roxb.	X	X	LC
CYPERACEAE	*Cyperus rotundus* L.	X	X	LC
CYPERACEAE	*Fuirena ciliaris* (L.) Roxb.	X	X	LC
DATISCACEAE	*Tetramelos nudiflora* R.Br.	X	X	LC
DIPTEROCARPACEAE	*Anisoptera costata* Korth		X	EN
DIPTEROCARPACEAE	*Dipterocarpus alatus* Roxb. ex G.Don		X	EN
DIPTEROCARPACEAE	*Dipterocarpus turbinatus* Gaertn.f.		X	CR
DIPTEROCARPACEAE	*Hopea odorata* Roxb.	X	X	VU
DIPTEROCARPACEAE	*Shorea roxburghii* G.Don	X	X	EN
DRYOPTERIDACEAE	*Diplazium esculentum* (Retz.) Sw.	X		LC
EBENACEAE	*Diospyros apiculata* Hiern	X	X	LC
EUPHORBIACEAE	*Homonoia riparia* Lour.	X	X	LC
GNETACEAE	*Gnetum montanum* Markgr.		X	LC
GRAMINEAE	*Saccharum spontaneum* L.	X	X	LC
GUTTIFERAE	*Calophyllum thorelii* Pierre	X	X	
GUTTIFERAE	*Cratoxylum cochinchinense* (Lour.) Blume	X	X	LC
GUTTIFERAE	*Cratoxylum formosum* (Jack) Dyer	X	X	LC
HYDROPHYLLACEAE	*Hydrolea zeylanica* (L.) Vahl	X	X	LC
LAURACEAE	*Beilschmiedia roxburghiana* Nees	X	X	LC
LEGUMINOSAE-CAESALPINOIDEAE	*Afzelia xylocarpa* (Kurz) Craib	X	X	EN
LEGUMINOSAE-CAESALPINOIDEAE	*Sindora siamensis* Teijsm. & Miq.	X	X	LC
LEGUMINOSAE-	*Aeschynomene indica* L.	X	X	LC

Family Name	Scientific Name	Resettlement Area	Huay Ngua	Status
PAPILIONOIDEAE LEGUMINOSAE-PAPILIONOIDEAE	*Dalbergia cochinchinensis* Pierre		X	VU
LEGUMINOSAE-PAPILIONOIDEAE	*Dalbergia oliveri* Gamble	X	X	EN
LENTIBULARIACEAE	*Utricularia aurea* Lour.	X	X	LC
MARSILEACEAE	*Marsilea crenata* C.Presl	X	X	LC
MELIACEAE	*Aglaia lawii* (Wight) C.J.Saldanha ex Ramamoorthy	X	X	LC
MELIACEAE	*Aphanamixis polystachya* (Wall.) R.Parker	X	X	LC
MYRISTICACEAE	*Knema globularia* (Lam.) Warb.	X	X	LC
MYRTACEAE	*Syzygium vestitum* Merr. & L.M.Perry		X	VU
POLYGONACEAE	*Persicaria attenuat*a (R.Br.) Soják subsp. *pulchera* (Blume) K.L.Wilson	X	X	LC
SAPINDACEAE	*Zollingeria dongnaiensis* Pierre	X	X	DD
SCHIZAEACEAE	*Lygodium microphyllum* (Car.) R.Br.	X	X	LC
SCROPHULARIACEAE	*Lindernia anagallis* (Burm.f.) Pennell	X	X	LC
THEACEAE	*Ternstroemia wallichiana* (Griff.) Engl.		X	VU
UMBELLIFERAE	*Centella asiatica* (L.) Urb.	X	X	LC
VERBENACEAE	*Phyla nodiflora* (L.) Greene	X	X	LC
ZINGIBERACEAE	*Amomum uliginosum* K.D.König	X	X	LC

Annex C

TISTR Fauna Survey Results

Family/Common Name	Scientific Name	Huay Ngua (PAFO)	Huay Ngua (TSTR 2013)	Resettlement Area (TSTR 2013)	Lao Status	IUCN Status
Mammals						
Asian elephant	*Elephas maximus*	X				EN
Asiatic brush-tailed porcupine	*Atherurus macrourus*	X		X		LC
Asiatic golden cat	*Pardofelis temminckii*	X			R	NT
Barking deer	*Muntiacus vaginalis*			X	P	LC
Berdmore's squirrel	*Menetes berdmorei*	X				LC
Black flying squirrel	*Aeromys tephromelas*	X				
Black giant squirrel	*Ratufa bicolor*	X				NT
Clouded leopard	*Neofelis nebulosa*	X				VU
Fishing cat	*Prionailurus viverrinus*	X				EN
Gaur	*Bos gaurus*	X				VU
Himalayan black bear	*Ursus thibetanus*	X				VU
Irrawaddy squirrel	*Callosciurus pygerythrus*	X				LC
Jungle cat	*Felis chaus*	X				LC
Large bamboo rat	*Rhizomys sumatrensis*	X			P	LC
Large brown flying squirrel	*Petaurista philippensis*	X				LC
Large spotted civet	*Viverra megaspila*	X				VU
Leopard	*Panthera pardus*	X			R	NT
Lesser bamboo bat	*Tylonycteris pachypus*		X			LC
Lesser mouse deer	*Tragulus javanicus*	X				
Malayan porcupine	*Hystrix brachyura*	X				LC
Pallas's squirrel	*Callosciurus erythraeus*	X				LC
Red muntjac	*Muntiacus muntjak*	X				LC
Red-cheecked squirrel	*Dremomys rufigenis*	X				LC
Roosevelts' muntjac	*Muntiacus rooseveltorum*	X				
Sambar	*Rusa unicolor*	X				VU
Striped-back weasel	*Mustela strigidorsa*	X				LC
Sun bear	*Helarctos malayanus*	X				VU
Wild boar	*Sus scrofa*	X		X		LC
Birds						
Asian brown flycatcher	*Muscicapa dauurica*		X	X		LC
Asian golden weave	*Ploceus hypoxanthus*	X				
Asian koel	*Eudynamys scolopacea*	X				
Barred buttonquail	*Turnix suscitator*	X				
Black-crested bulbul	*Pycnonotus melanicterus*		X	X		LC

Family/Common Name	Scientific Name	Huay Ngua (PAFO)	Huay Ngua (TSTR 2013)	Resettlement Area (TSTR 2013)	Lao Status	IUCN Status
Black-headed bulbul	*Pycnonotus atriceps*		X			LC
Black-naped monarch	*Hypothymis azurea*		X			LC
Blossom-headed parakeet	*Psittacula roseata*		X		P	LC
Brahminy kite	*Haliastur indus*	X				LC
Brown-backed needletail	*Hirundapus giganteus*		X			LC
Brown Shrike	*Lanius cristatus*			X		LC
Collared scops-owl	*Otus bakkamoena*		X	X	P	LC
Common kingfisher	*Alcedo atthis*	X				LC
Common myna	*Acridotheres tristis*	X		X		LC
Common tailorbird	*Orthotomus sutorius*		X	X		LC
Coppersmith barbet	*Megalaima haemacephala*		X	X		LC
Cotton pygmy goose	*Nettapus coromandelianus*	X				LC
Crested argus	*Rheinardia ocellata*	X				LC
Crested serpent-eagle	*Spilornis cheela*		X			LC
Emerald dove	*Chalcophaps indica*		X			LC
Eurasian tree sparrow	*Passer montanus*			X		LC
Garganey	*Anas querquedula*	X				LC
Great barbet	*Megalaima virens*	X				LC
Great hornbill*	*Buceros bicornis*	X			R	NT
Greater coucal	*Centropus sinensis*	X	X	X	R	LC
Greater racket-tailed drongo	*Dicrurus paradiseus*		X			LC
Green peafowl	*Pavo muticus*	X				EN
Green-eared barbet	*Megalaima faiostricta*		X			LC
Grey peacock-pheasant*	*Polyplectron bicalcaratum*	X			R	LC
Grey-eyed bulbul	*Iole propinqua*		X			LC
Grey-headed fish eagle	*Ichthyophaga ichthyaetus*	X				NT
Hill myna	*Gracula religiosa*	X	X	X	P	LC
Hoopoe	*Upupa epops*	X				LC
Indian roller	*Coracias benghalensis*			X		LC
Imperial eagle	*Aquila heliaca*	X				VU
Lesser fish eagle	*Ichthyophaga humilis*	X				NT
Lineated barbet	*Megalaima lineata*		X	X		LC
Little cormorant	*Phalacrocorax niger*	X				LC
Olive-backed sunbird	*Nectarinia jugularis*			X		LC
Orange-breasted green-pigeon	*Treron bicinctus*		X		P	LC
Oriental magpie-robin	*Copsychus saularis*			X		LC
Painted stork	*Mycteria*	X				NT

Family/Common Name	Scientific Name	Huay Ngua (PAFO)	Huay Ngua (TSTR 2013)	Resettlement Area (TSTR 2013)	Lao Status	IUCN Status
	leucocephala					
Pin-striped tit-babbler	*Macronous gularis*		X	X		LC
Plaintive cuckoo	*Cacomantis merulinus*		X	X		LC
Puff-throated babbler	*Pellorneum ruficeps*		X	X		LC
Red collared dove	*Streptopelia tranquebarica*	X				LC
Red junglefowl	*Gallus gallus*	X		X		LC
Red-breasted parakeet	*Psittacula alexandri*	X	X		R	LC
Red-rumped swallow	*Hirundo daurica*			X		LC
Red-wattled lapwing	*Vanellus indicus*	X				LC
Scaly-breasted munia	*Lonchura punctulata*		X			LC
Scaly-breasted partridge	*Arborophila chloropus*	X				LC
Scarlet-backed flowerpecker	*Dicaeum cruentatum*		X	X		LC
Shikra	*Accipiter badius*		X	X		LC
Siamese fireback	*Lophura diardi*	X			R	LC
Silver pheasant	*Lophura nycthemera*	X			R	LC
Spot-bellied eagle owl	*Bubo nipalensis*	X				LC
Spotted dove	*Stigmatopelia chinensis*	X	X		P	LC
Streak-eared bulbul	*Pycnonotus blanfordi*		X	X		LC
Tickell's blue-flycatcher	*Cyornis tickelliae*		X			LC
White breasted waterhen	*Amaurornis phoenicurus*	X				LC
White-browed scimitar-babbler	*Pomatorhinus schisticeps*		X	X		LC
White-rumped Shama	*Copsychus malabaricus*			X		LC
White-winged duck	*Cairina scutulata*	X				EN
Woolly-necked stork	*Ciconia episcopus*	X				LC
Reptiles						
Asian water dragon	*Physignathus cocincinus*	X				
Big-headed turtle	*Platysternon megacephalum*	X				EN
Common garden lizard	*Calotes versicolor*		X			
Common house gecko	*Hemidactylus frenatus*		X	X		LC
Common water monitor	*Varanus salvator*	X				LC
Impressed tortoise	*Manouria impressa*	X				VU
Radiated snake	*Elaphe radiata*	X				
Reticulated python	*Broghammerus reticulatus*	X			R	
Tokay gecko	*Gekko gecko*		X			
Amphibians						
Asian Grass frog	*Fejervarya*		X	X		LC

Family/Common Name	Scientific Name	Huay Ngua (PAFO)	Huay Ngua (TSTR 2013)	Resettlement Area (TSTR 2013)	Lao Status	IUCN Status
	limnocharis					
Beautiful pygmy frog	*Microhyla pulchra*			X		LC
Berdmore's narrow-mouthed frog	*Microhyla berdmorei*		X			LC
Bony-headed toad	*Ingerophrynus galeatus*		X			LC
Common Asiatic toad	*Bufo melanostictus*	X				LC
Common lowland frog	*Rana rugulosa*	X				LC
Dark-sided frog	*Hylarana nigrovittata*		X			LC
East Asian bullfrog	*Hoplobatrachus rugulosus*			X		LC
Large-headed frog	*Limnonectes kuhlii*		X			LC
Malaysian narrowmouth toad	*Kaloula pulchra*		X	X		LC
Ornate chorus frog	*Microhyla fissipes*			X		LC
Pointed-tongued floating frog	*Occidozyga lima*			X		LC
White-lipped tree frog	*Polypedates leucomystax*			X		LC
Unidentified	*Rana* sp.		X			
Fish						
Asian swamp eel	*Monopterus albus*			X		LC
Bandan sharp-mouth barb	*Scaphognathops bandanensis*		X			VU
Black tail catfish	*Hermibagrus wycki*	X				LC
Black-spotted catfish	*Pangasius larnaudiei*	X				LC
Bleekers sheatfish	*Micronema bleekeri*	X				
Bumblebee catfish	*Pseudomystus siamensis#*		X	X		LC
Clown knifefish	*Notopterus notopterus*	X				NT
Croaking gourami	*Trichopsis vittata*			X		LC
Dwarf snakehead	*Channa gachua*		X	X		LC
Flower spiny eel	*Mastacembelus favus#*		X			LC
Freshwater garfish	*Xenentodon cancila#*		X			
Giant barb	*Catlocarpio siamensis*	X				CR
Giant pipefish	*Doryichthys boaja*			X		LC
Golden barb	*Hypsibarbus wetmorei*			X		LC
Goonch	*Bagarius yarrelli*	X				NT
Horseface loach	*Acantopsis choirorhynchos#*		X			LC
Iridescent glassy perchlet	*Parambassis apogonoides*			X		LC
Jaguar loach	*Yasuhikotakia splendida*		X			VU

Family/Common Name	Scientific Name	Huay Ngua (PAFO)	Huay Ngua (TSTR 2013)	Resettlement Area (TSTR 2013)	Lao Status	IUCN Status
Java barb	*Barbonymus gonionotus#*		X			LC
Laos danio	*Devario laoensis*		X			LC
Long finn mystus	*Mystus singaringan#*		X			LC
Marbled goby	*Oxyeleotris mos morata#*	X				LC
Mekong bumblebee goby	*Brachygobius mekongensis*			X		LC
Mekong Rock goby	*Papuligobius ocellatus*			X		LC
Mud carp	*Cirrhinus molitorella*	X				NT
Nichol's Brook-loach	*Schistura nicholsi*			X		LC
Redtail catfish	*Hemibagrus nemurus*		X			LC
Sidestripe rasbora	*Rasbora paviana*		X	X		LC
Sikuk barb	*Sikukia gudgeri#*		X	X		
Silver flying fox	*Crossocheilus reticulatus*			X		LC
Small scaled mud carp	*Cirrhinus microlepis*	X				
Spiny barb	*Mystacoleucus marginatus*		X	X		LC
Striped catfish	*Pangasianodon hypophthalmus*	X				EN
Swamp barb	*Puntius brevis*			X		LC
Target puffer	*Monotrete leiurus*			X		LC
Thicklipped barb	*Probarbus labeamajor*	X				EN
Tiretrack spiny eel	*Mastacembelus armatus#*		X			LC
Transverse-bar barb	*Hampala macrolepidota*			X		LC
Walking catfish	*Clarias batrachus#*		X			LC
Yellow catfish	*Hemibagrus nemurus*			X		LC
Yellow tail brook barb	*Poropuntius deauratus*		X	X		EN
	Chitala blanci	X				
	Hemisilurus mekongensis	X				LC
	Lepidocephalichthys furcatus		X			
	Luciosoma bleekeri#	X				LC
	Monotrete leiurus		X			LC
	Mystacoleucus atridorsalis#		X			LC
	Nemacheilus pallidus		X			LC
	Nemacheilus platiceps		X			

Family/Common Name	Scientific Name	Huay Ngua (PAFO)	Huay Ngua (TSTR 2013)	Resettlement Area (TSTR 2013)	Lao Status	IUCN Status
	Opsarius koratensis		X			LC
	Puntius rhombeus		X			LC
	Wallago leeri	X			R	

Lao Status: R – Reserved species (Category 1); P – Protected species (Category 2) under the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF

IUCN Status: CR – Critically endangered; EN – Endangered; VU – Vulnerable; NT – Near threatened; LC – Least concern

represented migratory species

Annex D

Critical Habitat Candidate Species Profiles

Species	*Afzelia xylocarpa*
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species at the resettlement area, transmission line and Huay Ngua as well as other areas in the region (upper and lower Nam Ngiep. main dam, re-regulation dam)
	Indirect -
Distribution	The species is native to Cambodia, India, Lao PDR, Myanmar, Thailand and Viet Nam. TISTR survey detected the species at a number of locations throughout the Nam Ngiep catchment and it was also detected in upper and lower Nam Xan sampling plots. Specialists advice from Dr Pheng Phengsintham indicates that the distribution in Lao PDR includes Vientiane capital, Phouhin Namno National Biodiversity Conservation Area (pers. comm. 7/12/2013).
Population	Limited information is available regarding the population size of the species locally and globally however the direct data indicates a number of records locally.
Habitat	This tree is reported to grow in dense forest habitats and in transitional areas between evergreen and dry open dipterocarp forest. Altitude range of 100-650m in areas with uniform rainfall range, 1000-1500mm/year, a dry season od 5-6 months, mean annual temperature of 20-32°C is listed. Flowers March-April, fruiting September-December.
Threats	In Viet Nam the timber is values for carpentry. Other reports suggest the tree is harvested for medicinal purposes, pulp for cigarettes as well as wood turning
Summary	This species has been noted within a number of sampling plots during survey for NNP1 of the Nam Ngiep and Nam Xan catchment hence it appears that the species is distributed across the region. The species is also known from Vientiane and a protected area in the south of Lao PDR. Given the distribution of known records it is considered **unlikely that the Project area sustains >10 per cent of the global population (Tier 1), or, habitat of significant important or containing nationally important concentrations (Tier 2).** Measures such as planting and management of harvesting threats locally will assist in managing the local population of the species.
References	Nghia, N.H. 1998. *Afzelia xylocarpa*. In: IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 26 August 2013. Danida Forest Seed Centre Seed Leaflet No. 6 September 2000 *Afzelia xylocarpa* (Kurz) Craib

Species	*Anisoptera costata*
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species in a sampling plot within the Huay Ngua PPA survey in lower mixed deciduous forest habitat. The species was also detected in the lower Nam Xan survey location. *Indirect* The species is reported to occur in PKK.
Distribution	The species is native to Brunei, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam (Ashton, 1998c). It is not reported to be native to Lao PDR. TISTR survey detected the species at a number of locations throughout the Nam Ngiep catchment.
Population	Limited information is available regarding the population size of the species locally and globally however the recent survey noted the species as a dominant tree species within the proposed access road and in the adjacent area.
Habitat	It is reported to grow in semi-evergreen dipterocarp, evergreen and humid lowland forest.
Threats	The species is an economic tree and used for house construction.
Summary	This species was detected in the Huay Ngua PPA survey locations (by TISTR 2013) and reported from PKK. The species is not native to Lao PDR and as such is not considered a priority biodiversity value. **The species is not a candidate for critical habitat within the Project area.**
References	Ashton, P. 1998. *Anisoptera costata*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 12 September 2013.

