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Lao PDR: Monsoon Wind Power Project
Part 8: Main Report

Prepared by Impact Energy Asia Development Limited (IEAD) for the Asian Development Bank.

Monsoon Wind Power Project, Sekong and Attapeu Provinces, Lao PDR

Environmental and Social Impact Assessment

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8.4 Biological Environment Impact Assessment

8.4.1 Introduction

Renewable energy projects such wind farms play an important role in moving towards a more sustainable energy sector that can assist with combating the negative impacts of non-renewable energy on global climate (Bennun *et al.,* 2021). However, these 'clean' energy projects can also result in unintended negative impacts and consequences to the environment unless carefully planned and managed. This includes risks and potential impacts to biodiversity, which underpins the resilience and functions of ecosystems and the flow of ecosystem goods and services (Bennun *et al.,* 2021).

Biodiversity impact assessment is the process of determining the types and significance of effects a project will have on biodiversity, and the various components thereof, and is the core of the ESIA process (Hardner *et al*., 2015). Risks and impacts to biodiversity typically vary according to the project being assessed as well as the context of the receiving environment where the project is located. The biodiversity impact assessment that follows has been undertaken specifically for the Monsoon WF project located in Lao PDR.

8.4.2 Approach & Methods

The approach to the assessment of biodiversity impacts was as follows:

Step 1: Defining the AoI

The Area of Influence (AoI) for the project was defined to include the development footprint and any temporary works infrastructure, operational activities and infrastructure, any offsite facilities (borrow areas for example) as well as areas beyond the immediate area of effect that could be subjected to indirect impacts (e.g. emissions, noise, water quality issues, etc.).

Step 2: Identification of key ecological receptors and describe biodiversity values

Once the AoI had been defined, the biodiversity 'values' (*also termed biodiversity 'features' or 'attributes'*) and ecological sensitivity of the various environmental receptors were identified (i.e. relates back to key habitats and species identified in the baseline biodiversity assessment).

Step 3: Identification of impacts to biodiversity

Potential project impacts to the key ecological receptors and biodiversity values were identified, including site-specific direct, indirect and induced impacts to biodiversity. The following guidelines were also referred to in identifying and describing biodiversity impacts:

- "Good Practices for Biodiversity Inclusive Impact Assessment and Management Planning" (Hardner et al., 2015[1]); and
- "Mitigating biodiversity impacts associated with solar and wind energy development: Guidelines for project developers" (Bennun et al., 2021[2]).

Step 4: Assessment of impact significance

Biodiversity impact significance is the product of the value or importance of the biodiversity components that will be impacted and the intensity or magnitude (degree and extent of change) of the impact on those resources, systems and/or components. Some regulators, lenders, or corporate standards will use the term "significant" to refer to a threshold of consequence and/or risk that requires management or may not be acceptable. The approach to impact significance assessment is based on

[1] Hardner, J., R.E. Gullison, S. Anstee, M. Meyer. (2015). Good Practices for Biodiversity Inclusive Impact Assessment and Management Planning. Prepared for the Multilateral Financing Institutions Biodiversity Working Group. Available online at: https://publications.iadb.org/publications/english/document/Good-Practices-for-Biodiversity-Inclusive-Impact-Assessment-and-Management-Planning.pdf

[2] Bennun, L., van Bochove, J., Ng, C., Fletcher, C., Wilson, D., Phair, N., Carbone, G. (2021). Mitigating biodiversity impacts associated with solar and wind energy development. Guidelines for project developers. Gland, Switzerland: IUCN and Cambridge, UK: The Biodiversity Consultancy. Available online at: https://portals.iucn.org/library/sites/library/files/documents/2021-004-En.pdf

the traditional risk assessment formula which rates the **magnitude of effect** as the realistic 'worst-case' consequence or end-point of a project activity based on the perceived **importance and/or sensitivity** of a particular environmental receptor. Separate assessment matrices for habitat and species have been used for the assessment of impact significance, and these are contained in ***Table 8.44*** and ***Table 8.45***, respectively.