Species	*Dalbergia oliveri*
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species within the resettlement area, transmission line and Huay Ngua, and also other areas (upper Nam Xan, main dam, re-regulation dam, upper Nam Ngiep). *Indirect* -
Distribution	This species is not native to Lao PDR. It is native to Myanmar, Thailand and Viet Nam. TISTR survey detected the species at a number of locations throughout the Nam Ngiep catchment.
Population	Limited information is available regarding the population size of the species locally and globally.
Habitat	It is reported to be scattered among dense evergreen and semi-deciduous forest of up to 1200 m elevation.
Threats	
Summary	The species is not native to Lao PDR and as such is not considered a priority biodiversity value. **The species is not a candidate for critical habitat within the Project area.**
References	Nghia, N.H. 1998. *Dalbergia oliveri*. In: IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 26 August 2013.

Species	*Dipterocarpus alatus*
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species in Huay Ngua as well s other areas in the region (upper and lower Nam Ngiep, lower Nam Xan). *Indirect* The species is reported to occur within PKK.
Distribution	This species is not native to Lao PDR. It is native to Bangladesh, Cambodia, India, Myanmar, Philippines, Thailand and Viet Nam. The species is common in Southeast Asian countries. Phengsintham (2013) notes recording the species in several Lao PDR provinces including Vientiane capital, Bolikhamxay, Khammouane, Savannekhet, Saravane, Champasak and Attapeu.
Population	Limited information is available regarding the population size of the species locally and globally however the NUL survey noted the species both within the proposed access road and in the adjacent area.
Habitat	In Indo-China and Thailand the species occurs gregariously along river banks, and in the Philippines it is found in mixed dipterocarp forest. It is a tropical tree of dense evergreen and mixed dense forest.
Threats	The major threat to the species is habitat loss. In Cambodia it is a valued construction timber and resin used for proofing and traditional medicine.
Summary	This species was detected in the Project area at a number of survey locations. The species is not native to Lao PDR and as such is not considered a priority biodiversity value. **The species is not a candidate for critical habitat within the Project area.**
References	Ashton, P. 1998. *Dipterocarpus alatus*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 21 August 2013.

Species	*Dipterocarpus turbinatus*
Candidate Criteria	Criterion 1 – The species is listed as Critically Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species at Huay Ngua PPA as well as other areas in the region (main dam, re-regulation dam, upper Nam Ngiep, lower Nam Xan). *Indirect* -
Distribution	The species is native to Bangladesh, Cambodia, India, Lao PDR, Myanmar, Thailand and Viet Nam. TISTR survey detected the species at a number of locations throughout the Nam Ngiep catchment. Hossain and Nath note that in Bangladesh the species scattered in the tropical ever-green forests and tropical semievergreen forests of Chittagong, Chittagong Hill Tracts, Cox's Bazar and Sylhet while in Myanmar the species has a comparatively wide distribution in tropical semievergreen forestsand tropical moist deciduous forest. Dr Pheng Phengsintham indicated that the distribution in Lao PDR includes Vientiane province (pers. comm. 7/12/2013).
Population	Limited information is available regarding the population size of the species locally and globally.
Habitat	The species is found in mixed deciduous, evergreen and semi-evergreen forests. It is reported to often occur in wet dense forest.
Threats	In some countries the resin of the tree is used to prepare torches.
Summary	This species has been noted within a number of the Project area survey locations and affords a distribution across a number of countries outside Lao PDR. Given the distribution of known records it is considered **unlikely that the Project area sustains >10 per cent of the global population (Tier 1), or, habitat of significant important or containing nationally important concentrations (Tier 2).** Measures such as planting and management of harvesting threats locally will assist in managing the local population of the species.
References	Ashton, P. 1998. *Dipterocarpus turbinatus*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 21 August 2013. Hossain, M. K. and Nath, P.K. Part II Species Descriptions: *Dipterocarpus turbinatus* Gaertn. Institute of Forestry and Environmental Sciences, Chittagong University, Bangladesh

Species	*Shorea roxburghii*, White Meranti
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 survey recorded the species in resettlement, transmission line and Huay Ngua PPA as well as other areas in the region (upper and lower Nam Ngiep, upper and lower Nam Xan). *Indirect* -
Distribution	The species is native to Cambodia, India, Lao PDR, Malaysia, Myanmar, Thailand and Viet Nam. TISTR survey detected the species at a number of locations throughout the Nam Ngiep catchment. Phengsintham (2013) notes recording the species in several Lao PDR provinces including Vientiane capital, Savannekhet and Road no 13.
Population	Limited information is available regarding the population of the species, though healthy regenerating subpopulations are reported in the south of India.
Habitat	The species is considered unusual for its adaptation to withstand adverse climatic conditions and soil types. It occurs in dry evergreen or deciduous forest and bamboo forest, often on sandy soils.
Threats	
Summary	This species has been noted within a number of the Project area survey locations and affords a distribution across a number of countries outside Lao PDR. Given the distribution of known records it is considered **unlikely that the Project area sustains >10 per cent of the global population (Tier 1), or, habitat of significant important or containing nationally important concentrations (Tier 2).** Measures such as planting and management of harvesting threats locally will assist in managing the local population of the species.
References	Ashton, P. 1998. *Shorea roxburghii*. In IUCN 2013. IUCN Red List of Threatened Species Version 2013.1. www.iucnredlist.org. Downloaded on 12 September 2013.

Species	*Cuon alpinus*, Dhole/Asian wild dog
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. ERI 2007 biodiversity survey did not record the species. *Indirect* Biodiversity village surveys in 2013 apparently recognised the species in the upper Nam Ngiep area. Stakeholder village surveys in 2013 apparently recognised the species reporting that it is very commonly encountered in Ban Pou, Ban Xomxuen, Ban Pakyong and Ban Don though never encountered in Ban Kanyong and Ban Pakheuang villages. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified.
Distribution	The species is native to Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Kazakhstan, Kyrgyzstan, Lao PDR, Malaysia, Mongolia, Myanmar, Nepal, Russian Federation, Tajikistan, Thailand and Viet Nam. The species is thought to have ranged over most of Lao PDR, Cambodia, Viet Nam and Thailand although reliable site-specific information is scarce. Duckworth et al 1999 note the species to occur in north Lao (Phou Khaokhoay) and in southern Lao (Dong Hua Sao, Xe Pian and Dong Khanthung) and there are mote recent records from various other survey areas such as the Nakai plateau and Nam Et Phou Louey NPA.
Population	It is estimated that fewer than 2,500 mature individuals remain in the wild with a declining population trend. The Lao PDR population is not known, although the species evidently remains considerable more widespread in Lao PDR than do the big cats.
Habitat	The species is found in a wide variety of vegetation types including primary, secondary and degraded tropical dry and moist deciduous forest, evergreen and semi-evergreen forests, dry thorn forests, grassland scrub forest mosaics and alpine steppe. Habitat selection factors include the availability of medium to large ungulate prey, water, presence of other large carnivores, suitability of breeding sites and human population levels.
Threats	The most important threat in Lao PDR is likely to be hunting, although this is usually as bycatch in retaliation for livestock killing; as yet there is no evidence of significant trade demand. Secondary threats include habitat loss, depletion of prey population, interspecific competition, persecution and possibly disease.
Summary	Dholes plausibly remain widespread and perhaps even locally common in the Nam Ngiep area; but this is equally true of much of hilly north and central Lao PDR. **The Project area is only a small proportion of the nation's total such habitat and as such would not be expected to constitute critical habitat.**
References	Durbin, L.S., Hedges, S., Duckworth, J.W., yson, M., Lyenga, A. and Venkataraman, A. (IUCN SSC Canid Specialist Group – Dhole Working Group) 2008. Cuon alpinus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2 www.iucnredlist.org. Downloaded 16 December 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Elephas maximus*, Asian elephant
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. A herd of approximately 10 elephants is known from the conservation area near Na village. The village resident operate an elephant conservation area that caters for visitng tourists.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Stakeholder village surveys in 2013 recognised the species reporting it is not commonly encountered in Ban Pakyong and never seen in Ban Pou, Ban Xomxuen and Nam Xan villages. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified.
Distribution	The species is native to Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, Sri Lanka, Thailand and Viet Nam (Choudhury et al. 2008). Populations in Lao PDR are now numerically insignificant compared with those of south Asia, but in the context of even steeper declines in Vietnam and China and similar ones in Cambodia, they are highly significant in the maintenance of ancestral range. The species in Lao PDR is reported to be widely, but very patchily distributed in forested areas (highlands and lowlands) with potentially important populations Nam Phouy west of the Mekong and in northern Lao PDR; in Phou Phanang and Phou Khao Khoay in Vientiane Province; Nakai Nam Theun NPA and surrounding in Khammouane Province; Phou Xang He NPA in Savannakhet Province; Dong Ampham, Dong Khanthung, Xe Pian, close to Cambodian border; and Nam Et, Nam Xam, Phou Dendin, and Nam Ha in the north, close to the Vietnamese and Chinese borders. However recent information on most of these areas is sparse. Near the Project area, potentially important elephant populations have been reported at Phou Phanang and Phou Khao Khoay to the west (approximately 20 km) and Nam Xan. An area to the east (approximately 20 km) of Huay Ngua PPA is considered important for a population of elephants that links to Nam Kading National Protected Area (pers comm. Kham khoun Khounboline 19/11/2013).
Population	It was estimated in 2003 that the global population of the species is between 41,410 and 52,345 (however this has been contested) which includes between 500 and 1000 in Lao PDR. Estimate of national population is expected to be larger than the 200-500 estimated in Lair (1997) and the Lao PDR population has been considered to be the most important national population for conservation in Indochina. However, ongoing declines in Lao PDR and recent discoveries in Cambodia suggest this statement may require modification.
Habitat	The species is found in many habitat types up to atleast 1200 m, remaining widely distributed in forested, hilly areas. The species is a generalist occurring in grassland, evergreen forest, semi-evergreen forest, moist deciduous forest, dry deciduous forest, dry thorn forest, scrublands and cultivated and secondary forests. The Asian elephant is an herbivore requiring large amounts of food per day. Their dung contributes to germinating seed dispersal. The home range varies but is considered to be large with ranges in excess of 60,000 ha recorded in India and only 16,000 ha range in Sri Lanka.
Threats	The overwhelming threat to the species in Lao PDR and surroundings is hunting, both for trade and resulting from crop destruction. Subsidiary threats

Species	*Elephas maximus*, Asian elephant
	include habitat loss, degradation and fragmentation, chiefly because these increase the likelihood of human-elephant conflict and enhance the ease of poaching. Large areas of prime elephant habitat in Lao PDR have already lost the species.
Summary	The location of the indirect records east of Huay Ngua is outside the Project area. Near the known elephant herd at Na, the alignment will be parallel to the currently under construction EDL transmission line and will be located outside the conservation areas maintained by the Na village. Similarly there are a number of locations noted for the species other countries. As such, the **Project area is not considered likely to be part of one of 10 or fewer habitat areas or required to sustain greater than 10 per cent of the global population (C1 Tier 1).** The Project area is not a known important area in Lao PDR for the species however suitable habitat exists and management measures should be considered for the species to manage human-elephant conflict scenarios.
References	Choudhury, A., Lahiri Choudhurym D.K., Desai, A., Duckworth, J.W., Easa, P.S., Johnsingh, A.J.T., Fernando, P., Hedges, S., Gunawardena, M., Kurt, F., Karanth, U., Lister, A., Menon, V., Riddle, H., Rubel, A. and Wikramanayake, E. (IUCN SSC Asian Elephant Specialist Group) 2008. *Elephas maximus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 03 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Manis javanica*, Sunda pangolin
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not directly record the species. One was photographed in the lower Nam Ngiep area in early 1999 that had reportedly been collected 30 minutes' walk in a village from the village of Ban Sopyouk; two more unidentified pangolins were seen then in Ban Houaypamom, reportedly collected a few hours' walk away. Specific location information is unavailable.
	Indirect The Huay Ngua MP (2010) notes presence of pangolins, assumed to be the species within the preserved area. Stakeholder village surveys in 2013 recognised pangolins, assumed to be the species is commonly encountered in Ban Pou (of Nam Ngiep) and Ban Pakheuang (of Nam Xan) and less common in Ban Xomxuen, Ban Pakyong and Ban Kanyong. He species is noted as very common at Ban Don village. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: There is some uncertainty associated with these indirect data sources for the species as there can be confusion between *Manis javanica* and the other pangolin species of Lao PDR, Chinese pangolin *M. pentadactyla*. However, pangolins as a group are readily recognised and because no pangolin species remains widespread or common in Lao PDR, the information at group level remains of value.
Distribution	The species ranges of much of mainland Southeast Asia, including southern Myanmar through central and southern Lao PDR, Thailand, central and southern Viet Nam, Cambodia, Peninsular Malaysia, Sumatra, Java and Borneo. In Lao PDR it is expected that the species is restricted to the Mekong plain and adjacent foothills to around 900 m, with potential occurrence in the Bolaven Plateau. Duckworth et al 1999 noted records from many survey areas in the 1990s. However very high levels of trade-driven hunting since hen suggest that pangolins are likely now to be very rare and plausibly widely extirpated from suitable habitat in Lao PDR.
Population	The species is rarely observed and as such population size information is unavailable. The species is noted as common in parts of Singapore and relatively common Sabah though reports of substantial declines are noted in areas of Viet Nam and Lao PDR.
Habitat	Found in primary and secondary forest as well as cultivated areas, gardens and plantations. The species inhabits hollows for sleeping and den sites and as such primary forest might occupy more individuals because they contain higher numbers of older, larger trees with suitable hollows. The species is largely nocturnal and solitary, feeding on ants and termites. Home range size has been estimated at 6.97 ha.
Threats	The overwhelming threat to the species is hunting for (formerly) local use and (now, almost entirely) international trade (skins, scales, meat). Pangolins are highly adaptable to some modified habitats (those with sufficient food), where not hunted.
Summary	There is some uncertainty associated with the indirect data sources for the species as there can be confusion between *Manis javanica* and other pangolin species. The key threat to the species is hunting and although current information does not confirm critical habitat, the precautionary approach should be considered and the threats to the species should be managed throughout the Project construction and operation and within any Biodiversity Offset Design.
References	Duckworth, J.W., Pattanavibool, A., Newton, P. and Nguyen Van Nhuan. 2008. *Manis javanica*. In: IUCN 2013. IUCN Red List of Threatened Species. Version

Species	*Manis javanica*, **Sunda pangolin**
	2013.2. www.iucnredlist.org. Downloaded on 17 December 2013.
	Duckworth, J.W., Satler, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Nomascus leucogenys*, Northern white-cheeked gibbon
Candidate Criteria	Criterion 1 – The species is listed as Critically Endangered on the IUCN Red List. It also has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey recorded a vocalisation of a gibbon assumed to be the species in the upper Nam Ngiep survey area in the main dam inundation area. Targeted primate survey was undertaken in November 2013 by Dr Phaivanh Phiapalath of the IUCN SSC/Primate Specialist Group which reported two records (vocalisation) of gibbons in uphill mountain area outside the inundation area.
	Indirect -
Distribution	The species is native to Lao PDR and Viet Nam and (now very much reduced) in China. In Lao gibbons probably of this species have been recorded widely in the northern highlands, potentially south into the northern Annamites in Nakai-Nam Theun and Nam Kading NPAs. However, ongoing challenges in identifying gibbons to species render many claims provisional. The gibbons of the Nam Ngiep catchment may include this species, but may also include, or even be entirely comprised of Southern white-cheeked gibbon *N. siki*.
Population	Population numbers are highest in Lao PDR due to larger tracts of natural habitat remaining in comparison to Viet Nam and China where forest habitat is much more fragmented and hunting has been in general, at higher levels for longer.
Habitat	The species is strictly arboreal though there is very little behavioural ecology information, including home range extent. Habitat includes tall primary and heavily degraded evergreen and semi-evergreen forest. The diet is dominated by fruits and some small amounts of leaves and insects. Anecdotal reports suggest group sizes of 3-4 individuals. Targeted primate survey identified a number of key habitat areas for the species, thought located outside the inundation area.
Threats	Hunting has been so heavy in much of Lao PDR that many forest blocks have now lost gibbons entirely or support only tiny numbers. However, in some areas local traditional beliefs have resulted in the survival of potentially viable numbers in areas where almost all other wildlife species of similar, or even much lower, sensitivity to offtake have been seriously reduced. These areas are particularly important in retaining gibbons in the northern half of Lao PDR, but general erosion of these beliefs is high threat to these remnant populations.
Summary	Key habitat areas for the species are reported by Dr Phaivanh Phiapalath at Phou Thin, Phouru Pha Noy, Phou Pha hua and Phou Sam Liem. These locations are outside the transmission line Project area. **As such the Project area is not considered to be critical habitat**.
References	Bleisch, B., Geissmann, T., Manh Ha,., Rawson, B. and Timmins, R.J. 2008a. *Nomascus leucogenys*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org. Downloaded on 21 August 2013.

Species	*Nycticebus bengalensis*, **Bengal slow loris**
Candidate Criteria	Criterion 1 – The species is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. *Indirect* Biodiversity village surveys in 2013 apparently recognised the species to occur in the upper Nam Ngiep area. Stakeholder village surveys in 2013 apparently recognised lorises, reporting to be as very common at all the villages surveyed: Ban Pou, Ban Xomxuen, Ban Pakyong, Ban Kanyong, Ban Pekheuang and Ban Don. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified.
Distribution	The species has a broad distribution in south-east Asia and occurs in: Bangladesh, Cambodia, southern China, north-eastern India, Lao PDR, Myanmar, Thailand, and Viet Nam (except the south).
Population	In Lao PDR, the population seems to be large and occurs in both large forest tracts and in degraded and fragmented areas. In the 1990s large lorises were among the most common species seen during spotlight surveys in much of central and southern Lao PDR (the north had no comparable surveys), and – in the absence of repeat survey – the limited credible village information gathered since then suggests no major declines within remaining suitable habitat.
Habitat	The species is arboreal and nocturnal, and inhabits tropical evergreen rainforest, semi-evergreen forest, and moist deciduous forest (Streicher 2008b).
Threats	The species is hunted and traded for food, traditional medicine, sport and as pets. Presently, in Lao PDR, this seems to be at lower levels than in countries such as Cambodia, although an escalation of hunting pressure may occur. The species' habitat is being reduced by farming, human settlement, infrastructure development (roads, dams and transmission lines) and fires, but very large areas remain in Lao PDR and the species is not yet anywhere close to being threatened by habitat factors.
Summary	This loris plausibly remains widespread and common in the Project area, but this is equally true of much of Lao PDR. **The Project area is only a small proportion of the nation's total such habitat and as such would not be expected to constitute critical habitat.**
References	Streicher, U., Singh, M., Timmins, R.J. & Brockelman, W. 2008b. *Nycticebus bengalensis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on **07 November 2013**.

Species	*Panthera pardus*, Leopard
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not directly record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the protected area. Biodiversity village interviews in 2013 apparently recognised the species has been seen in the upper Nam Ngiep area. The Project EIA (2007) does not note the species. Note: Verbal village information on cats is close to impossible to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Leopard presence in the Project area.
Distribution	The species also occurs across most of sub-Saharan Africa, as remnant populations in north Africa, and in the Arabian peninsula and Sinai/Judean Desert (Egypt/Israel/Jordan), south-western and eastern Turkey and through southwest Asia and the Caucasus into the Himalayan foothills, India, China and the Russian Far East as well as Java and Sri Lanka. The species distribution includes Lao PDR. In the 1990s there were rather few confirmed records during extensive surveys (Duckworth et al. 1999) but methods were not very suitable for finding the species. There have been few records since (again in part reflecting the limited application of suitable methods). However, the extreme rarity with which big cat signs are now found in most of Lao PDR means that the species's distribution in the country is probably now highly fragmented.
Population	There is no reliable global population estimate, and population estimates for India and Africa are considered unreliable. Many populations west of southeast Asia are believed to be increasing, and there are high levels of human-leopard conflict. In Lao PDR the identification of the species by local reports and signs is challenging and many claims are over-confident (as proven almost whenever skins or other relicts are available to be examined). The species might still be widespread in the Bolikhamxay province though at very low density (IEWMP 2006).
Habitat	In south-east Asia, the species is found in all forest types, from tropical rainforest to the temperate deciduous and alpine coniferous (up to 5,200 m in the Himalaya), and also in dry scrub and grasslands.
Threats	The massive declines in Indochina have been driven at least almost entirely by hunting. Suitable habitat remains widespread in Lao PDR but mostly no longer supports the species, at least at potentially viable levels.
Summary	Given the large range of the species, certainty of records and secondary information from local village representatives it is **unlikely that the Project area and immediate surrounds supports greater than 10 per cent of the global population or habitat of significant importance.** The key threat to the species is hunting and although current information does not confirm critical habitat and there is uncertainty of the relevance of the villege interview data, the precautionary approach should be considered and the threats to the species should be managed throughout the Project construction and operation and within any Biodiversity Offset Design.
References	Henschel, P., Hunter, L., Breitenmoser, U., Purchase, C., Khorozyan, I., Bauer, H., Marker, L., Sogbohossou, E. and Breitenmoser-Wursten, C. 2008. *Panthera pardus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org Downloaded 3 November 2013

Species	*Panthera pardus*, **Leopard**
	Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Prionailurus viverrinus*, Fishing cat
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. *Indirect* The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Stakeholder village surveys in 2013 apparently recognised the species, reporting it is common in Ban Kanyong and Ban Don of Nam Xan while noted the species as less common Ban Pou and Ban Pakyong of Nam Ngiep River. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on cats is close to impossible to assign to species despite the often overconfident presentation in interview reports. Fishing cat is so widely misidentified in South-east Asia (e.g. Duckworth *et al*. 2010) yet so universally reported in verbal village information that these reports should not be taken as even weakly indicative of Fishing cat presence in the Project area. In fact, there is no confirmation that the species occurs in Lao PDR at all. Most of the valid recent records from southeast Asia are from coastal areas, and while there are historical specimens from a few inland areas, there are too few inland records to make a habitat-based prediction of Fishing cat's likely status in the Project area.
Distribution	The species is native to Bangladesh, Bhutan, Cambodia, India, perhaps Indonesia, perhaps Lao PDR, Myanmar, Nepal, Sri Lanka, Thailand and Viet Nam. The species is primarily found in wetland habitats, which are increasingly being settled, degraded and converted; its occurrence may now be highly localised in southeast Asia, and is almost certainly so, away from the coast. The species has not been seen captive or in trade in Lao PDR suggesting that it is extremely rare or not likely to occur (pers comm. Will Duckworth 15/11/2013).
Population	Population estimates are not well understood. There are very few reports from Lao, all either certain or plausible errors. It is possible that the species is extinct or never occurred in Lao PDR; it is inconceivable that, if present, it is other than extremely rare. This is also true of Cambodia even though a sizeable number of captive animals have been reported in this latter country. In southeast Asia recent records are infrequent suggesting a decline in populations.
Habitat	Past statements on habitat use in SE Asia are confounded by incorporation of information from misidentified animals. Almost all recent SE Asian records are from the coast, although a few historical specimens prove inland occurrence. All such latter records seem to have been from the level lowlands, in areas with many standing waterbodies. The species is thought to feed mainly on fish but also small rodents, reptiles and amphibians. Home ranges reported in Nepal ranged between 400 and 1600 ha.
Threats	Main threats to the species include wetland destruction and degradation.
Summary	There is no reason to think that Fishing cat inhabits the Project area, but equally it cannot be excluded that it does so. However, the Project area's habitat is not distinct in any way from typical Lao hill-country, and **so there is no reason to conclude that the Project area could be considered critical habitat for the species.**
References	Mukherjee, S., Sanderson, J., Duckworth, W., Melisch, R., Khan, J., Wilting, A., Sunarto, S. and Howard, J.G. 2010. *Prionailurus viverrinus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 03 September 2013.

Species	*Prionailurus viverrinus*, **Fishing cat**
	Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Trachypithecus phayrei*, Phayre's leaf monkey
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List. Its treatment in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF is ambiguous; it is not mentioned by English or scientific name, but is best seen as listed as Restricted, taking the entity translated as Silvered Langur to in fact refer to all grey langurs (=leaf monkeys).
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. Targeted primate survey was undertaken in November 2013 by Dr Phaivanh Phiapalath of the IUCN SSC/Primate Specialist Group which reported one record (vocalisation) and three mineral licks were found within the upper Nam Ngiep area. A shot individual was photographs in the lower Nam Ngiep in early 1999 however specific location information is unavailable. *Indirect* Biodiversity village surveys in 2013 suggested the species in the main dam inundation area. Stakeholder village surveys in 2013 apparently recognised the species, reporting that it is very common in Ban Pou, common at Ban Xomxuen and Ban Kanyong however is never encountered at Ban Pakyong, Ban Pakheuang or Ban Don. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Although interviews cannot reliably distinguish the various taxa of *Trachypithecus* inhabiting Lao PDR, on geographical grounds Indochinese Silvered Leaf Monkey *T. germaini* can be eliminated, and the Project area seems to support little if any habitat rugged enough for François's Leaf Monkey (sensu lato) *T. fancoisi*.
Distribution	The species is native to Bangladesh, China, India, Lao PDR, Myanmar, Thailand and Viet Nam (Bleisch et al., 2008b). In Lao PDR the species has been confirmed only in the northern parts (including the Project area), perhaps extending marginally into central Lao PDR. Viet Nam records are from less than five areas. In Thailand there are good populations in Nam Nao National Park and Phukhio Wildlife Sanctuary and Western Forest complex. In Lao PDR, Timmins et al. (2013) note the species to occur from the Mekong Valley up to at least 800m, with one record (at a mineral lick) at 1125m.
Population	Populations are generally small and isolated. China has reported healthy populations in a number of reserves though overall the species population is reported on serious decline globally. Timmins et al. (2013) noted recent Lao records only from ten survey areas (in some, merely objectively identified as grey leaf monkeys, but which on range can be assumed to be this species), with little evidence for large numbers in any survey area.
Habitat	The species inhabits primary and secondary evergreen and semi-evergreen forest, mixed moist deciduous forest as well as bamboo areas, light woodlands and near tea plantations. In Lao it seems to be particularly occurring in edge and degraded areas, which suggest high tolerance to habitat perturbation, but, because such areas are often on the margins of wilderness areas, elevated rick from hunting. It is a predominantly arboreal species that is folivorous. Home range extent not reported.
Threats	The main threat to the species In Lao PDR is hunting, its effects may be exacerbated by the species's habitat use. Most of the areas within the species's geographic range large enough to have remotes cores with relatively lower hunting have such areas above 800m, and thus probably support few if any of this species. However, the numbers of records from outside the protected area system and fairly close to heavy human activity suggest higher resilience to hunting than shown by, for example, Red-shanked douc langur.

Species	*Trachypithecus phayrei*, **Phayre's leaf monkey**
Summary	This species is probably among the mammal species for which the Project area provides a significant contribution to national conservation prospects. However, even at the national level it is implausible that the Project area supports close to 10 per cent of the population, given that it comprises far less than 10% of the species's presumed present area of occupancy in today's Lao PDR. **As such the Project area is not considered to be critical habitat for the species.** Key habitat areas for the species are reported by Dr Phaivanh Phiapalath at Phou Thin, Phouru Pha Noy, Phou Pha hua and Phou Sam Liem. These locations are outside the Project area.
References	Bleisch, B., Brockelman, W., Timmins, R.J., Nadler, T., Thun, S., Das, J. and Yongcheng, L. 2008b. Trachypithecus phayrei. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org. Downloaded on 21 August 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Buceros bircornis*, Great hornbill
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Biodiversity village survey apparently recognised the species, reporting it as less commonly encountered in the upper and lower Nam Xan only. Note: Verbal village information on hornbills is difficult to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Great Hornbill presence in the Project area. In most of Lao PDR Great Hornbill is much more declined than Wreathed Hornbill, and most village reports of 'great hornbills' and taken by the interviewers to mean Great Hornbill in fact probably refer to Wreathed Hornbill.
Distribution	The species has a wide distribution, occurring in China, India, Nepal, Bhutan, Bangladesh, Myanmar, Thailand, Lao PDR, Vietnam, Cambodia, Malaysia and Indonesia. Surveys in the 1990s recorded the species in a fair number in areas across Lao PDR, although almost invariably in small numbers (Duckworth et al. 1999); there is recent information only from few areas, reflecting patchy survey but some local extirpations are likely to have occurred in the intervening period.
Population	Although the species has a large range it occurs at low densities and is patchily distributed. In Lao PDR, the species was formerly common but now (although still widespread) is scarce. Based on population estimates in India, the species global population is estimated at 10,000 to 70,000 individuals. It is probably best placed in the band 20,000-49,999 individuals.
Habitat	This species frequents evergreen, semi-evergreen and mixed deciduous forests, ranging out into open deciduous areas to visit fruit trees and ascending slopes to at least 1,560 m. The species is perhaps most common in unlogged forest.
Threats	The primary threat to the species in Lao PDR is hunting; many large tracts of prime habitat support only small numbers, or none, because of this threat.
Summary	Great hornbill plausibly still occurs in the Project area but probably only in low numbers. Its status is similar across large parts of Lao PDR. **The Project area is small in proportion to the nation's total suitable habitat and as such is most unlikely to constitute critical habitat.**
References	BirdLife International. 2013. *Buceros bircornis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Cairina scutulata*, White winged duck
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. *Indirect* The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Stakeholder village surveys in 2013 apparently recognised the species, reporting it as common in Ban Xomxuen and Ban Pakyong of the Nam Ngiep River though never seen in Ban Pou. In Nam Xan River villagers responded that the species is common in Ban Kanyong and Ban Don and very common in Ban Pakheuang. The Project EIA (2007) notes the species occurrence outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on ducks and other swimming birds is impossible reliably to assign to species despite the often overconfident presentation in interview reports. In particular, inept interview teams almost invariably record White-winged Duck almost anywhere in Lao PDR that villagers report ducks of any species. Given that the considerable specific search effort for White-winged Duck in the 1990s and to a lesser extent in the 2000s found only few areas to support the species, and that competently executed interview surveys very rarely find reports that conform in morphological and behavioural aspects with White-winged Duck, it is obvious that most purported White-winged Duck interview claims are in error. The same is assumed to hold here. However, the habitat is suitable for the species, and would surely have held it previously, and it cannot be excluded that small numbers remain.
Distribution	The species is native to Bangladesh, Cambodia, India, Indonesia, Lao PDR, Myanmar, Thailand and Viet Nam. Duckworth et al (1999) note 2 – 3 population centres for the species in Lao PDR. There are no recent (post-1950) records or convincing reports of the species in Lao PDR from north of the Nakai plateau, there are also no historical reports, but in the light of highly limited survey efforts, the species is assumed to have been overlooks in the many Mekong tributary systems upstream of the Nam Kading to atleast the Nam Sang. Recent intensive activity in the Nam Theun catchment suggests that very small numbers may survive for some years in areas where conventional survey under practical levels of effort cannot guarantee to find then, even by sign. Therefore, the actual status (extirpated vs reduced to very small numbers) in north Lao PDR in and since the 1990s cannot be determined.
Population	Estimates of global population report 450 individuals in India, low hundreds in Myanmar, 100 in Cambodia and 150 in Indonesia. Precautionary estimates places the global population between 350 and 1500 individuals. Total numbers in Lao PDR are likely to be no more than a few dozen, and probably now are many fewer.
Habitat	The species occur in stagnant or slow-flowing wetlands (natural and artificial) within or adjacent to evergreen, deciduous or swamp forest. Individuals roost and nest in the tree hollows. The species is secretive and forages at night on seeds, aquatic plants, grain, rise, small fish and invertebrates. Duckworth et al (1999) note records from slower moving stretches of forested streams and rivers, and pools in forests, up to 600 m.
Threats	The primary threat to the species in Lao PDR is hunting, apparently mainly for local use; many large tracts of prime habitat support only small numbers, or none, because of this threat. The threat from hunting is exacerbated by the species's habitat use: riverine and riparian forest habitats, and are among those most heavily used and degraded by human activity. Thus, although there