Table 8.44: Matrix used to rate Impact Significance Criteria for Habitat

Habitat Importance / Sensitivity		Magnitude of Effect			
		Negligible	**Small**	**Medium**	**Large**
Negligible	Habitats with negligible interest for biodiversity.	Insignificant	Insignificant	Insignificant	Insignificant
Low	Habitats with no or local designation / recognition; habitats of significance for species of Least Concern (LC) on IUCN RDL of Threatened Species; habitats which are common and widespread within the region, or with low conservation interest based on expert opinion.	Insignificant	Insignificant	Minor	Moderate
Medium	Habitats within nationally designated or recognised areas, habitats of significant importance to globally Vulnerable (VU) Near Threatened (NT), or Data Deficient (DD) species, habitats of significant importance for nationally restricted range species, habitats supporting nationally significant concentrations of migratory species and / or congregatory species, and low value habitats used by species of medium value.	Insignificant	Minor	Moderate	Major
High	Habitats within internationally designated or recognised areas; habitats of significant importance to globally Critically Endangered (CR) or Endangered (EN) 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, and low or medium value habitats used by high value species.	Insignificant	Moderate	Major	Critical

***Magnitude of Effect definitions for habitat receptors**:*

***Negligible** - Effect is within the normal range of natural variation.*

***Small** - Affects only a small area of habitat, such that there is no 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 thereof, to the extent that the viability/function of the habitat is threatened.*

Table 8.45: Matrix used to rate Impact Significance Criteria for Species

Species Importance / Sensitivity		Magnitude of Effect			
		Negligible	**Small**	**Medium**	**Large**
Negligible	Species with no specific value or importance attached to them.	Insignificant	Insignificant	Insignificant	Insignificant
Low	Species and sub-species of LC on the IUCN RDL, or not meeting criteria for medium or high value.	Insignificant	Insignificant	Minor	Moderate
Medium	Species listed on IUCN RDL as VU, NT, or DD, species protected under national legislation, nationally restricted-range species, nationally important numbers of migratory, or congregatory species, species not meeting criteria for high value, and species vital to the survival of a medium value species.	Insignificant	Minor	Moderate	Major
High	Species included on the IUCN RDL as CR or EN. Nationally or internationally important populations of Annex II or Annex IV species. Species with restricted ranges or global breeding range for birds of less than 50,000 km^2.) Internationally important concentrations of migratory and/or congregatory species, key evolutionary species, and species vital to the survival of a high value species.	Insignificant	Moderate	Major	Critical

***Magnitude of Effect definitions for species receptors**:*

***Negligible** - Effect is within the normal range of variation for the population of the species.*

***Small** – Effect does not cause a substantial change in the population of the species, or other species dependent on it.*

***Medium** – Effect causes a substantial change in abundance and / or reduction in distribution of a population over one, or more generations, but does not*

threaten the long term viability / function of that population, or any population dependent on it.

***Large** - Affects entire population, or a significant part of it causing a substantial decline in abundance and / or change in and recovery of the population (or another dependent on it) is not possible either at all, or within several generations due to natural recruitment (reproduction, immigration from unaffected areas).*

Step 5: Impact mitigation and management measures

Appropriate impact mitigation and management measures are recommended to reduce the magnitude (based on aspects that include the scale, probability and intensity of impact) and thereby reduce the significance of the impact consequence to an environmentally acceptable level where possible. The following best/good practice guidelines were referred to closely for informing impact management and the suite of mitigation measures recommended:

- "Good Practices for Biodiversity Inclusive Impact Assessment and Management Planning" (Hardner et al., 2015);
- "Mitigating biodiversity impacts associated with solar and wind energy development: Guidelines for project developers" (Bennun et al., 2021); and

- "A cross-sector guide to implementing the Mitigation Hierarchy" (Ekstrom et al., 2015[1]).

Step 6: Assess residual impacts

The final step is to assess residual impacts, which are those impacts that are likely to persist after taking into account the mitigation and management measures recommended as part of the mitigation strategy for the project, and their likely implementation success.

8.4.3 Biodiversity Impact Assessment

8.4.3.1 *Project* AoI

The AoI (Area of Influence) of the WF project was considered for the construction and operational/maintenance phases of the project, and is documented in ***Table 8.46.***

The reader is also referred to ***section 3.3*** of the ESIA for the full detailed description of project facilities and components as well as a map (***Figure 3.2***) indicating the location of the turbines, access roads, substations and transmission lines and a second map (***Figure 3.7***) showing the location of ancillary facilities (local crush stone location, batching plants, worker camps, laydown areas).