Species	*Cairina scutulata*, White winged duck
	seems to be no trade demand for the species in Lao PDR, incidental/opportunistic hunting occurs throughout its Lao PDR range at levels sufficient for widespread local extirpation.
Summary	White winged duck might possibly still occur in the Project area but at best only in very low numbers. Despite major loss of habitat in the last half century, tracts similar in extent and condition to the Project area remain in many parts of Lao PDR. The Project area is only a small proportion of the national's total suitable habitat and as such it is **unlikely to constitute critical habitat.**
References	BirdLife International. 2012c. *Cairina scutulata*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Centropus sinensis*, Greater coucal
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey recorded the species in Huay Ngua PPA the upper and lower Nam Ngiep, resettlement site, and upper and lower Nam Xan.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified.
Distribution	This species has an extremely large distribution and is native to: Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, and Viet Nam.
Population	The global population size has not been quantified, but the species is reported to be common almost everywhere throughout its range. National population sizes have been estimated at c.100-10,000 breeding pairs and c.50-1,000 individuals on migration in China; and c.100-10,000 breeding pairs in Taiwan. It is widespread and generally abundant, including in areas with very heavy human use and bird hunting pressure, across Lao PDR.
Habitat	Habitat is noted to be forest edge, scrub, tall secondary growth and grassland including ponds and villages.
Threats	There are no threats to Greater coucal populations in Lao PDR. Although it is often hunted, it seems resilient to current levels, and while populations may by below carrying capacity in heavily settled areas, there has been no significant contraction of range. The species has doubtless benefitted hugely from the major conversion and degradation of Lao PDR's forests over the last century.
Summary	Greater coucal is probably abundant over the deforested and degraded parts of the Project area. **This is so across Lao PDR however the Project area constitutes an insignificant proportion of the nation's total suitable habitat and as such does not constitute critical habitat.**
References	BirdLife International. 2012. *Centropus sinensis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Lophura diardi*, Siamese fireback
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species. *Indirect* The Huay Ngua MP (2010) notes presence of the species within the protected area. Biodiversity village surveys in 2013 apparently recognised the species, reporting it is less common in upper and lower Nam Xan however did not recognise its presence in Nam Ngiep and Huay Ngua visited areas. Stakeholder village surveys in 2013 recognised the species as very common in Ban Pou and Ban Xomxuen of the Nam Ngiep River though common in Ban Pakyong. In Nam Xan River villagers responded that the species is very common in Ban Kanyong, Ban Pakheuang and Ban Don. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on pheasants in Lao PDR is difficult to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Siamese fireback presence in the Project area. However, the area contains suitable habitat in its lower-lying parts, and the species is extremely resilient to hunting and forest degradation (it may even benefit from some level of the latter). Thus, it is highly likely that Siamese fireback inhabits the area.
Distribution	The species occurs in Thailand, Lao PDR, Cambodia and Vietnam. 1990s surveys recorded the species widely across lower-lying parts of Lao PDR.
Population	The species is locally common in much of its range. The total population is suspected to number 20,000-49,999 individuals based on a conservative estimate of c.2,000 individuals in Cambodia and an estimate of c.5,000 individuals in Thailand; the Lao PDR population is likely to dwarf both of these.
Habitat	The species occurs in evergreen, semi-evergreen and bamboo forest, secondary growth and scrub, often near roads and tracks through the forest, chiefly in the plains and foothills to 500 m, but occasionally much higher.
Threats	This species is declining in Lao PDR in proportion to wholesale conversion of lowland and lower-hill forest to plantations and other uses. However, very large areas of suitable habitat persist, and there are a sufficient number of records in the last decade to be sure that the species is not threatened in Lao PDR. Despite earlier concerns, it is now clear the species is highly resilient to hunting, perhaps including large-scale snaring, although this largely takes place in forests above it main altitudinal range.
Summary	Siamese fireback is very likely to occur, perhaps widely, in the Project area. Nonetheless, the **Project area constitutes an insignificant proportion of suitable habitat across Lao PDR, so does not constitute critical habitat**.
References	BirdLife International. 2013. *Lophura diardi*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Lophura nycthemera*, Silver pheasant
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the protected area. Biodiversity village surveys in 2013 apparently recognised the species, reporting it is less common in upper and lower Nam Xan however did not recognise its presence in Nam Ngiep and Huay Ngua visited areas. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on pheasants in Lao PDR is difficult to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Silver pheasant presence in the Project area. However, the area contains suitable habitat in its higher-lying parts, and the species is extremely resilient to hunting and forest degradation in Lao PDR. Thus, it is highly likely that Silver pheasant inhabits the area.
Distribution	The species occurs broadly across south-east Asia. The species is native to Thailand, Myanmar, Lao PDR, Vietnam, Cambodia and southern China.
Population	The global population size of the Silver Pheasant has not been quantified, but the species is reported to be widespread and seemingly common in suitable habitat. The population size in China has been estimated at c.10,000-100,000 breeding pairs (BirdLife International 2013). Lao PDR supports large populations as the species is widespread and locally common.
Habitat	Occurs in hill and montane forest (mainly evergreen) and tall secondary growth. Generally found between 500m and 2020m although occasionally down to 200m.
Threats	Silver pheasant is declining in Lao in proportion to wholesale conversion of occupied hill forest to plantations and other uses. However, very large areas of suitable habitat persist, and there are a sufficient number of records in the last decade to be sure that the species is not threatened in Lao PDR. Despite earlier concerns, it is now clear the species is highly resilient to hunting, perhaps including large-scale snaring (most of which occurs in this species's main altitudinal range), although this is so far not well assessed.
Summary	Silver Pheasant is very likely to occur, perhaps widely and commonly, in the Project area. Nonetheless, the Project area constitutes an insignificant proportion of suitable habitat across Lao PDR, so does **not constitute critical habitat**. This remains so even if one treats the various morphologically distinctive races as separate conservation units.
References	BirdLife International. 2013. *Lophura nycthemera*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Pavo muticus*, Green peafowl
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Note: Verbal village information on pheasants in Lao PDR is difficult to assign to species despite the often overconfident presentation in interview reports. This is so even for the morphogically distinctive Green peafowl, which is often confused/amalgamated with Crested argus (*Rheinardia ocellata*) but also often is 'reported' from outside the plausible present-day range of either. In the context of huge range contraction of Green peafowl in Lao PDR in the last 60 years and the great rarity of surviving remnant populations outside of Savannakhet, these interview reports are most sensible taken as in error.
Distribution	The IUCN mapped distribution across the Project area is mapped as 'possibly extinct'. Birdlife International recognises almost 2,500 ha on the south-western periphery of PKK as an Important Bird Area (IBA) where individuals have been heard at a roosting site in 1994, 1995 and 2002, and were credibly reported as still present in 2009. All other remnant populations of Green peafowl confirmed in Lao PDR since 1990 are al far to the south of the Project area.
Population	The estimates of global population size are 15,000-30,000 individuals. Birdlife International (2003) notes while the population is of moderate to high national significance, it is of low global significance given the larger populations in parts of Cambodia. Duckworth et al 1999 report five areas that are likely to retain populations large enough to be viable in Lao PDR, including PKK.
Habitat	The species has been reported to occupy a variety of habitats including primary and secondary, tropical and subtropical, evergreen and deciduous forest types, mixed coniferous forest, swamp forest, open woodland, forest edge, bamboo, grasslands, savannah, scrub and farmland edge.
Threats	The main threat to the species in Lao PDR is hunting, including egg collection. Habitat modification and fragmentation may locally compound the problem. These threats have led to widespread extirpation across Lao PDR and adjacent countries.
Summary	Assuming that the interview reports are in error, there is **no reason to consider that the Project area constitutes critical habitat**. However, the rather anomalous survival of the small population around Ban Nakhaty, Phou Khao Khoay NPA, emphasises the possibility that other remnants may also survive, and it cannot be excluded that the Project area might support one. Such a population could be significant at the national level.
References	BirdLife International. 2012. *Pavo muticus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 12 September 2013 Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Polyplectron bicalcaratum*, Grey peacock-pheasant
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Biodiversity village surveys in 2013 apparently recognised the species, reporting it is less common in upper and lower Nam Xan however did not recognise its presence in Nam Ngiep and Huay Ngua visited areas. Note: Verbal village information on pheasants in Lao PDR is difficult to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Grey peacock-pheasant presence in the Project area. However, the area contains extensive suitable habitat, and the species is extremely resilient to hunting and forest degradation. Thus, it is highly likely that Grey peacock-pheasant inhabits the area, and it is quite probably common.
Distribution	The species is native to Bangladesh, Bhutan, Cambodia, China, India, Lao PDR, Myanmar, Thailand and Viet Nam.
Population	The population size has not been quantified however it is not believed to be <10,000 mature individuals. The species is reported to be locally common to fairly common and rare. The population is suspected to be declining owing to habitat loss and degradation and, locally, overexploitation. It remains widespread and common almost across the Lao PDR.
Habitat	Occurs in evergreen forest from lowlands to 1850 m. The species is reported to be tolerant to degradation of forest.
Threats	As with other evergreen forest pheasants in Lao PDR, although hunting is very high within this species's habitats, it seems highly resilient to offtake. There are thus no serious threats to the species in Lao PDR presently, although its population is presumably declining in proportion to the conversion of forest to plantations and other non-forest habitats.
Summary	Grey Peacock Pheasant is very likely to occur, perhaps widely and commonly, in the Project area. Nonetheless, the Project area constitutes an insignificant proportion of suitable habitat across Lao PDR, so **does not constitute critical habitat**.
References	BirdLife International. 2012. *Polyplectron bicalcaratum*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Psittacula alexandri*, **Red-breasted parakeet**
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey recorded the species in Huay Ngua PPA. The survey did not detect the species the Nam Ngiep, Nam Xan or resettlement site areas.
	Indirect Biodiversity village surveys in 2013 apparently recognised the species, reporting it is common in Huay Ngua. The Project EIA (2007) notes the species occurrence within and outside the Project area based on a secondary data source though no location is specified. Note: Verbal village information on parakeets in Lao PDR is difficult to assign to species despite the often overconfident presentation in interview reports. These reports are thus no more than weakly indicative of Red-breasted parakeet presence in the Project area. However, the area contains some suitable habitat and there are recent records from relatively nearby (lower Nam Kading plain; Pakxan wetlands) so it is quite plausible that Red-breasted parakeet inhabits the area, although, given general recent trends in its population in Lao PDR, it is unlikely to be common.
Distribution	The species has a broad distribution and is native to Bangladesh; Bhutan; Cambodia; China; India; Indonesia; Lao PDR; Myanmar; Nepal; Thailand; and Viet Nam.
Population	The global population size has not been quantified; however the species is reported to be generally common. The species has been heavily traded, and 125,695 wild-caught individuals have been recorded in international trade since 1981. In Lao, Duckworth et al 1999 report flocks exceeding 1000 to occur (recorded in southern Lao PDR) but in most areas rarely number more than 20-30. The species has particularly declined in the northern half of the country, and has been widely extirpated.
Habitat	In Lao the species occurs in deciduous forests and adjacent secondary growth, mostly below 400m.
Threats	Four species of parakeets occur in Lao PDR the populations of all of them have probably declined hugely although this is based on status documented in neighbouring countries (where flocks are typically much larger than in Lao PDR, especially in Cambodia, China and, locally, in Vietnam) rather than on direct evidence of decline: historical Lao information is insufficiently precise. Declines have been particularly severe in the northern half of the country, where suitable habitat is naturally more fragmented and in smaller patches. The decline is assumed to have been driven by the cagebird trade, because there is no evidence of other trade in significant volumes, and ample suitable habitat remains widespread but supporting only very small numbers.
Summary	Accepting the likelihood of this species's occurrence in the Project area, it is however **unlikely, that in the context of the much larger numbers remaining in parts of Central and South Lao PDR, that the Project area could comprise critical habitat.**
References	BirdLife International. 2012. *Psittacula alexandri*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 04 September 2013. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.

Species	*Broghammerus reticulatus*, Reticulated python
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the protected area. Biodiversity village surveys in 2013 apparently recognised the species, reporting it is less common in upper and lower Nam Ngiep, resettlement site and upper and lower Nam Xan however did not recognise its presence in Huay Ngua. Stakeholder village surveys in 2013 recognised the species as very common in Ban Pou, Ban Xomxuen and Ban Pakyong of the Nam Ngiep River as well as Ban Pakheuang and Ban Don of the Nam Xan River. Ban Kanyong of the Nam Xan River noted the species as common.
Distribution	The species occurs in Indonesia, Timor-Leste, Bangladesh, Brunei Darussalam, Cambodia, India, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.
Population	The species is considered to be widespread in Lao PDR, and populations are considered to be of low global significance.
Habitat	Duckworth et al (1999) noted the species is expected to occur in most forest types though it is also documented to inhabit humid forests and is typically found in riparian areas (Raffles Museum of Biodiversity Research 2013). It also occurs in agricultural areas, scrubland, mangroves and urban areas (Raffles Museum of Biodiversity Research 2013).
Threats	It is threatened by commercial exploitations for the skin trade.
Summary	Given that the Lao PDR population is not considered to be of global significance and that is it widespread it is **unlikely that the Project area sustains greater than 10 per cent of the global population or is one of 10 discrete management sites globally for the species (C1 Tier 1).** The baseline information **does not provide an indication that the habitat is of significant importance, or that records are part of an important concentration (C1 Tier 2).**
References	Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management. Raffles Museum of Biodiversity Research. 2013. *Broghammerus reticulatus* (Schneider, 1801). In: The DNA of Singapore. < http://rmbr.nus.edu.sg/dna/> Downloaded on 08 November 2013. Uetz, P & Hallerman, J. 2013. *Broghammerus reticulatus* (Schneider, 1801). In: The Reptile Database. Zoological Museum Hamburg. < http://reptile-database.reptarium.cz/>. Downloaded on 08 November 2013.

Species	*Platysternon megacephalum*, Big-headed turtle
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area. Biodiversity village surveys in 2013 apparently recognised the species, reporting it is less common in upper Nam Ngiep and upper Nam Xan.
Distribution	The species is native to China, Lao PDR, Myanmar, Thailand and Viet Nam. The species has been reported to occur in PKK to the west of the Project area as well as other records in Annamite mountains and southern Lao PDR in 1999 (Duckworth et al 1999).
Population	There is limited information regarding the size of the population of the species. In 1999 Duckworth et al. reported that Lao PDR populations are considered to be of moderate global significance with the species being widespread. In 2006 IEWMP reported the species probably occurs widely in the Bolikhamxay Province with known records from the Ban Nape area, Nam Nouang and NNT.
Habitat	The species inhabits fast flowing, cool, rocky mountain brooks and streams, usually narrower than 1 m and less than 10 cm deep. There are a number of low order streams that the Project area intersects. The species is thought to be nocturnal when it forages along the stream bottom and stream edge. It is a carnivorous species.
Threats	A key threat wil the species will be improved access to the area for illegal wildlife collectors, either via the reservoir itself, or via project access roads
Summary	The key threat to the species is hunting and although current information does not confirm critical habitat, the precautionary approach should be considered and the threats to the species should be managed throughout the Project construction and operation and within any Biodiversity Offset Design.
References	Asian Turtle Trade Working Group. 2000. *Platysternon megacephalum*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 12 June 2013. Kirkpatrick, D.T. 1995. The Big-headed Turtle, *Platysternon megacephalum*. Originally published in Reptile and Amphibian Magazine, November/December 1995, pages 40-47. Duckworth, J.W., Salter, R.E. and Khounboline, K. 1999. Wildlife in Lao PDR 1999 Status Report. Vientiane: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management. IEWMP. 2006. Significant Wildlife and Wildlife Habitats of Bolikhamxay Province. Bolikhamxay Provincial Agriculture and Forestry Office and Wildlife Conservation Society. Vientiane Lao PDR.

Species	*Catlocarpio siamensis*, Giant barb
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List Criterion 3 – The species is migratory
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area.
Distribution	The species is native to Cambodia, Lao PDR, Thailand and Viet Nam.
Population	The size of the population is reported to have declined rapidly since 1990. The species is very rare in Thai and Lao Mekong and associated tributaries.
Habitat	The species inhabits floodplain and main river habitats feeding on algae, phytoplankton, vegetation and small fish. Spawning areas are unknown and little is known about spawning behaviour. The Mekong River Commission notes juveniles are mainly seen in floodplain habitats and small tributaries, and that mature fish are only found in large streams. Large mature fish have not been observed in floodplain habitats and it is more likely the species spawns in certain habitats within the main river channel where juveniles can reach rearing habitats on the floodplain. The species is reports to undertake short-distance migrations however further research is needed on the migratory patterns of the species.
Threats	Main threats to the species include over-harvest and habitat fragmentation.
Summary	Specialist input identified that there is very little survey data from the Nam Ngiep catchment (pers. comm. Dr Maurice Kottelat 7/11/2013). The species is threatened throughout its range and any area where the species reproduces would be considered critical habitat (pers. comm. Dr Maurice Kottelat 7/11/2013). Species profile information suggests that the species spawning occurs in main or larger river channels and identifies the importance of floodplain areas. Given that the transmission line will be elevated across waterways crossing it is not expected that there will be a direct impact to aquatic habitats for the species. Indirect impacts to aquatic habitats will require management.
References	Hogan, Z. 2011. *Catlocarpio siamensis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 12 September 2013. MRC. 2005a. Key Mekong fish species – migration paths. *Catlocarpio siamensis*. http://ns1.mrcmekong.org/programmes/fisheries/mig_catlocarpio.htm. Accessed 20 November 2013.

Species	*Pangasianodon hypophthalmus*, **Striped catfish**
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List Criterion 3 – The species is migratory
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area.
Distribution	There is limited information regarding the size of the population of the species however the species remains common and popular aquaculture species. It is used in aquaculture.
Population	The species is native to Cambodia, Lao PDR, Thailand and Viet Nam.
Habitat	It inhabits main channels and floodplains, moving off-channel for feeding and nursing. The species feeds mainly on algae, plants, zooplankton, insects, fruits, crustaceans and fish. The species is reported to move seasonally from main channels floodplains of large rivers to floodplains and marshland for feeding and nursing. The species is capable of migration in excess of 300 km.
Threats	Major threats to the species globally include overexploitation, habitat degradation, and changes in water quality and flow. Plans to dam the Mekong may disrupt the species life cycle as the migratory requirements appear to rely on flow or water quality to facilitate migration, cue spawning, and aid dispersal of young.
Summary	Species profile information suggests that the species utilises main or larger river channels and floodplain areas and undertakes long distance migrations and as such more confirmation of presence of the species is required. In the event there is spawning area downstream of the dam, the area may be considered critical habitat. Further targeted village interviews are scheduled to identify the locations where the species has been noted in the Nam Ngiep and neighbouring catchments. Given that the transmission line will be elevated across waterways crossing it is not expected that there will be a direct impact to aquatic habitats for the species. Indirect impacts to aquatic habitats will require management.
References	Vidthayanon, C. and Hogan, Z. 2011. *Pangasianodon hypophthalmus*. In IUCN 2012. IUCN Red Lost of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 12 September 2013.

Species	*Poropuntius deauratus*, Yellow tail brook barb
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List
Record	*Direct* TISTR 2013 biodiversity survey recorded this species in all sites surveyed of Nam Ngiep, Huay Ngua and Nam Xan. At Huay Ngua 13 individuals were detected in comparison to much larger counts in Nam Ngiep (up to 139 individuals).
	Indirect -
Distribution	The species is listed as native to Viet Nam from coast river drainages. Records in Cambodia, China, La PDR, Malaysia and Thailand are noted to be misidentification.
Population	
Habitat	Species habitat is listed as coastal river drainages in Central Viet Nam (Hukstorf and Freyof, 2011) and it is considered that the survey record is a misidentification.
Threats	Overfishing and habitat degradation.
Summary	Species profile and specialist input (pers. comm. Dr Maurice Kottelat 11/11/2013) suggest that the species record is a misidentification and as such further confirmation on the record is currently being sought in order to identify critical habitat status. Potential candidates for the identification include (but not limited to) *P. carinatus* (LC), *P. angustus* (DD) or *P. normani* (LC). Additional waterway surveys are being undertaken. Given that the transmission line will be elevated across waterways crossing it is not expected that there will be a direct impact to aquatic habitats for the species. Indirect impacts to aquatic habitats will require management.
References	Huckstorf, V. and Freyof, J. 2011. *Poropuntius deauratius*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org. Downloaded 20 November 2013.

Species	*Probarbus labeamajor*, **Thick lipped barb**
Candidate Criteria	Criterion 1 – The species is listed as Endangered on the IUCN Red List Criterion 2 – The species is endemic to the Mekong Criterion 3 – The species is migratory
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area.
Distribution	The species is endemic to the Mekong and reported only from the Mekong mainstream from Nakorn Phanom Province (Thailand) and Sambor District, Kratie District (Cambodia). It has also been found in Sesan, Sekong and Srepok tributaries of the Mekong.
Population	Population size is not well understood though it is noted to be decreasing and a population decline of at least 50% is inferred across the global population.
Habitat	The species inhabits the deep, slow reaches of the main channel of large rivers with a sand or gravel substrate and abundant mollusc population. It is known to undertake short distance migrations for spawning in November and January. The species feeds on aquatic plants, insects and shelled molluscs. The species is reported to undertake short distance migrations for spawning in November and January.
Threats	Threats to the species include overfishing, habitat destruction and large dams.
Summary	Specialist input (Dr Maurice Kottelat pers comm 11/11/2013) indicated that the species is not known to occur in the Project area part of the catchment and the record would require verification. The species is very distinctive and identification is generally unproblematic, as such the record is likely valid. Species profile information suggests that the species utilises main or larger river channels. Should the record be correct, the habitat in the lower reaches of the Nam Ngiep River may be susceptible to indirect impacts from the propose dam, however the area is unlikely to represent >10% of the habitat within the Mekong. **The Project area is not considered to be critical habitat for the species.**
References	Baird, I. 2011a. *Probarbus labeamajor*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org Downloaded on 12 September 2013.