[1] Ekstrom, J., Bennun, L. and Mitchell, R. (2015). A cross-sector guide for implementing the Mitigation Hierarchy. The Biodiversity Consultancy Ltd with inputs from the IFC (International Finance Corporation). Cambridge, United Kingdom. Available online at: https://www.csbi.org.uk/wp-content/uploads/2017/10/CSBI-Mitigation-Hierarchy-Guide.pdf

Table 8.46: Defining the AoI for Construction and Operational/Maintenance Components of the Project

Project Component	Habitats	Plants	Terrestrial Fauna (volant)	Terrestrial Fauna (non-volant)	Aquatic Ecosystems	Notes
CONSTRUCTION PHASE						
Access roads	350 m	350 m	250 m	250 m	Small streams crossed	■ Several small streams crossed by planned roads
Substations	350 m	350 m	250 m	250 m	n/a	■ Based on dust emissions (350m) and likely disturbance distance of most sensitive species. ■ Based on literature such as Kwon et al. (2018[1]), there is a strong possibility that species could be disturbed by noise up to a radius of approximately 250m from the construction site, and outside of the 250m, noise level from construction should have been attenuated to background noise levels, with the exception of when piling occurs in which case which the disturbing zone could be larger
Wind Turbines	350 m	350 m	250 m	250 m	n/a	
Worker camps	350 m	350 m	250 m	250 m	n/a	
Laydown areas	350 m	350 m	250 m	250 m	n/a	
Concrete batching plants	350 m	350 m	250 m	250 m	n/a	
Crush stone locations	350 m	350 m	250 m	250 m	n/a	
Transmission lines	350 m	350 m	250 m	250 m	Streams / rivers crossed	■ Transmission line impacts to linear ecosystems such as streams/rivers are likely to be minimal.
OPERATIONAL / MAINTENANCE PHASE						
Wind Turbines	350 m	350 m	10 km	250 m	n/a	■ Adjacent areas, including protected areas and key biodiversity areas within a 10km range from the project development area (to account for potential risks to volant populations up to, due to the nature of wind farm projects and their potential avifauna collision risks
Access roads	350 m	350 m	250 m	250 m	Small streams crossed	■ Several small streams crossed by planned roads.
Transmission lines	350 m	350 m	10 km	250 m	Streams / rivers crossed	■ Transmission line impacts to linear ecosystems such as streams/rivers are likely to be minimal.

[1] Kwon, N., Song, K., Lee, H.-S., Kim, J. & Park, M. (2018). Construction Noise Risk Assessment Model Focusing on Construction Equipment. Journal of Construction Engineering and Management, vol. 144. Available online at: https://www.researchgate.net/publication/324259324_Construction_Noise_Risk_Assessment_Model_Focusing_on_Construction_Equipment

8.4.3.2 Key Receptors & Biodiversity Values

Key ecological receptors and important biodiversity values linked with the AoI for the project include the various habitat types and species identified in the Baseline Biodiversity Assessment (see ***Chapter 7.4** of the ESIA*). Several medium to high sensitivity ecological receptors and important biodiversity values linked with the project AoI were identified, and these are summarized in ***Table 8.47***. Critical habitats identified in the CHA (***Appendix G***) have also been included here, including their value from an ecosystem services perspective.

Table 8.47: Summary of Key Ecological Receptors and Biodiversity Values for the Project area

Ecological value	Applicability to the Project
Species level aspects of biodiversity	
Protected/Threatened species of conservation importance (Red Data Listed): **flora**	1 Red List plant species: *Zingiber mellis* (EN), recorded within Montane Forest vegetation community
Protected/Threatened species of conservation importance (Red Data Listed): **fauna**	Several Red Data List species of fauna have been confirmed or recorded as likely to be present in the study area, including CR, EN, VU, NT and DD species of bird, mammal and reptile. **Birds:** 5 Red Data List bird species (includes VU & NT) ■ Greater Hornbill, *Buceros bicornis* (VU) ■ Chestnut-eared Laughing thrush, *Garrulax konkakinhensis* (VU) ■ Black-crowned Barwing, *Actinodura sodangorum* (NT) ■ Mountain Hawk-eagle, *Nisaetus nipalensis* (NT) ■ Rufous-bellied Eagle, *Lophotriorchis kienerii* (NT) **Mammals:** 11 Red Data List mammal species (includes CR, EN & VU) ■ Bengal Slow Loris, *Nycticebus bengalensis* (EN) ■ Pygmy Slow Loris, *Nycticebus pygmaeus* (EN) ■ Northern Buff-cheeked gibbon, *Nomascus annamensis* (EN) ■ Red-shanked Douc Langur, *Pygathrix nemaeus* (CR) ■ Chinese Pangolin, *Manis pentadactyla* (CR) ■ Sunda Pangolin, *Manis javanica* (CR) ■ Owston's Civet, *Chrotogale owstoni* (EN) ■ Large-antlered Muntjac, *Muntiacus vuquangensis* (CR) ■ Annamite Striped Rabbit, *Nesolagus timminsi* (EN) ■ Indochinese Silvered Langur, *Trachypithecus germaini* (EN) ■ Northern Yellow-cheeked Crested Gibbon, *Nomascus annamensis* (EN) **Reptiles**: 3 Red Data List reptile species (includes EN, VU & DD) ■ Red River Krait, *Bungarus slowinskii* (VU) ■ Impressed Tortoise, *Manouria impressa* (EN) ■ Annam Keelback, *Hebius annamensis* (DD) **Amphibians:** no Red Data amphibian species recorded or likely to be present. **Bats**: no Red Data List bat species recorded or likely to be present.