Species	*Wallago leeri*
Candidate Criteria	Criterion 1 – The species has an elevated protection status nationally and is listed as Restricted in the Regulation of the Ministry of Agriculture and Forestry No. 0360/MAF.
Record	*Direct* TISTR 2013 biodiversity survey did not record the species.
	Indirect The Huay Ngua MP (2010) notes presence of the species within the provincial preserved area.
Distribution	The distribution of the species reaches from the Mekong delta to northern Lao PDR and Thailand. Other sources note that reports of the species from the Mekong River basin are mis-identifications of *Wallago micropogon*. *W. leeri* is restricted to western Indonesia and Malay Peninsula where in the Mekong River *W. micropogon* occurs.
Population	
Habitat	*W. micropogon* is found in rivers and smaller streams. It moves to flooded forests during high water levels and migrates from rivers to smaller srteams to spawn.
Threats	Threats to *W. micropogon* are likely related to loss of riverine forest and possibly changes to flow regimes.
Summary	*Wallago micropogon* is listed as data deficient on the IUCN Red list, it has been previously misidentified as *W. leeri* in the Mekong. **As such the species is not a candidate for critical habitat.**
References	Allen, D. 2011. *Wallago micropogon*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.ord. Downloaded on 20 November 2013.

Species	Migratory Fish Species
Candidate Criteria	Criterion 3 – These species are migratory
Record	*Direct* TISTR 2013 biodiversity survey recorded each of the species listed below.
General	• *Acantopsis choirorhynchos* (Horseface loach) – potamodromous, occurs in swift, clear streams with sand or gravelly substrate, also large rivers. IUCN distribution does not include Lao PDR (Ng 2012a). • *Barbonymus gonionotus* (Java barb) – potamodromous, occurs in rivers, streams, floodplains and occasionally reservoirs. Prefers standing water habitats. Local migrant from the Mekong to small streams and flooded areas (Thinh et al 2012). The species is widely distributed and cultivated. • *Henicorhynchus lineatus* – occurs mainly in medium to large-sized rivers and enters flodded fields (Allen 2011). • *Henicorhynchus ornatipinnis* • *Hypsibarbus venayi* • *Luciosoma bleekeri* (Shark minnow) – occurs in rivers and tributaries, moving to floodplains in the rainy season (Vidthayanon 2012a). • *Mystacoleucus atridorsalis* – occurs in lowland rivers and submontane streams and tributaries (Vidthayanon 2012c). • *Oxyeleotris marmorata* (Marbled goby) – occurs in wetlands, rivers, ponds, reservoirs, canals, swamps and flooded forest. Prefers little to no water movement (Allen 2011b). • *Scaphognathops bandanensis* • *Sikukia gudgeri* (Sikuk barb) – common throughout its range, potamodromous, migrates from Cambodia to southern Lao PDR and northeastern Cambodia between November and February (Baird 2012).
Summary	For species where the aquatic habitats up and downstream of the access road crossings may play a role in migration pathways, the area may be considered critical habitat. Further investigation into the migratory species relevant to the Project area is scheduled. Given that the transmission line will be elevated across waterways crossing it is not expected that there will be a direct impact to aquatic habitats for the species. Idirect impacts to aquatic habitats will require management.
References	Ng, H.H. 2012a. *Acantopsis choirorhynchos*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013. Thinh, D.V., Van, N.S. and Nguyen, T.H.T. 2012. *Barbonymus gonionotus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013. Allen, D. 2011a. *Clarias batrachus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013. Allen, D. 2011. *Gymnostomus lineatus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 16 January 2014. Vidthayanon, C. 2012. *Luciosoma bleekeri*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013. Rayamajhi, A., Jha, B.R. and Sharma, C. 2010. *Mastacembelus armatus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Species	Migratory Fish Species
	Vidthayanon, C. 2012b. *Mastacembelus favus*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Vidthayanon, C. 2012c. *Mystacoleucus atridorsalis*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Ng, H.H. 2012b. *Mystus singaringan*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Allen, D. 2011b. *Oxyeleotris marmorata*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Ng, H.H. 2012c. *Pseudomystus siamensis*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Baird, I. 2012. *Sikukia gudgeri*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.
	Dey, S.C. 2010. *Xenentodon cancila*. In IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 26 November 2013.

Annex D

Best Available Techniques

CodeBMP-01
Group General Site Management

Scheduling

Objective :

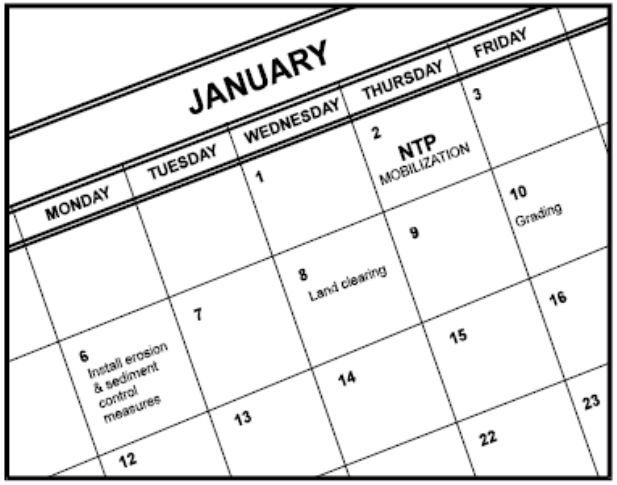
	Housekeeping Practices		*Stabilize Disturbed Areas*
	Water Pollution Control		*Public Health & Safety*
	Air & Noise Pollution Control	✓	*Natural Resources Conservation*
✓	*Minimize Disturbed Areas*		*Internal Erosion Control*

Reference sub-plans :

SP01: Erosion and Sediment Control
SP21: Cultural Resources
SP13: Unexploded Ordinance (UXO) Survey and Disposal

Responsibilities :

✓	*Site Management Team*	✓	*Environmental Team*
	Site Supervisor		*Social Team*
	Site Worker		*Safety Team*
	Driver		
	Etc.		



Description Development of a plan that addresses the sequence of construction activities as it relates to the local climate. Scheduling considerations may minimize soil erosion resulting from exposure to wind, rain, runoff, and vehicle tracking.

Applications Proper scheduling shall be used on all projects.

Installation and Implementation Requirements

- Minimize the area of active construction.
- Minimize work involving soil disturbing activities during the rainy season.
- Schedule disturbed areas to be stabilized prior to additional grading of other areas.
- Minimize duration of time trenches remain open. Schedule trenching activities to ensure trenches are closed prior to excavating new trenches.
- Implement erosion and sediment control year round.

Limitations None

Inspections and Maintenance

- Monitor progress of construction activities relative to construction schedule. Implement remedial measures if progress deviates from schedule.
- Revise the schedule as necessary.

Source: Construction Best Management Practices Field Manual, 2008

Code BMP-02
Group General Site Management

Dust Control

Objective :

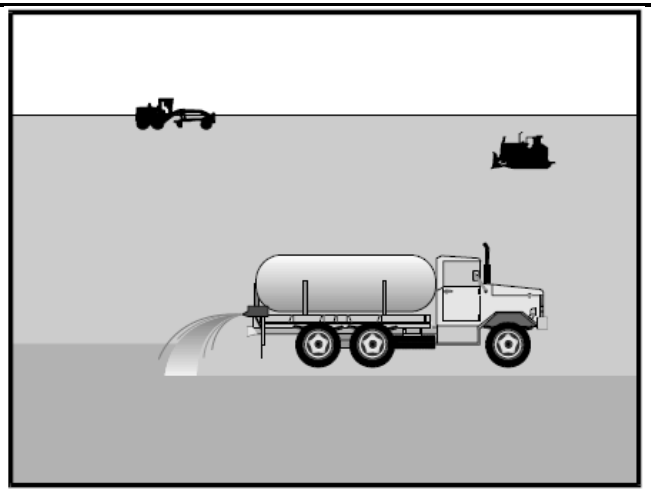
	Housekeeping Practices		*Stabilize Disturbed Areas*
	Water Pollution Control	✓	*Public Health & Safety*
✓	*Air & Noise Pollution Control*		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

Reference sub-plans :

SP03: Emissions and Dust Control
SP07: Vegetation Clearing

Responsibilities :

	Site Management Team	✓	*Environmental Team*
✓	*Site Supervisor*	✓	*Social Team*
✓	*Site Worker*	✓	*Safety Team*
✓	*Driver and Operator*		
	Etc.		



Description

Application of water and/or dust control measures to minimize erosion due to wind or reduce the amount of dust generated by construction activities.

Applications

Dust control shall be used on all exposed soils or any construction activity generating dust. Dust control shall apply to the following:

- Clearing, grubbing, and grading;
- Construction vehicular travel on unpaved roads;
- Drilling and blasting;
- Sediment tracking onto paved roads;
- Soil and debris stockpiles;
- Batch drop from front-end loaders; and
- Unstable soil areas.

Installation and Implementation Requirements

- Minimize exposed areas through the schedule of construction activities.
- Utilize vegetation, mulching, sprinkling, and stone/gravel layering to quickly stabilize exposed soil.
- Identify and stabilize primary entrances/exits prior to commencement of construction.
- Anticipate the prevailing wind direction to minimize the amount of dust generated.
- Do not over-spray water for dust control purposes.
- Direct construction vehicular traffic to stabilized roadways.

Limitations

- Daily or more frequent applications of water may be necessary since water is a short-term dust preventative.
- Erosion may result from overwatering.
- Oil may not be used for dust control since the oil may discharge into a drainage way or seep into soil.
- Some dust suppression chemicals may cause soil to be water repellent resulting in increased runoff.

Inspections and Maintenance

Inspect construction site periodically and after rain to identify areas requiring installation, repair, or replacement of additional BMPs to cover bare ground or redirect off-site runoff.

Source: Construction Best Management Practices Field Manual, 2008

Code **BMP-03**
Group **Material Management**

Material Delivery and Storage

Objective :

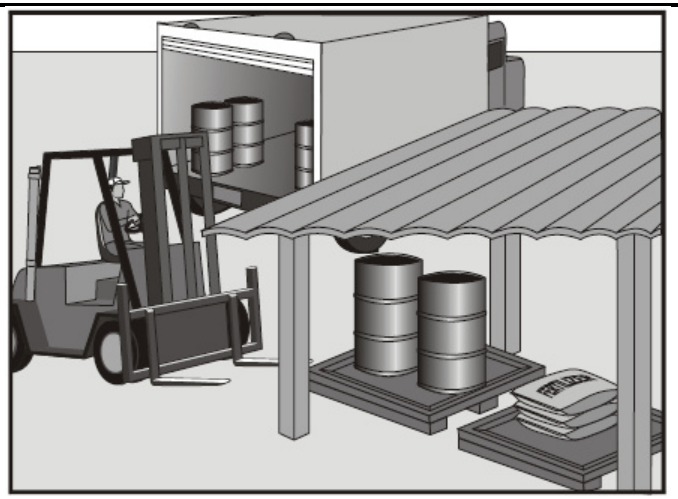
✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
✓	*Water Pollution Control*	✓	*Public Health & Safety*
✓	*Air & Noise Pollution Control*		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

Reference sub-plans :

SP02: Water Quality Monitoring
SP06: Hazardous Material Management
SP20: Emergency Preparedness
SP16: Environmental Awareness

Responsibilities :

	Site Management Team	✓	*Environmental Team*
✓	*Site Supervisor*	✓	*Social Team*
✓	*Site Worker*	✓	*Safety Team*
✓	*Driver and Operator*		
	Etc.		



Description

Practices and procedures that promote proper handling and storage of construction materials to prevent or reduce storm water pollution, injury to workers or visitors, groundwater pollution, and soil contamination..

Applications

Storage and handling activities on construction sites involving one of the following:

- Soil;
- Soil stabilizers and binders;
- Fertilizers;
- Pesticides and herbicides;
- Detergents;
- Plaster;
- Hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds;
- Petroleum products such as fuel, oil, and grease; and
- Asphalt and concrete products.

Installation and Implementation Requirements

- Provide training for employees and contractors on proper material delivery and storage practices and procedures.
- Designate on-site material delivery and storage areas. Areas shall be located near construction entrances and away from watercourses. Earth berms or other containment measures shall surround storage areas.
- Maintain accurate and up to date records of material delivered and stored on-site.
- Minimize on-site inventory.
- Retain a complete set of material safety data sheets (MSDS) on-site.
- Minimize handling of hazardous materials.
- Store materials under cover during the rainy season.
- Store chemicals, drum, and bagged materials on a pallet and when possible,
- If drums must be stored in an uncovered area, place them at a slight angle to minimize ponding of rainwater on the lids to minimize corrosion.
- Hazardous chemicals shall be well-labeled and stored in the original containers.
- Employees with emergency spill cleanup training shall be present during unloading of dangerous materials or liquid chemicals.
- Any significant residual materials remaining on the ground after the completion of construction shall be removed and properly disposed. If the residual materials contaminate the soil, then the contaminated soil shall also be removed and properly

Code BMP-03 Group Material Management	**Material Delivery and Storage**	
	under cover in secondary containment.	disposed.
Limitations	Storage sheds shall comply with building and fire code requirements.	
Inspections and Maintenance	• Storage areas shall be clean and well organized. • An ample supply of spill cleanup materials shall be kept with work crew supplies.	• Conduct weekly inspections of material containers for corrosion. • Conduct weekly inspections of storage areas which may require repair or replacement.

Source: Construction Best Management Practices Field Manual, 2008

Code **BMP-04**
Group **Waste Management**

Concrete Waste Management

Objective :

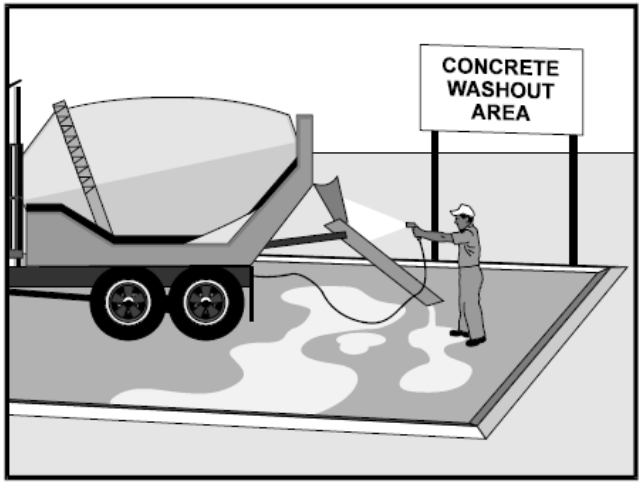
✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
✓	*Water Pollution Control*		*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

Reference sub-plans :

SP20: Emergency Plan for Hazardous Material
SP05: Waste Management and Disposal
SP16: Environmental Training for Workers

Responsibilities :

✓	*Site Management Team*	✓	*Environmental Team*
	Site Supervisor		*Social Team*
	Site Worker		*Safety Team*
	Driver and Operator		
	Etc.		



Description
Practices and procedures to prevent or reduce the discharge of concrete waste to the drainage system or adjacent water bodies.

Applications
- Projects involving use of concrete as a construction material or demolition activities generating concrete dust and debris.
- On-site wash areas used for concrete-coated vehicles or equipment.
- Activities such as saw cutting and grinding which result in the formation of slurries containing Portland cement concrete or asphalt concrete.

Installation and Implementation Requirements
- Properly store concrete materials away from runoff and under cover.
- Avoid mixing excess concrete, if possible. Discard excess concrete in the designated area.
- Wash concrete-coated vehicles or equipment off-site or in the designated wash area. Locate on-site concrete wash area a minimum of 50 feet away from storm drain inlets, open drainage facilities, or water bodies. Runoff from the on-site concrete wash area shall be contained in a temporary pit or level bermed area where the concrete can set.
- Allow wash water to evaporate or collect wash water and all concrete debris in a concrete washout system bin.
- Break up and properly dispose of hardened concrete from wash area.
- Collect and properly dispose of aggregate concrete sweepings.
- Provide concrete waste management training for employees and contractors.

Limitations
Off-site concrete wash areas may be impracticable.

Inspections and Maintenance
- Inspect concrete wash areas for damage and repair as necessary.
- Regularly remove and dispose hardened concrete.
- Monitor contractors to ensure proper concrete waste management measures are implemented.

Source: Construction Best Management Practices Field Manual, 2008

Code **BMP-05**
Group **Waste Management**

Solid Waste Management

Objective :

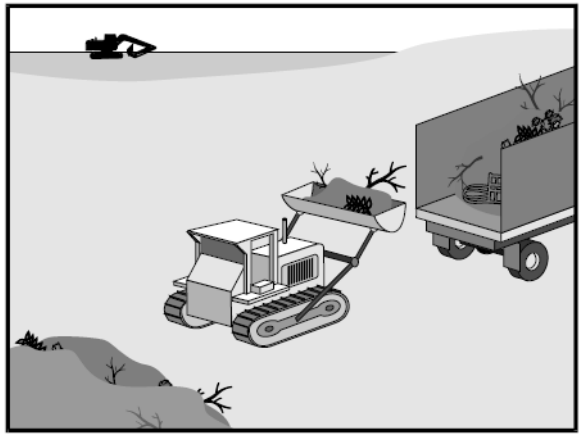
✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
✓	*Water Pollution Control*	✓	*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

Reference sub-plans :

SP05: Waste Management
SP16: Environmental Training for Workers

Responsibilities :

✓	*Site Management Team*	✓	*Environmental Team*
✓	*Site Supervisor*	✓	*Social Team*
✓	*Site Worker*	✓	*Safety Team*
✓	*Driver and Operator*		
	Etc.		



Description

Practices and procedures to prevent or reduce the discharge of pollutants from construction site wastes to the drainage system or adjacent water bodies.

Applications

Construction projects generating non-hazardous solid wastes from construction and demolition (C&D) activities. These wastes include C&D wastes, inert fill material, and recycle/reuse material.

C&D wastes include materials originating from the demolition of roads, buildings, or other structures. Materials generated from these activities include concrete, brick, bituminous concrete, wood, masonry, composition roofing, roofing paper, steel, plaster, and minor amounts of metals.

Inert fill materials are wastes that are not contaminated with hazardous materials such as asbestos or lead-based paint. Inert fill materials do not decompose or produce leachate or other products harmful to the environment. Inert fill materials include earth, soil, rock, cured asphalt, brick, and clean concrete (no exposed steel-reinforcing rod) with no dimension greater than eight inches.

Recycle/reuse materials include but are not limited to: asphalt pavement, cardboard, concrete aggregate (no LBP, asbestos-free), electronic equipment, excavated rock, soil (uncontaminated), Freon from appliances, glass, green waste, metals, ferrous/non-ferrous, used tires, wood and lumbers, furniture, etc.

Installation and Implementation Requirements	• Separate contaminated clean up materials from C&D wastes. Contamination may be from hazardous substances, friable asbestos, waste paint, solvents, sealers, or adhesives.	• Inert fill material shall not contain vegetation, organic material, or other solid waste. • Inert fill materials shall not be mixed with other C&D waste.
Limitations	None	
Inspections and Maintenance	• Inspect construction waste and recycling areas regularly. • Schedule solid waste collection regularly.	• Schedule recycling activities based on construction/demolition phases.