Ecological value	Applicability to the Project
	Fish: no Red Data fish species recorded or likely to be present.
Keystone species performing a key ecological role (e.g. key predator, primary producer)	No specific species identified that may be considered keystone species contributing to long-term forest health, etc.
Large or congregatory species populations	None identified.
Endemic species or species with **restricted ranges**	Several endemic and/or range-restricted species of birds, mammals, reptiles, amphibians and plant species recorded or likely to be present. **Birds:** 2 endemic and range-restricted bird species ■ Chestnut-eared Laughing thrush, *Garrulax konkakinhensis* ■ Black-crowned Barwing, *Actinodura sodangorum* **Mammals:** 2 range-restricted mammal species ■ Red-shanked Douc Langur, *Pygathrix nemaeus* ■ Large-antlered Muntjac, *Muntiacus vuquangensis* **Reptiles:** 2 endemic and range-restricted reptile species ■ Red River Krait, *Bungarus slowinskii* ■ Annam Keelback, *Hebius annamensis* **Amphibians**: 3 species potentially 'new to science' that could also be endemics (see below). **Fish:** 2 LC endemic and range-restricted fish species could possibly occur ■ *Schistura imitator* ■ *Schistura clatrata* **Plants**: 11 species potentially 'new to science' that could also be endemics (see below). **Bats:** none.
Previously unknown species	**Amphibians**: 3 species of frog that could be potentially 'new to science' (requiring further confirmation) ■ Quasipaa sp. ■ Maosons Horned Toad, *Xenophrys cf maosonensis* ■ *Rhacophorus* sp nov **Plants**:10 plant species that could be potentially 'new to science' (requiring further confirmation) ■ *Camellia sp.* ■ *Garcinia sp.* ■ *Lasianthus sp. 1* ■ *Lasianthus sp. 2* ■ *Machilus sp.* ■ *Melastoma sp.*

Ecological value	Applicability to the Project
	■ *Neolitsea sp.* ■ *Polyosma sp.1* ■ *Polyosma sp.2* ■ *Smilax sp.*
Community & ecosystem level aspects of biodiversity	
Distinct or diverse communities or ecosystems	The 'Southern Annamites Montane Rain Forests' ecoregion (IM0152) as defined by the World Wildlife Fund ("WWF") is considered to be 'Vulnerable' in terms of conservation/threat status.
Unique ecosystems	The Project area is unlikely to comprise highly unique ecosystems.
Locally adapted communities or assemblages	The Project area is unlikely to contain unique species assemblages
Species-rich or diverse ecosystems	The less impacted and more contiguous Montane Forest and Wet Evergreen Forest communities are considered to have high overall species richness.
Communities with a **high proportion of endemic species or species with restricted ranges**	Montane Forest and Wet Evergreen Forest vegetation communities (including forested streams and rivers) are likely to host the highest proportion of endemic and/or range-restricted species of birds, mammals, reptiles, amphibians and plant species for the project area (*see above*). As a result of the potentially high level of animal and plant endemism associated with the ecoregion, it is considered likely that the Project Area may be important in the conservation of key evolutionary processes.
Communities with a **high proportion of threatened and/or declining species**	Montane Forest and Wet Evergreen Forest vegetation communities host the highest proportion of threatened (Red Data Listed) birds, mammals, reptiles and plant species for the project area (see above) or species with declining populations for the region.
The main uses and users of the area and its ecosystem goods and services: **important ecosystem services** (e.g. important water yield area, coastal buffer), **valued ecosystem goods** (e.g. harvestable goods important for lives and / or livelihoods), **valued cultural areas.**	Given the potential for the forest ecosystems to provide key ecosystem services at both a local/regional and global scale, which are also considered 'Priority ecosystem services' as per the definition provided in IFC PS6 (as impacts to these ecosystems may result in adverse impacts to Affected Communities, in terms of undermining cultural values and conflicting with subsistence resource needs), the evergreen forest ecosystems are considered important. In addition, the 'Sacred Forest' identified has a unique local history and spiritual/cultural importance associated with local beliefs, which appears to also be more widespread and regionally practiced.
Landscape level aspects of biodiversity	
Protected Areas & Key Biodiversity Areas (KBAs)	Song Thanh Nature Reserve located on the Laos-Viet Nam border to the east of the Project area and within close proximity to the transmission line, is known to be an important area of the Annamite Ranges, comprising one of the most extensive contiguous forests in Viet Nam. The Reserve reportedly contains a good population of the Vietnamese Crested Argus (CR). Dakchung Plateau is both a KBA and IBA located in the middle of the Project area. Although extensively degraded, it is thought to hold important concentrations of Black-crowned Barwing (CR), and potentially the Yellow-billed Nuthatch (NT), both species which have adapted to disturbed and secondary habitats.