Source: Construction Best Management Practices Field Manual, 2008

Code BMP-06
Group Waste Management

Sanitary/Septic Waste Management

Objective :

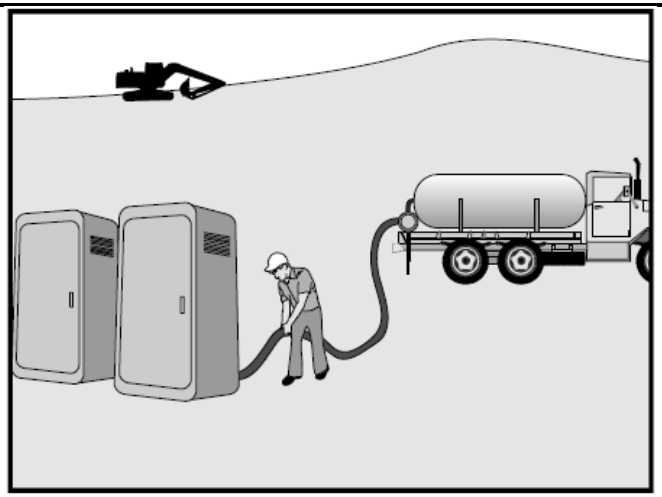
✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
✓	*Water Pollution Control*	✓	*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

Reference sub-plans :

SP05: Waste Management
SP16: Environmental Training for Workers
SP02: Water Availability and Pollution Control

Responsibilities :

	Site Management Team	✓	*Environmental Team*
✓	*Site Supervisor*	✓	*Social Team*
✓	*Site Worker*	✓	*Safety Team*
	Driver and Operator		
	Etc.		



Description
Practices and procedures to reduce or prevent the discharge of sanitary wastes from construction sites into the storm drain system or adjacent water bodies.

Applications
Construction sites containing temporary or portable sanitary/septic waste systems.

Installation and Implementation Requirements

- Locate sanitary facilities in a convenient place away from drainage facilities.
- Untreated wastewater shall not be discharged to the ground or buried.
- Sanitary/septic systems discharging to the environment shall comply with the local standard.
- A licensed service provider shall maintain sanitary/septic facilities in good working order.
- Schedule regular waste collection by a licensed transporter.
- Capacity of the sanitary/septic facilities shall be sufficient designed to the wastewater quantity.

Limitations
None

Inspections and Maintenance

- Inspect and maintain facilities regularly.
- Schedule regular waste collection.
- Prevent illicit discharges.

Source: Construction Best Management Practices Field Manual, 2008

Code **BMP-07**
Group **Waste Management**

Hazardous Waste Management

Objective :

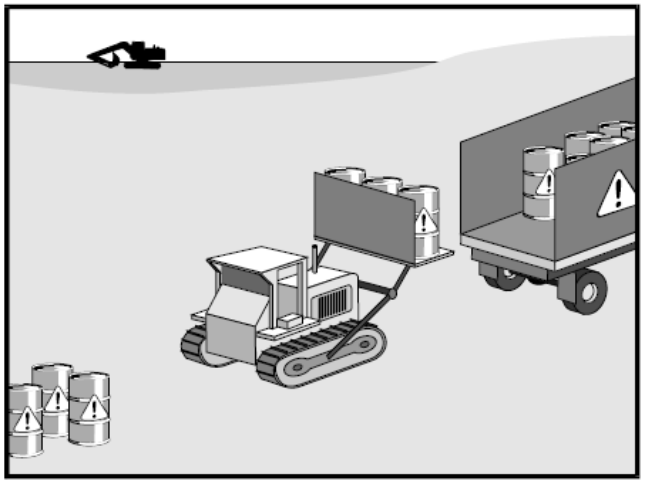
✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
✓	*Water Pollution Control*	✓	*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

Reference sub-plans :

SP20: Emergency Preparedness
SP05: Waste Management
SP16: Environmental Training and Awareness

Responsibilities :

	Site Management Team	✓	*Environmental Team*
✓	*Site Supervisor*	✓	*Social Team*
✓	*Site Worker*	✓	*Safety Team*
	Driver and Operator		
	Etc.		



Description

Practices and procedures to prevent or reduce the discharge of hazardous waste to the land, storm drain system, or adjacent water bodies.

Applications

Handling procedures on construction sites involving one of the following hazardous wastes:

- Paints and solvents;
- Petroleum products such as oils, fuels, and grease;
- Herbicides;
- Acids for cleaning masonry;
- Concrete curing and repair compounds; and
- Contaminated waste material.

Hazardous waste management shall also be implemented for wastes from existing structures including:

- Sandblasted material such as grit or chips containing lead, cadmium, or chromium-based paints;
- Asbestos; and
- Polychlorinated Biphenyls (PCBs). Older transformers are a common source of PCBs.

Installation and Implementation Requirements

Recognize potentially hazardous waste by implementing the following:

- Review product label and shipping papers;
- Identify key words such as flammable or ignitable (able to catch fire); carcinogenic (causes cancer); toxic or poisonous (injures or harms people or animals); and hazardous, danger, caustic or corrosive (burns through chemical action).
- Review material safety data sheets (MSDS) from the manufacturer and supplier of the product; and

Material use practices and procedures for hazardous waste management include the following:

Hazardous Waste Management

• Dispose container only after all of the product has been used;
• Keep the original product label on the container since it includes important safety and disposal information;
• Restrict amount of herbicide prepared to quantity necessary for the current application. Comply with the recommended usage instructions. Do not apply herbicides during or just before a rain event; and
• Remove as much paint from brushes on painted surface. Avoid cleaning or rinsing water-based paint brushes in soil, streets, gutters, storm drains, or streams. Filter and re-use solvents and thinners. Dispose of oil-based paints and residue as a hazardous waste.

Waste recycling and disposal practices and procedures for hazardous waste management include the following:
• Designate areas for collection of hazardous wastes;
• Store hazardous materials and wastes in covered containers;
• Provide secondary containment for hazardous waste containers;
• Keep wastes separate to prevent chemical reactions which make recycling and disposal difficult;
• Recycle useful materials such as oil or water-based paint;
• Avoid disposal of toxic liquid wastes (solvents, used oils, and paints) or chemicals (additives, acids, and curing compounds) in dumpsters allocated for construction debris;
• Schedule periodic waste collection to prevent overflow of containers; and
• Ensure collection, removal, and disposal of hazardous waste complies with regulations.

Hazardous waste management training shall include the following:
• Awareness of potential dangers from hazardous wastes;
• Identifying hazardous wastes;
• Proper hazardous waste storage and disposal procedures;
• Safety procedures for hazardous wastes;
• Placement of warning signs in areas recently treated with chemicals;
• Use of cleanup materials for spills;

Limitations

Hazardous waste that cannot be reused or recycled shall be disposed of by a licensed hazardous waste hauler.

Inspections and Maintenance

• Regularly inspect hazardous waste collection and storage areas and containers.
• Schedule hazardous waste collection regularly.

Source: Construction Best Management Practices Field Manual, 2008

Code **BMP-08**
Group **Waste Management**

Spill Prevention and Control

Objective :

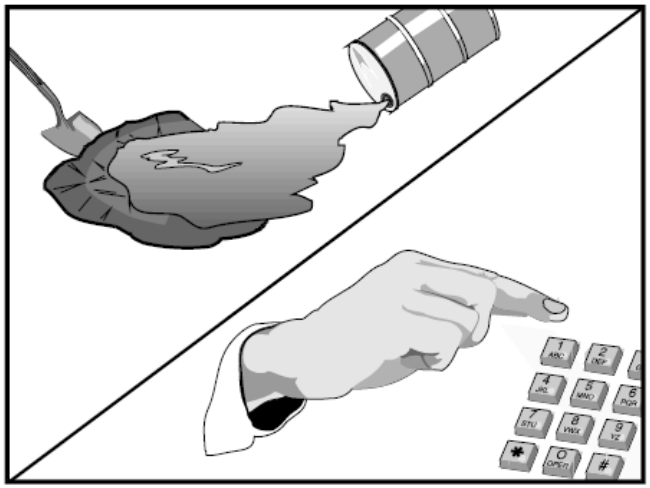
✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
✓	*Water Pollution Control*	✓	*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

Reference sub-plans :

SP06: Hazardous Material Management
SP05: Waste Management

Responsibilities :

	Site Management Team	✓	*Environmental Team*
✓	*Site Supervisor*	✓	*Social Team*
✓	*Site Worker*	✓	*Safety Team*
✓	*Driver and Operator*		
	Etc.		



Description
Practices and procedures to reduce or prevent leaks or spills which may be discharged into the storm drain system or adjacent water bodies.

Applications
Construction projects involving the storage of chemicals or hazardous substances.

Installation and Implementation Requirements

General Requirements include the following:
• Store hazardous materials and wastes in covered containers and protect containers from vandalism;
• Maintain an ample supply of cleanup materials for spills shall be readily accessible;
• Train employees on proper spill prevention and cleanup; and
• Review spill response requirements at all applicable work sites.

Cleanup Requirements include the following:
• Immediately clean up leaks and spills;
• Use minimal water to clean up spills on paved surfaces. For small spills, use a rag. For general cleanup, use a damp mop. For larger spills, use absorbent materials. Properly dispose of materials used to clean up hazardous materials; and
• Avoid hosing down or burying dry material spills.

Vehicle and equipment maintenance activities requirements include the following:
• Use a designated area and/or secondary containment for on-site repair or maintenance activities. These areas shall be located away from drainage courses;
• Complete regular inspections of on-site vehicles and equipment, including delivery trucks and employees' vehicles, for leaks. And should be fixed immediately when detected;
• Secondary containment devices such as drop cloths and drain pans shall be used to catch leaks or spills while removing or changing fluids from

Code	BMP-08	**Spill Prevention and Control**
Group	Waste Management	

vehicles or equipment;
• Place drip pans or absorbent materials under paving equipment not in use;
• Use absorbent materials on small spills. Avoid hosing down or burying spills. Remove and properly dispose of cleanup materials;
• Immediately transfer used fluids to the appropriate waste or recycling containers. Avoid leaving full drip pans and open containers on-site;
• Drain excess oil from oil filters prior to disposal by placing filter in a funnel over a waste oil recycling drum. Recycle oil filters if this service is available; and
• Store all cracked batteries in a non-leaking secondary container even if the acid appears to have drained out. Handle dropped batteries as cracked batteries until assured it is not leaking.

Vehicle and equipment fueling activities requirements include the following:
• Use designated areas for required on-site fueling. Fueling areas shall be located away from drainage courses;
• Avoid "topping off" of fuel tanks; and
• Use secondary containment devices such as drain pans to catch spills or leaks while fueling.

Limitations
Use of a private spill cleanup company may be necessary.

Inspections and Maintenance
• Update spill prevention and control plans and stock necessary cleanup materials as the chemicals used or stored on-site change.
• Ample supplies of materials for spill control and cleanup shall be located on-site near maintenance and material storage or unloading areas.

Source: Construction Best Management Practices Field Manual, 2008

Code **BMP-09**
Group **Waste Management**

Contaminated Soil Management

Objective :

✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
✓	*Water Pollution Control*	✓	*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

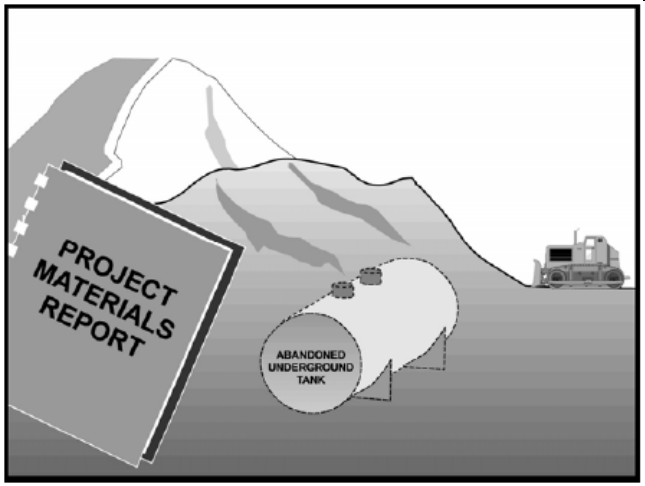
Reference sub-plans :

SP06: Hazardous Material Management

SP05: Waste management
SP16: Training and Awareness

Responsibilities :

	Site Management Team	✓	*Environmental Team*
✓	*Site Supervisor*	✓	*Social Team*
✓	*Site Worker*	✓	*Safety Team*
	Driver and Operator		
	Etc.		



Description Practices and procedures to prevent or reduce the discharge of pollutants to the drainage system, adjacent water bodies, or land.

Applications Projects in urbanized or industrial areas where previous site usage, undetected spills or leaks, illicit discharges, or underground storage tank leaks may have contributed to soil contamination.

Installation and Implementation Requirements

- Research records of previous site uses and activities.
- Identify soil discoloration, odors, soil property differences, abandoned underground tanks or pipes, or buried debris to determine possible soil contamination.
- Prevent leaks and spills.
- Test soil at a certified laboratory if soil is suspected of contamination.

Limitations Dispose of contaminated soils at permitted facilities. Transfer contaminated soils via approved transporter.

Inspections and Maintenance

- Conduct daily inspections of excavated areas for evidence of contaminated soil.
- Regularly inspect hazardous waste disposal areas and receptacles.
- Monitor on-site contaminated soil storage and disposal procedures.
- Prevent leaks and spills by implementing Spill Prevention and Control practices and procedures.

Source: Construction Best Management Practices Field Manual, 2008

Code **BMP-10**
Group **Vehicle and Equipment Management**

Vehicle and Equipment Cleaning

Objective :

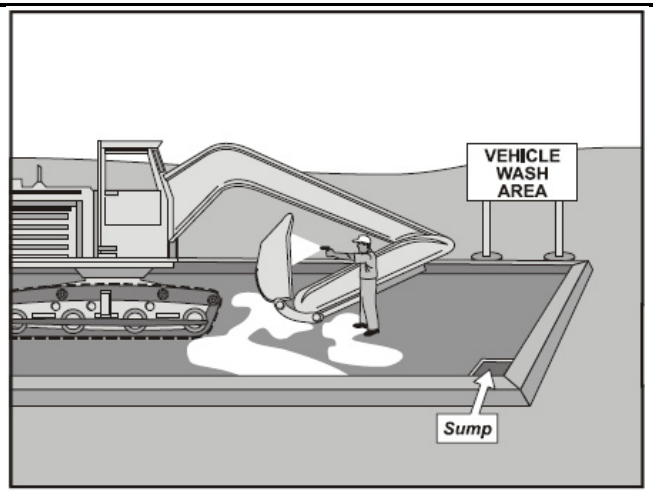
✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
✓	*Water Pollution Control*		*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

Reference sub-plans :

SP02: Water Availability and Pollution Control
SP06: Hazardous Material Management
SP04: Noise and Vibration
SP03: Emission and dust control

Responsibilities :

	Site Management Team	✓	*Environmental Team*
✓	*Site Supervisor*		*Social Team*
✓	*Site Worker*		*Safety Team*
✓	*Driver and Operator*		
	Etc.		



Description Practices and procedures to reduce or prevent the discharge of pollutants from vehicle and equipment cleaning activities to storm drain.

Applications Construction or maintenance activities involving cleaning of vehicles and equipment.

Installation and Implementation Requirements

- Use off-site vehicle wash racks or commercial washing facilities when practical. Off-site cleaning facilities may be better equipped to properly handle and dispose of wash waters.
- If on-site cleaning is necessary, designate bermed wash areas for cleaning activities. The wash area may be sloped to facilitate collection of wash water and evaporative drying.
- Minimize water use to avoid the need for erosion and sediment controls for the wash area.
- Train employees on pollution prevention measures.
- Steam cleaning shall not occur in uncontained areas. Significant pollutant concentrations may be generated from steam cleaning.

Limitations Do not discharges wash water directly into streams.

Inspections and Maintenance

- Train employees on implementation of revised procedures.
- Inspect and maintain structural controls.

Source: Construction Best Management Practices Field Manual, 2008

Code BMP-11
Group Vehicle and Equipment Management

Vehicle and Equipment Maintenance

Objective :

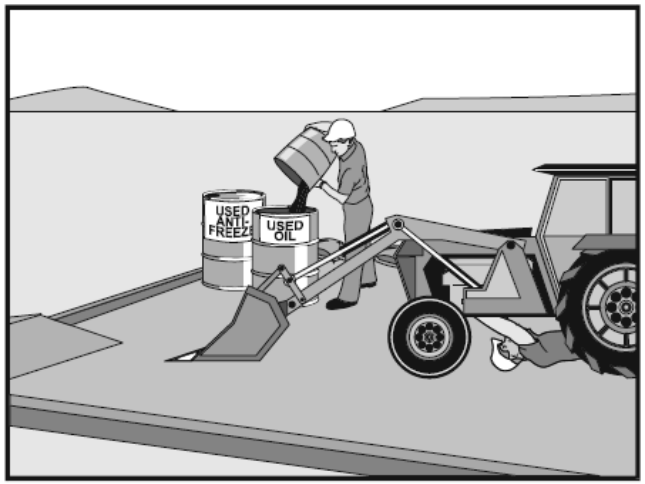
✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
✓	*Water Pollution Control*		*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

Reference sub-plans :

SP02: Water Availability and Pollution Control
SP06: Hazardous Material Management
SP04: Noise and Vibration
SP03: Emission and dust control

Responsibilities :

	Site Management Team	✓	*Environmental Team*
✓	*Site Supervisor*		*Social Team*
✓	*Site Worker*		*Safety Team*
✓	*Driver and Operator*		
	Etc.		



Description
Practices and procedures to prevent or reduce the discharge of pollutants from vehicular and equipment maintenance procedures into the storm drain system or adjacent water bodies.

Applications
Construction sites with on-site areas for storage and maintenance of vehicles and equipment.