Ecological value	Applicability to the Project
	Phou Ahyon and Ngoc Linh are designated as KBAs, IBAs and Alliance for Zero Extinction (AZE) sites, located north of the project area. These areas hold some of the last remaining populations of restricted-range bird species found in the Kon Tum Plateau EBA, such as the Vietnames Crested Argus (CR), and Yellow-billed Nuthatch (NT). Additionally, Ngoc Linh also contains populations of the Black-crowned Barwing (CR). Upper Xe Kaman is a KBA and an IBA supporting relatively intact old-growth semi-evergreen forest and riverine habitats, with key species including Masked Finfoot *Heliopais personata* (EN), hornbill species, a range of gibbon species and Siamese crocodile *Crocodylus siamensis* (CR).
Key ecological processes (e.g. seed dispersal, pollination, primary production, carbon sequestration)	The forest ecosystems are known to provide a range of important ecosystem goods and services which society values (mainly extractive use of timber, plants and wildlife for direct consumption by communities or re-sale to local markets).
Areas with large congregations or species and/or breeding grounds	None identified.
Migration routes/corridors Importance as a **link or corridor to other fragments** of the same habitat, to protected or threatened or valued biodiversity areas **Importance and role in the landscape** with regard to a range of 'spatial components of ecological processes', comprising processes tied to fixed physical features (e.g. soil or vegetation interfaces, river or sand movement corridors, upland-lowland interfaces) and flexible processes (e.g. upland-lowland gradients and macro-climatic gradients), as well as important movement or migration corridor for species	Key ecological linkages in the project area include the less fragmented and more contiguous forested corridors, watercourses (streams and rivers) and areas providing connectivity to and between Protected Areas (PAs) and Key Biodiversity Areas (KBAs). The Project area is also situated within one of the designated biodiversity corridors of the ADB-funded Biodiversity Conservation Corridor Project ("BCCP"), in recognition of its importance in maintaining the forest ecosystem connectivity between Xe Sap National Protected Area ("PA") in Sekong province, and Dong Ampham NPA in Attapeu province (ADB, 2021).

***Key to table**:*

***IUCN Global Red List status**: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient; NE = Not Evaluated.*

Note that there is no national Red List available for Lao PDR.

8.4.3.3 *Identification* of Biodiversity Impacts

Detailed information on the Construction Phase of the project (***section 3.8.2*** of the ESIA) and Operational/Maintenance Phase (***section 3.8.3***) were referred to specifically in identifying and assessing biodiversity impacts. Maintenance has been included in the operational phase, noting that onshore wind farms typically have low maintenance and servicing requirements (Brennun *et al.,* 2021). The project concession period will be 25 years with little information on the decommissioning phase available, however decommissioning phase impacts are likely be similar to construction phase impacts and have therefore not been assessed directly. Cumulative impacts are addressed later on in the ESIA, and include cumulative impacts on biodiversity.

Biodiversity impacts identified for the Monsoon WF project and related activities and infrastructure have been conceptualized and discussed in detail in ***Table 8.48***. Impacts are defined in terms of construction and operational (including maintenance) project phases, and include direct, indirect and induced impacts. Pathways of effect are used to understand how biodiversity may be impacted (e.g. direct habitat loss, indirect habitat loss due to disturbance, increased hunting pressure due to settlement associated with the creation of new access roads and other infrastructure).

Impacts associated with the WF are considered to be both ‘area based’ and ‘linear‘ in nature, and relate to the construction and operation of several wind turbines, electrical substations, the planned electricity distribution network (transmission line) from the WF towards Vietnam, as well as temporary worker camps and equipment laydown areas:

- Biodiversity impacts appear most intimately linked with direct and indirect impacts to that natural and modified terrestrial forest ecosystems, as well as the biodiversity components that these important habitat types support, including the species of fauna & flora that characterize the study area and the ecosystem services that forest ecosystems supply at local, regional and even global scales.
- There are also likely to be localized impacts on freshwater biodiversity, associated mainly with the construction of new access roads across watercourses such as small streams. The risk of incurring potential impacts to these highly connected ecosystems needs to be acknowledged.
- There are also likely to be a range of permanent operational impacts of lower significance associated with the installation and operation of the hard infrastructure (turbines and transmission lines).
- Construction-phase impacts likely to be more temporary in nature (e.g. temporary areas, noise, vibrations and emissions) and therefore far less significant in the long-term.

Table 8.48: Biodiversity impacts identified and conceptualized for the Monsoon WF project

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
Direct Impacts: *linked with the development project footprint and key activities*				
1a Physical destruction and/or disturbance of vegetation	**Construction phase:** The physical footprint of the wind farm (including turbines, electrical substations, access roads and transmission lines) will be relatively small in scale, being localised and limited to the actual footprint of infrastructure where vegetation will be cleared and converted to artificial surfaces (i.e. wind turbine foundations, access roads, substation foundations and pylons for the transmission line) or modified from wooded (forest) vegetation and maintained as low shrub or grass cover for the transmission line corridor. The following vegetation communities will be affected: • Montane Forest and Wet Evergreen Forest subject to varying degrees of existing degradation and fragmentation, • smaller isolated (highly fragmented and degraded) forest patches, • secondary or young/seral forest patches, and • modified (artificial) shrub land/grassland. The perceived importance of the biodiversity loss associated with loss of forest vegetation is typically linked to the conservation/threat status of the vegetation type, which has not been formally determined for Lao PDR, however the ecoregion is considered 'Vulnerable'. Given the extent of loss of forest vegetation which has been sustained (according to the WWF, 2021, "*in excess of 75% of the ecoregion's natural habitat has been converted or degraded"*), the vegetation threat status may actually be higher than VU realistically, and moreover the forest communities have been identified as important for harbouring threatened/RDL plant species (e.g. *Zingiber mellis,* EN) as well as plants that may be potentially 'new to science'. Therefore, the perceived importance of the biodiversity features that stand to be impacted is considered 'High'. Whilst there will also be localised impacts to other vegetation communities, including shrub land and small grassland patches, these vegetation types have been identified as having been artificially created through	Habitat	High	Small

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
	shifting cultivation practices, and are therefore rather small and transitionary habitat types of limited biodiversity value as herbaceous communities, in comparison to the forest types in the project area. Most significant is likely to be the transmission line corridor impact, particularly for the portion of the transmission lines to the north and north-west, affecting some relatively contiguous areas of Montane Forest and Wet Evergreen Forest, some being primary forest that has not been subjected to extensive disturbance. In this case the vegetation will not be lost but will be modified from forest to a shorter herbaceous vegetation type, such as wooded shrub lands for example, and maintained as such. Based on the land use mapping undertaken, and a rapid scan of the satellite imagery in GIS, this suggests that the transmission line to the north-east will likely affect areas of lesser impacted/more contiguous forest over a distance of up to 15km of line will affect areas of contiguous forest, with the second transmission line in the north covering a distance exceeding 15km through largely contiguous, dense and lesser impacted forest. If one factors in power line corridor width (40m), the actual extent of vegetation change is likely to exceed about 100 ha. Where there is no or limited access to remote areas, new access road infrastructure across 'greenfield' areas will almost certainly result in the direct transformation of forest, mainly associated with some of the lesser impacted and more contiguous Montane Forest community. Based on the land use mapping undertaken and a rapid scan of the satellite imagery in GIS, this suggests that the new roads through the older growth and least impacted forest habitats could extend over a distance upwards of 20km. If one factors in average road construction corridor width (likely to be approx. 25m), the actual extent of vegetation loss due to new road construction is likely to be in the region of 50 ha. Where existing access roads will be upgraded only, the additional loss of vegetation is considered to be negligible and largely insignificant, especially given the level of degradation and fragmentation of the forest communities that has already occurred in these areas. In the context of there being significant areas of natural and modified forest remaining within the EAAAs, an estimated modification in the region of 100ha and transformation of roughly 50 ha of the lesser impacted forest habitat can be considered relatively 'small' in terms of the actual magnitude of effect. The WF			