Installation and Implementation Requirements

- Prevent excessive accumulation of oil and grease by keeping vehicles and equipment clean.
- Use off-site repair and maintenance facilities where practical.
- Designate a maintenance area away from drainage courses to prevent pollutants from entering the drainage system.
- Place drip pans or drop cloths under vehicles and equipment to absorb spills or leaks.
- Provide an ample supply of readily accessible spill cleanup materials.
- Use absorbent materials on small spills. Promptly remove and properly dispose of absorbent materials. Do not hose down or bury small spills.
- On-site vehicles and equipment shall be inspected regularly for leaks and all leaks shall be immediately repaired.
- Incoming vehicles and equipment shall be checked for leaks and shold be fixed immediately when detected.
- Segregate and recycle wastes from vehicle/equipment maintenance activities such as used oil or oil filters, greases, cleaning solutions, antifreeze, automotive batteries, and hydraulic and transmission fluids.
- Properly dispose of wastes generated by vehicle/equipment maintenance activities.
- Provide employee training on proper maintenance and spill cleanup practices and procedures.

Limitations
Off-site maintenance facility may not be easily accessible.

Inspections and Maintenance

- Regularly inspect vehicle and maintenance areas.
- Ample supplies of spill cleanup materials shall be kept on-site.

Source: Construction Best Management Practices Field Manual, 2008

Code BMP-12
Group Vehicle and Equipment Management

Vehicle and Equipment Refueling

Objective :

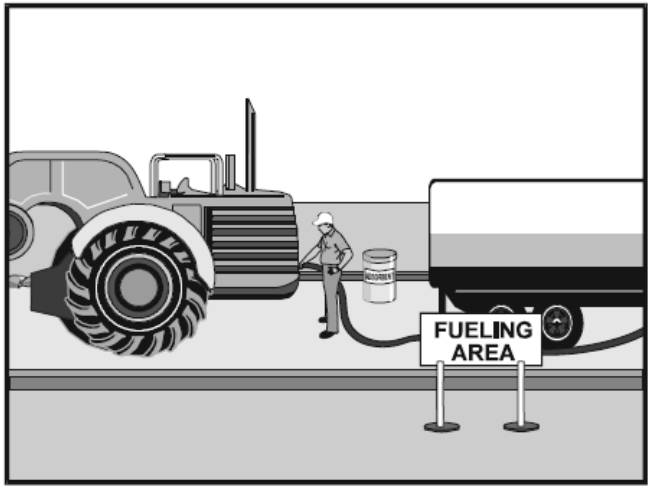
✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
✓	*Water Pollution Control*	✓	*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

Reference sub-plans :

SP06: Hazardous Material Management

Responsibilities :

✓	*Site Management Team*	✓	*Environmental Team*
	Site Supervisor		*Social Team*
	Site Worker		*Safety Team*
✓	*Driver and Operator*		
	Etc.		



Description Practices and procedures to prevent or reduce the discharge of pollutants to storm water from vehicle and equipment fuel leaks or spills.

Applications Construction or maintenance activities involving fueling of vehicles or equipment.

Installation and Implementation Requirements

- Comply with requirements regarding stationary, above ground storage tanks.
- Use off-site fueling sites when practical. Off-site fueling sites may be better equipped to service and handle spills due to multiple vehicles or pieces of equipment.
- If on-site fueling is necessary, locate designated fuel areas away from drainage courses to prevent contamination of storm water.
- Avoid "topping-off" of fuel tanks.
- Drip pans or drop cloths shall be used to absorb leaks or spills during fueling.
- Absorbent spill cleanup materials shall be available and located in fueling areas.
- Use absorbent materials on small spills instead of hosing down or burying the spill. Promptly remove and properly dispose the absorbent materials.
- Minimize mobile fueling of construction equipment by transporting equipment to designated areas for fueling.
- Train employees on proper fueling and cleanup procedures.

Limitations Off-site fueling of vehicles and equipment may not be practical.

Inspections and Maintenance

- Ample supplies of materials for fuel spill control and cleanup shall be located on-site near fueling areas.
- Regularly inspect fueling areas and storage tanks.

Source: Construction Best Management Practices Field Manual, 2008

Code BMP-13
Group Sediment Control

Sediment Trap

Objective :

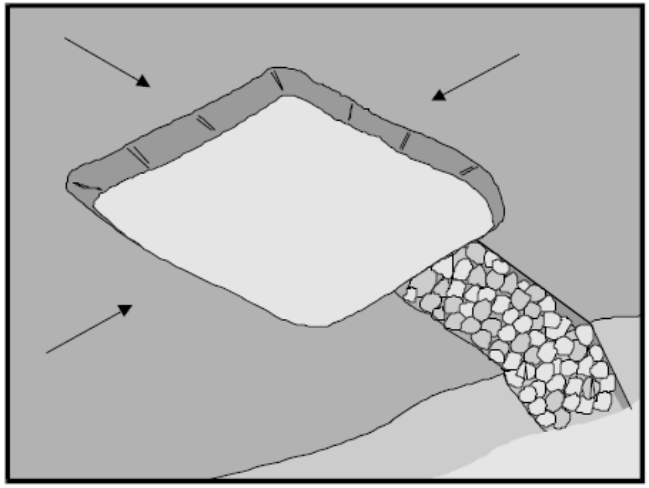
✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
	Water Pollution Control		*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
✓	*Minimize Disturbed Areas*	✓	*Internal Erosion Control*

Reference sub-plans :

SP01: Erosion and Sediment Control

Responsibilities :

✓	*Site Management Team*	✓	*Environmental Team*
✓	*Site Supervisor*		*Social Team*
	Site Worker		*Safety Team*
	Driver and Operator		
	Etc.		



Description

A temporary runoff containment area, which promotes sedimentation prior to discharge of the runoff through a stabilized spillway.

Applications

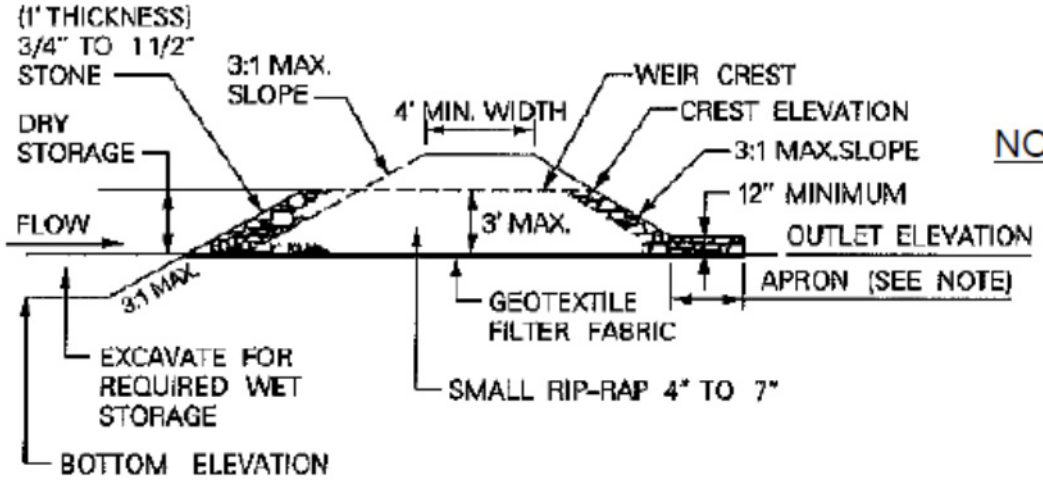
- Drainage areas less than 5 acres.
- Areas along the perimeter of the site where sediment-laden runoff is discharged off-site.
- Areas requiring additional sediment containment measures such as bodies of water or discharge points to a drainage system.
- On-site discharge points to a stabilized or natural area or waterway.

Installation and Implementation Requirements

- Construct sediment trap prior to engaging in clearing, grubbing, or grading activities.
- Location shall be based on the following:
  - o Area where a low embankment may be constructed across a swale;
  - o Area where failure of sediment trap will not cause property damage or loss of life; and
  - o Area where maintenance crew may easily access sediment trap.
- Sediment trap size shall be based on the following:
  - o Minimum trap settling volume of 133 cubic yards per acre;
  - o Minimum trap sediment storage volume of 33 cubic yards per acre;
  - o Trap width shall be less than half of the trap length; and
  - o Flood volume which may contain a major flood without damage to upstream areas or overtopping the embankment.
- Construct sediment trap by excavating ground or constructing an earthen embankment to create a containment area.
- Area under embankment shall be cleared, grubbed, and stripped of vegetation and root mat.
- Fill material for embankment shall be free of roots, woody vegetation, over-sized stones, rocks, organic material, or other objectionable material. Compact embankment by traversing with construction equipment.
- Stabilize trap outlet with stone or vegetation.

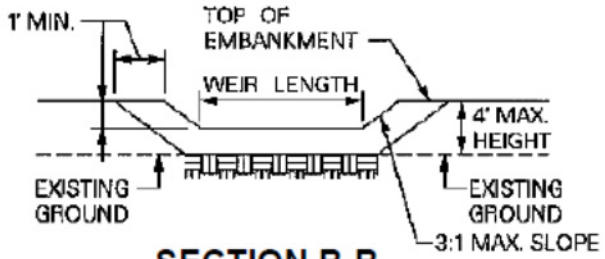
Code BMP-13 Group Sediment Control	**Sediment Trap**
	• Install fencing to prevent unauthorized entry and for safety purposes. • All pipe joints shall be watertight when a riser is used. • The top 2/3 of the riser shall be perforated with holes 1 to 4 inch in diameter. The holes shall be vertically spaced at 8 inch intervals and horizontally spaced at 10 to 12 inch intervals. • Outlet crest elevation of an earth or stone outlet shall be a minimum of 1 foot below the top of the embankment.
Limitations	• Applies to maximum drainage area of 5 acres. Drainage areas exceeding 5 acres shall implement Sediment Basins. Refer to BMP-14 (Sediment Basin) in this manual for more information. • Only removes large and medium size particles. • Requires protective fencing. • Do not install in live streams. • Availability of right-of-way may limit size of sediment trap.
Inspections and Maintenance	• Inspect weekly during dry periods as well as within 24 hours of any rainfall of 0.5 inch or greater which occurs in a 24-hour period and daily during periods of prolonged rainfall. • Inspect spillway and outlet for obstructions or damage. Remove obstructions and repair damage as necessary. • Inspect outlet for erosion and stabilize as necessary. • Inspect fencing for damage and repair as necessary. • Remove sediment which has accumulated to within 1 foot of the top of the dry storage volume. • Properly dispose of sediment and debris removed from sediment trap.

Source: Construction Best Management Practices Field Manual, 2008

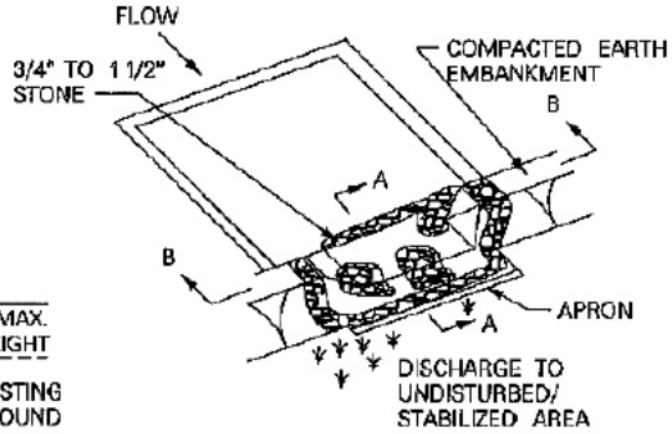


SECTION A-A
NTS

NOTE: MAXIMUM DRAINAGE AREA = 5 ACRES.



SECTION B-B
NTS

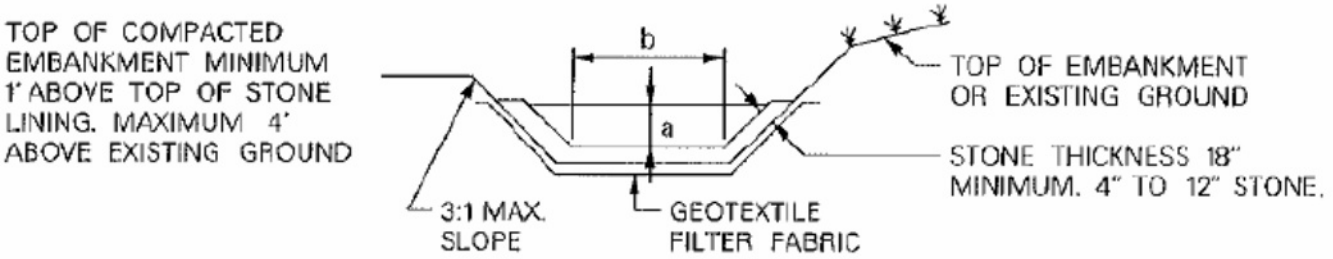


PERSPECTIVE VIEW
NTS

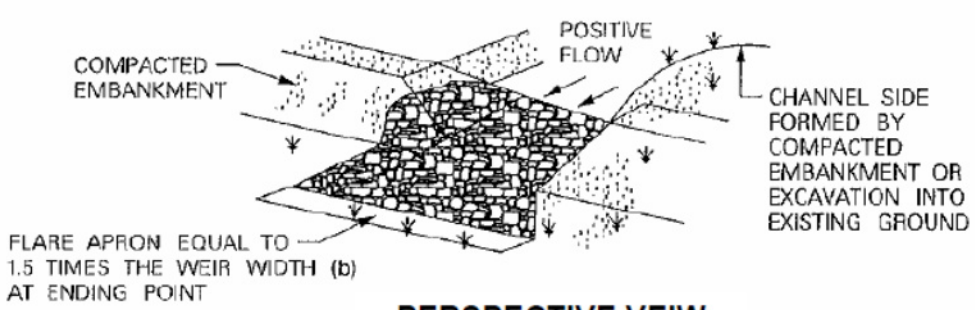
STONE OUTLET SEDIMENT TRAP

LEGEND

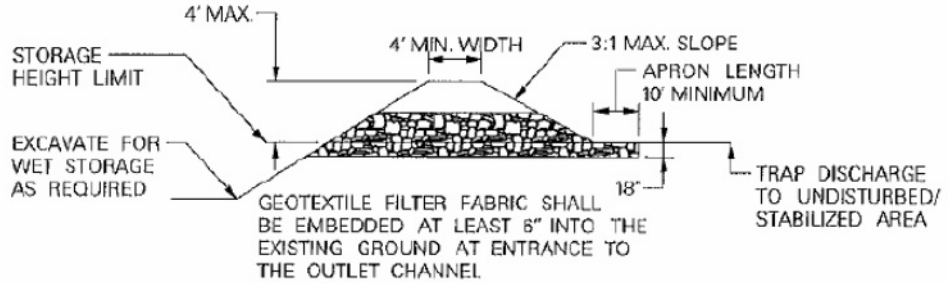
a = MINIMUM DEPTH OF CHANNEL
b = BOTTOM WIDTH OF WEIR



CROSS SECTION
NTS



PERSPECTIVE VEIW
NTS



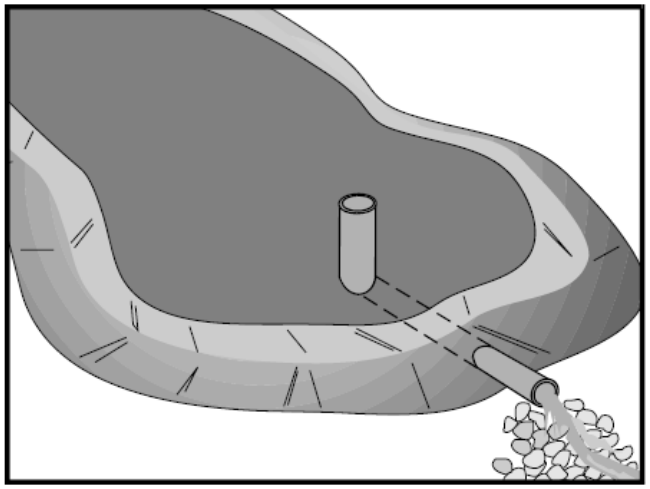
PROFILE
NTS

NOTE: MAXIMUM DRAINAGE AREA = 5 ACRES.

RIP-RAP SEDIMENT TRAP

Code **BMP-14**
Group **Sediment Control**

Sediment Basin



Objective :

✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
	Water Pollution Control		*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
✓	*Minimize Disturbed Areas*	✓	*Internal Erosion Control*

Reference sub-plans :

SP01: Erosion and Sediment Control

Responsibilities :

✓	*Site Management Team*	✓	*Environmental Team*
✓	*Site Supervisor*		*Social Team*
	Site Worker		*Safety Team*
	Driver and Operator		
	Etc.		

Description

A temporary basin which intercepts sediment-laden runoff and allows sediment to settle prior to discharge of the runoff from the site.

Applications

- Drainage areas larger than 5 acres.
- Areas where sediment-laden runoff is discharged to the drainage system or watercourses.

Installation and Implementation Requirements

- Construct sediment basins prior to clearing, grubbing, or grading activities.
- Location shall be based on the following:
  - o Area where terrain forms a natural basin;
  - o Area which minimizes construction interference;
  - o Area where maximum benefit may be achieved from the existing terrain to minimize excavation or construction effort to install sediment basin;
  - o Area where failure of sediment basin will not cause property damage or loss of life;
  - o Area where maintenance crew may easily access sediment basin; and
  - o Area where permanent detention basin will be constructed.
- Sediment basin shall be designed to allow 70 to 80 percent of the sediment to settle during a 24 to 40 hour detention time.
- The sediment basin is divided into two zones:
  - o Sediment storage zone with a minimum of 1 foot in depth and
  - o Settling zone with a minimum of 2 feet in depth
- Sediment basin design shall be based on the following requirements:
  - o Settling zone volume shall be determined by the following equation:

$$V=1.2(SD)Q/VSED$$

Code	BMP-14	Sediment Basin
Group	Sediment Control	

Where:
V =Settling zone volume
SD =Settling depth, which shall be a minimum of 2 feet and greater than the average distance from inlet to outlet of the basin divided by 200
VSED=Settling velocity of the design soil particle (medium silt). The settling velocity of a medium silt soil particle is 0.00096 feet per second
Q =CIA

Where:
Q =Discharge rate measured in cubic feet per second
C =Runoff coefficient
I =Precipitation intensity for the 10 year, 1 hour rain event
A =Area draining into the sediment basin in acres;

o Basin geometry for the sediment storage zone shall be determined by a minimum depth of 1 foot and 3:1or flatter side slopes extending from the bottom of the basin. Basin bottom shall be level;
o Provide an emergency spillway with the top of the riser pipe 1 foot below the crest elevation;
o Sediment basin length to settling depth ratio (L/SD) shall not exceed 200; and
o Sediment basin length to width ratio shall not be less than 6:1 or baffles shall be installed.
• Anti-seep collar shall be securely anchored and installed on the outlet pipe/riser.
• Construct sediment basin by excavating ground or constructing an embankment of compacted soil.
• Sediment basin may have more than one inflow point.
• Stabilize inlet, outlet, and slopes of basin with rock or vegetation.
• Install fencing to prevent unauthorized entry and for safety purposes.