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
	development is unlikely to threaten the long-term viability of the forest habitat or species dependent on it, with large areas of forest to remain undisturbed. **Operational/Maintenance Phase:** The physical destruction/disturbance of vegetation is primarily a construction-phase impact initiated by construction activities, albeit that the effects will be permanent in many cases where vegetation is changed.			
1b Reduction in habitat for supporting key RDL species	**Construction phase:** Changes to species habitat is linked to the direct destruction of or change to the corresponding forest vegetation communities and any additional disturbance through typical edge impacts adjacent to construction activities. The reduction in habitat is primarily a construction-phase impact initiated by construction activities and vegetation transformation, albeit that the effects will be permanent in many cases where habitat is transformed by infrastructure such as foundations and roads. Transmission line corridor habitat will be modified (forest to be modified to shrub land most likely) but not lost entirely. Given that forest-dependent species that are CR and EN could be affected by reduced habitat availability, linked with the change in forest vegetation described above, the biodiversity importance associated with this impact is considered to be reasonably 'High'. One can expect losses of some RDL species, particularly the slower moving and more sedentary species (such as tortoises and frogs) and this will be more relevant to the lesser impacted, more contiguous forest habitat in the north and east sections of the project area, however it is probably unlikely that significant populations of RDL herpetofauna could be negatively affected. Most species of mammals and birds are highly mobile and the more sensitive species are capable of moving away from areas as human presence increases at the construction site. Since the direct loss of habitat will be relatively small, the impact is unlikely to result in a substantial change in the populations of forest-dwelling species, with sufficient forest habitat remaining available in the area (magnitude of effect is likely to be 'small' as a result). **Operational/Maintenance Phase:**	Habitat & Species	High	Small

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
	This impact is initiated during construction but can be permanent in the case of hard structures such as foundations and roads, and more long-term in the case of habitat change associated with transmission lines.			
1c Illegal hunting/poaching and collection of forest resources	**Construction phase:** Whilst increased human activity in the area could result in increased pressure on local forest resources (through illegal hunting/poaching and harvesting of forest products, for example), this will likely be highly localised and relatively short-lived. Given that fauna species in particular (species that are RDL CR and EN) are already at risk in the area, further hunting of fauna could diminish local species populations further. *This is also addressed in terms of the project Cumulative Impact Assessment ("CIA") later*. This impact may possibly occur if not mitigated but is not likely to result in a substantial change in the population of species identified, thus magnitude of effect is likely to be relatively 'small'. **Operational/Maintenance Phase:** This impact will likely be less important during operation, as construction crews would have vacated the site and only a small operations and maintenance staff complement would remain on site, and not all the time.	Species	High	Small
1d Bird & bat collisions with wind turbines resulting in injury or mortality	**Construction phase:** This impact is not relevant to the construction phase. **Operational/Maintenance Phase:** Bird and bat species that utilise the airspace in the project area are potentially at risk of collision with wind turbine rotator blades and risk incurring serious injury or death. **Birds:** ■ Bennun *et al.* (2021) indicate that collision risk for migratory species is considered generally greater than for more sedentary species. Larger birds with lower aerial manoeuvrability (such as cranes, storks, geese/swans, eagles and vultures) would probably be most at risk of collision. While most species in the area likely to be affected by the wind farm are considered locally common resident species of Least Concern (LC), there are several birds that are RDL species. It was concluded that	Species	Medium	Small