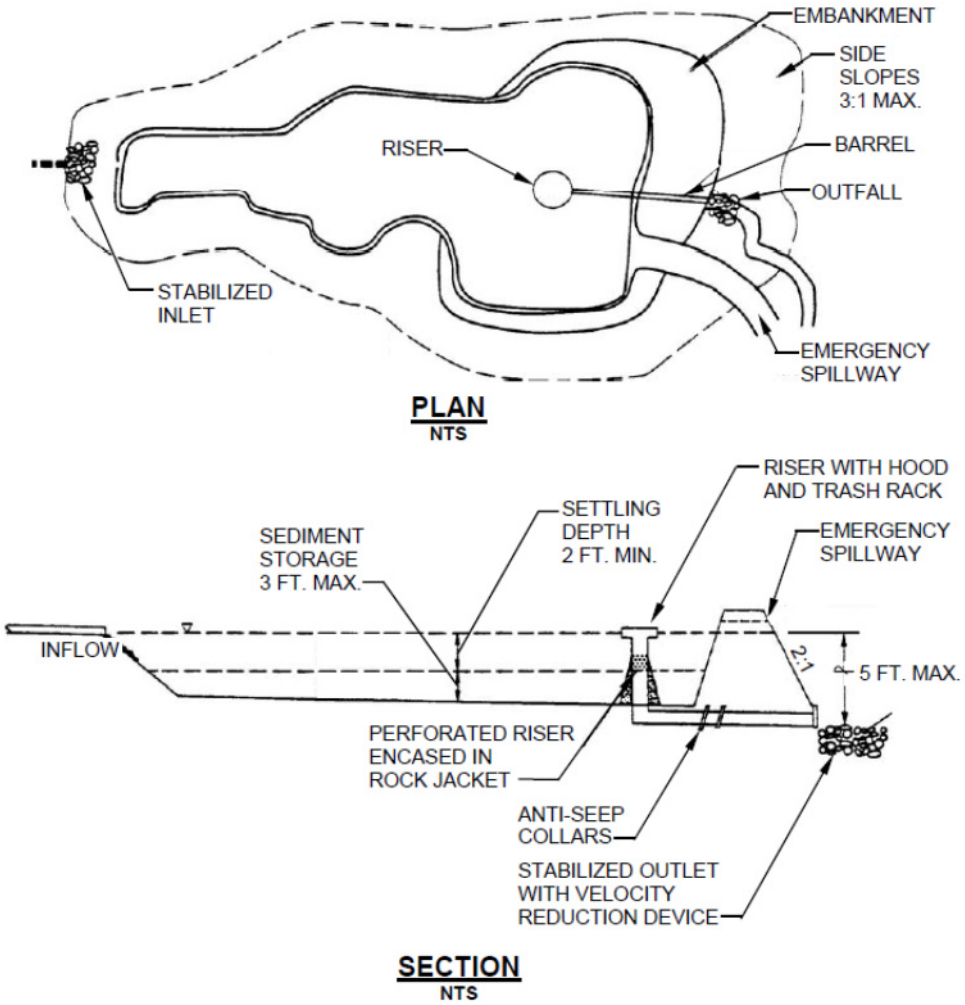
Limitations

• Limited design life of 12 to 18 months.
• Sediment basin removes medium size particles.
• Additional BMPs such as seeding, mulching, and diversion dikes should be used to reduce the amount of sediment intercepted by the basin.
• Requires protective fencing.
• Inappropriate for installation in live streams.
• Availability of right-of-way may limit size of sediment basin.
• Large basins may be subject to state/local requirements for dam safety.

Inspections and Maintenance

• Inspect weekly during dry periods as well as within 24 hours of any rainfall of 0.5 inch or greater which occurs in a 24-hour period and daily during periods of prolonged rainfall.
• Inspect inlet and outlet for obstructions or damage. Remove obstructions and repair damage as necessary.
• Inspect outlet for erosion and stabilize as necessary.
• Inspect fencing for damage and repair as necessary
• Remove sediment when the sediment storage volume is half full.
• Properly dispose of sediment and debris removed from sediment basin.

Source: Construction Best Management Practices Field Manual, 2008



SEDIMENT BASIN

Code **BMP-15**
Group **Waste Management**

Sludge Management

Objective :

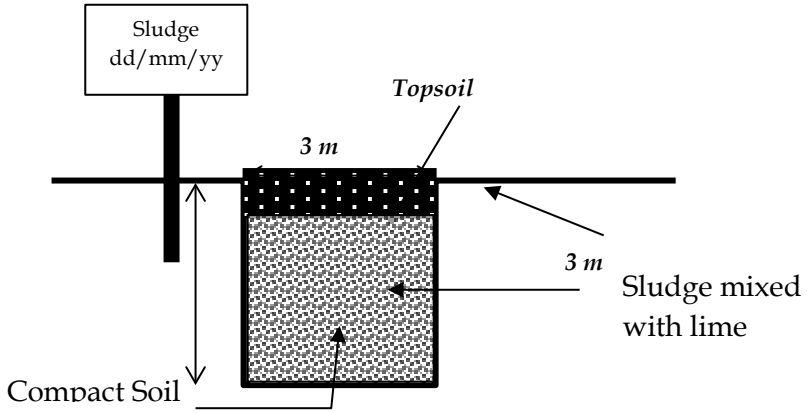
✓	*Housekeeping Practices*		*Stabilize Disturbed Areas*
✓	*Water Pollution Control*	✓	*Public Health & Safety*
	Air & Noise Pollution Control		*Natural Resources Conservation*
	Minimize Disturbed Areas		*Internal Erosion Control*

Reference sub-plans :

SP05: Waste Management
SP16: Environmental Training for Workers

Responsibilities :

✓	*Site Management Team*	✓	*Environmental Team*
✓	*Site Supervisor*		*Social Team*
✓	*Site Worker*		*Safety Team*
	Driver and Operator		
	Etc.		



Description
Applications

Wet sludge from septic tanks generated in Worker's Camp must be removed, stored, and treated in a specific area.
A sludge pit will be designated for approximate 20 m^3. Add lime slurry to the pit that is storing sludge that was discharged from the sanitary truck. A possibility is to add 5 kg lime / 1 m^3 sludge, and then uniformly mix the materials in the pit. The sludge and lime would be mixed manually before the pit will be covered by topsoil. In case the capacity of the pit is not reached, pit will be temporarily covered with a woven bamboo cap.

Lime (Calcium Hydroxide) will be applied for sludge treatment. The 0.12 kg lime /kg sludge is an effective dose rate. The treatment of wet sludge by lime treatment is specifically prescribed in U.S. EPA regulations (40 C.F.R. 503). Lime treatment controls the environment needed for the growth of pathogens in biosolid and converts sludge into a usable product. Lime stabilization is a cost-effective option that generally has lower capital costs than alternative treatment options. The mechanism of lime treatment of biological wastes is based on several chemical reactions:

- Calcium hydroxide is an alkaline compound that can create pH levels as high as 12.4. At pH levels greater than 12, the cell membranes of harmful pathogens are destroyed. The high pH also provides a vector attraction barrier, preventing flies and other insects from infecting the treated biological waste. Because lime has low solubility in water, lime molecules persist in wet sludge. This helps to maintain the pH above 12 and prevent regrowth of pathogens.
- When lime is used, an exothermic reaction with water occurs. This heat release can increase the temperature of the biological waste to 70°C, which provides effective pasteurization.
- The solubility of calcium hydroxide also provides free calcium ions, which react and form complexes with odorous sulfur species such as hydrogen sulfide. Thus the biological waste odors are actually destroyed.

Code BMP-15 Group Waste Management	**Sludge Management**
Installation and Implementation Requirements	See above
Limitations	The sludge disposal area shall be designated with the soil property is > 50% clay with low permeability. This area must be far away from local communities, also no beneficial use of groundwater within 50 meters. The pit located at high elevation which > 8 m higher than water table.
Inspections and Maintenance	• Septic tanks and sludge disposal area to be inspected regularly. • Sludge collection to be scheduled regularly. • A signboard showing the date of disposing will be provided to identify each pit and a fence will be installed to secure the place.

Source: Site Specific Environmental Plan: Waste Disposal Site at Ban Phon Sa-ard. ADDENDUM 02 : SLUDGE DISPOSAL AREA Nam Theun 2 Hydroelectric Project, 2006

Code **BMP-16**
Group **Watercourses**

Bridge Design and Construction

Objective :

	Housekeeping Practices	✓	*Stabilize Disturbed Areas*
✓	*Water Pollution Control*	✓	*Public Health & Safety*
	Air & Noise Pollution Control	✓	*Natural Resources Conservation*
✓	*Minimize Disturbed Areas*	✓	*Internal Erosion Control*

Reference sub-plans :

SP01: Erosion and Sediment Control
SP07: Vegetation Clearing
SP10: Biodiversity Management

Responsibilities :

✓	*Site Management Team*	✓	*Environmental Team*
✓	*Site Supervisor*		*Social Team*
✓	*Site Worker*		*Safety Team*
	Driver and Operator		
	Etc.		

Description

Drainage, Culvert and Bridge Placement and Design-

Roads in many of the provinces pass through low-lying lands and as such pass across complex surface drainage systems. The existing roads have either acted as dams for surface drainage or prevented adequate water from reaching lands downstream of the road. Most of the culverts on the roads to be improved will need to be replaced and designers should take advantage of this to make sure that the sizing and placement of culverts leads to no-net impact and in fact improves any past erosion or flooding problems. As part of the design exercise cross-drainage features will need to be designed to match the movement of flood waters during the monsoon period, in order to avoid unwanted ponding and possible flood damage.

A simple reconnaissance of the surface water drainage features for all road is needed to prevent flooding and damage to newly reconstructed roads. Decisions on the type, size, location and frequency of culverts, are all part of project design; and are, based on the knowledge of maximum flows and overall surface drainage characteristics. Generally, these data are derived from surface hydrology models, which once provided with reconnaissance data, provide specific design data such as type, dimensions and preferred locations of structures.

The problems arise with their physical placement since for small roads these design considerations are left to the contractor. Culverts often become chronic erosion points and weak links in road design and operation.

Therefore, four design elements relating to future environmental impacts will need to be carefully identified for each culvert. These are:

1. culvert placement,
2. culvert diameter,

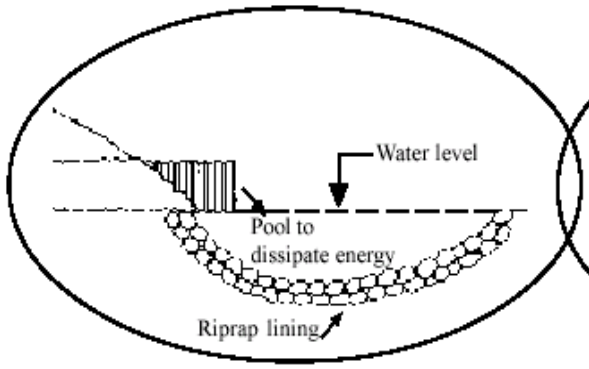
3. slope of the structure from upstream to downstream and

4. design of erosion protection measures at the inflow and outflow of each culvert.

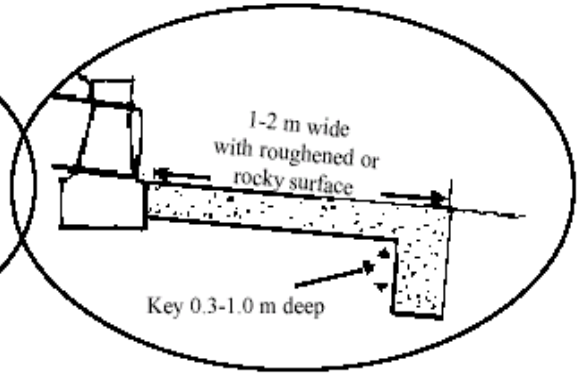
The steeper the gradient of the culverts, the greater the need for scour protection at both inlets and outlets. The sketches define culvert-erosion protection options on rural roads, but can be adapted to provincial roads, since basic design considerations are the same.

Many provinces has special issues with culverts since during the dryer periods they are blocked of by local people in order to collect any running water. This creates unique problems since if a larger storm does come quickly, roads are flooded and crossing eroded. Local PDoT engineers must be consulted by PMU1 designers before culvert designs and placements are finalized. Further PDoT engineers will consult local officials about the culvert uses in their area and design the structures accordingly. With this local involvement, communities will be encouraged to participate in culvert maintenance.

Finally, all present culverts should be photographed and a culvert inventory created. All engineering specs and digital photos of the culvert's inlet and outlet should be place in a record sheet and used by the PDoT to maintain these assets. These sheets should be provided by the contractor as the work proceeds.



Detail of outlet with riprap and plunge pool.



Detail of splash apron with scour cutoff key.

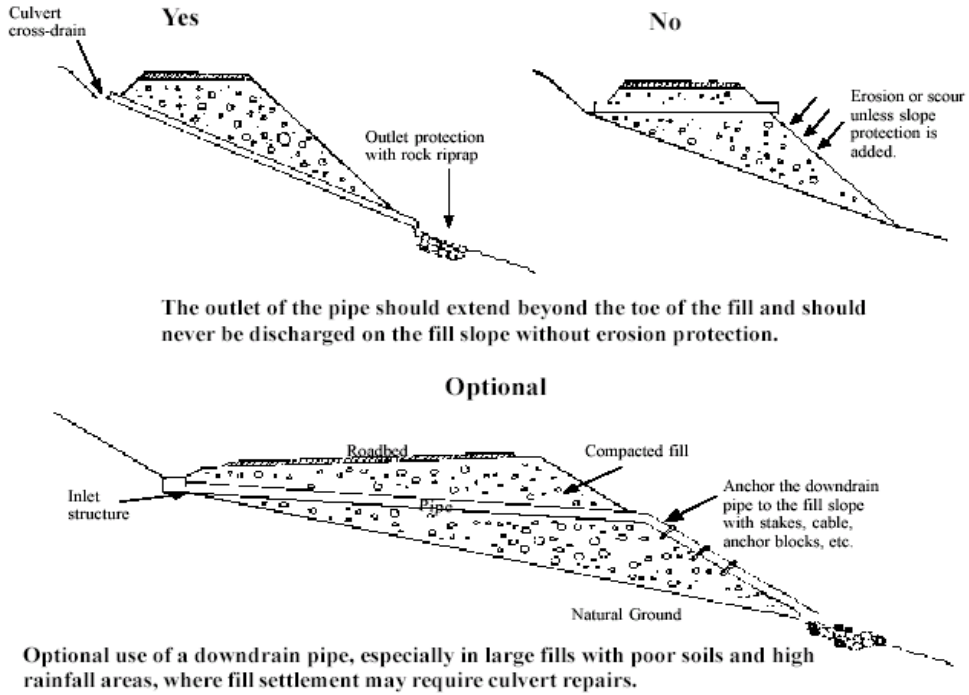


Figure 1 Environmentally acceptable culvert design details

ENVIRONMENTALLY COMPATIBLE BRIDGE DESIGN / REHABILITATION ACTIONS

In many section of this rehabilitation project there are potential risks in increasing erosion and transport of materials to the streams/channels. The result of laying bitumen pavement on non-paved roads will lead to increasing road surface run off resulting in excess risk for erosion on the road side or in the draining installations along the road.

The Vietnamese design standards have introduced methods which are specifically accounting for these problems and which should be followed. The photo hereunder shows in details what have been done in order to ensure the bridge embankment of a cross channel bridge.'

Bridge Design and Construction

Precaution should be taken in design, construction and maintenance of any item on the road which is directly related to water stream and channels and draining.

For this project, environmental consideration when designing bridges involve assuring that waterway channels are not restricted, that visually the structure fits the surrounding natural and built environment and that the timing of work does not interfere with important aquatic species movement and migration.

Environmentally responsible design and construction methods are easily achievable so long as the designers and builders follow the following fourteen guiding principals:

DESIGN OPTIONS TO CONSIDER AND IMPLEMENT

1. Use an adequately long bridge span to avoid constricting the natural active (bank-full) flow channel. Minimize constriction of any overflow channel;
2. Protect the upstream and downstream approaches to structures with wing walls, riprap, gabions, vegetation, or other slope protection where necessary;
3. Place foundations on to non-scour susceptible material (ideally bedrock or coarse rock) or below the expected maximum depth of scour.
4. Prevent foundation or channel scour with the use of locally placed heavy riprap, gabion baskets, or concrete reinforcement. Use scour protection as needed;
5. Locate bridges where the water channel is narrow, straight, and uniform. Avoid placing abutments in the active water channel;
6. Where necessary, place in-channel abutments in a direction parallel to the water flow;
7. Channels that are sinuous, have meanders, or have broad flood plains may change location within that floodplain. Consider natural channel adjustments and possible channel location changes over the design life of the structure;
8. Use retaining structures as needed in steep, deep drainages to retain the approach fills, or use a relatively long bridge span;
9. Allow for enough free-board between the bottom of bridge girders and expected high water level and floating debris, plus any other passage expected, such as small vessels,

etc.

10. Alternatively, a bridge may be designed as a 'ford', eliminating the need for freeboard, increasing the need for an erosion resistant deck and approach slabs.

DESIGN OPTIONS TO AVOID

1. Placing piers or footing in the active water channel or mid channel;
2. Placing approach fill material in the drainage channel;
3. Placing structural foundations on soil deposits such as silts and fine sands;
4. Constricting or narrowing the width of the natural water channel.

ERM has over 100 offices across the following countries worldwide

Argentina
Australia
Belgium
Brazil
Canada
Chile
China
Colombia
France
Germany
Hong Kong
Hungary
India
Indonesia
Ireland
Italy
Japan
Kazakhstan
Korea
Malaysia
Mexico
The Netherlands
New Zealand
Panama
Peru
Poland
Portugal
Puerto Rico
Romania
Russia
Singapore
South Africa
Spain
Sweden
Taiwan
Thailand
United Arab Emirates
United Kingdom
United States
Venezuela
Vietnam

ERM's Bangkok Office

179 Bangkok City Tower
24th Floor, South Sathom Road
Tungmahamek, Sathorn
Bangkok 10120, Thailand
Tel: +66 2 679 5200
Fax: +66 2 679 5209

www.erm.com