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
	there will not be a meaningful collision risk within the lifetime of the WF based on the level of aerial occupancy by key RDL species of birds, including Mountain Hawk-eagle (*Nisaetus nipalensis*, NT) and Rufous-bellied Eagle (*Lophotriorchis kienerii*, NT) observed in the area associated with the planned east-central turbine arrays (*noting here that the ecologically acceptable mortality rate or threshold for near threatened species should typically be considered lower or more stringent than for species of least concern*). . Given the species NT status of RDL birds, the importance/sensitivity of these biodiversity features is considered 'Medium'. ■ Most of the common resident bird species (of LC) are also unlikely to trigger a significant collision risk and all species belong to widespread and locally common and stable populations. Only local effects on common species of LC may occur, due to the statistically low likelihood of collision and widespread and common nature of these bird populations. Furthermore, there are no IBAs (Important Bird Areas) within 50km of the proposed wind farm that could be negatively impacted in terms of bird behaviour for key species or large congregations of birds and extensive field observations during key migratory periods suggest that the study area does not represent a significant migratory or congregatory area. ■ Migrant species are also of LC, and most recorded levels of flight at collision risk height, which based on experience, is unlikely to result in a significant risk of collision within the lifetime of the WF. The only migrant species that recorded relatively high levels of flight at collision risk was the Grey-faced buzzard (*Butastur indicus,* LC), which was subject to further Collision Risk Modelling (CRM). The CRM concluded that *"In the worst-case scenario of 10,000 individuals, the project is likely to cause 0.16% of the total annual global non-natural mortalities that could occur before significant negative impacts on the global population occur*". The project magnitude of effect on birds susceptible to collision was therefore considered to be small. **Bats:** ■ . With the exception of *Rhinolophus francisi* and *Kerivoula* de*pressa* which have yet to be evaluated by the IUCN, all bat species identified during the baseline biodiversity assessment are considered locally common species of LC, and as such the importance/sensitivity of these biodiversity features is considered relatively 'Low'. ■ Most bat species mortalities linked to WF projects relate mainly to migratory, foliage-roosting and tree-roosting species, and especially those species adapted for foraging insects in open spaces above the ground and far from vegetation. Based primarily on foraging strategy, 10 of the bat species recorded are considered to be at high risk for collision and potential fatality, with 11 medium risk of collision species. As bats are typically long-lived and have exceptionally low reproductive rates, fatalities of significant bat numbers could affect local populations of LC species.			

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
	■ Since local bat activity can change after WF construction, pre-construction studies have consistently proven to be poor predictors of the scale and magnitude of bat fatality impacts at species and population levels (Hein *et a*l., *2013*, Lintott *et al*., 2016). Given the constraints in determining bat fatality impacts prior to operation of the WF, it will be necessary to undertake further operational monitoring to validate operational impacts and to inform appropriate mitigation options.			
1e Bird & bat collisions with transmission lines or electrocution resulting in injury or mortality	**Operational phase only:** Collisions with the earth wire of transmission lines (which is typically quite poorly visible to avifauna) may lead to injury or even fatalities in bird and bat species. TL projects can also result in electrocution when birds or bats earth live elements of the line, which is particularly relevant for larger species (with large wing spans). Electrocution risk is relevant to the transmission lines and substations. **Birds**: ■ Electrocution risk is typically quite species-specific, and may disproportionally affect species that utilise the pylons as perches when hunting or for nesting purposes, and this is most significant for raptors and other larger perching birds with large wing spans (Bennun *et al.,* 2021). There is therefore some risk posed to some of the larger perching raptor species such as Mountain Hawk-eagle (*Nisaetus nipalensis,* NT) and Rufous-bellied Eagle (*Lophotriorchis kienerii,* NT), with other raptors such as Black Eagle, Crested Serpent Eagle being locally common resident species of Least Concern (LC). For larger voltage lines, electrocution risk will be minimised as live elements will be placed at a distance from each other such that the chance of birds completing the live circuit will be negligible. However, the lower voltage distribution lines (e.g. 35 kV and 115 kV) that are more compact in design may present a risk of electrocution for perching and low-flying birds with larger wingspans. ■ Although the incidence of collisions of raptors per km of power line is typically quite low in general, collisions are also more likely where species are more abundant and in areas with higher flight activity. The results of the VP monitoring suggest that common resident raptor species of Least Concern (LC) such as Black Eagle (*Ictinaetus malaiensis*), Crested Serpent Eagle (*Spilornis cheela*), Grey-faced Buzzard (*Butastur indicus*), Oriental Honey Buzzard (*Pernis ptilorhynchus*) and Shikra (*Accipiter badius*) were the most abundant and recorded the greatest flight times. However, most species were observed at great heights (exceeding 100m and up to 3000m elevation), such that it is only the less commonly observed species such as Rufous-bellied Eagle and particularly the Great Hornbill (*Buceros bicornis*, VU) that are likely to fly at lower heights typically where risk of collision with overhead power lines could become a concern. Previous experience with collision risk modelling and assessments would conclude that based on the level of aerial occupancy at collision height for the Rufous0Bellied	Species	Medium	Small

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
	Eagle and Great Hornbill, that collision risk would be unlikely. However, given the propensity for Great Hornbill to utilise evergreen forest habitats, some of which will be traversed by the planned TL to Vietnam, there may be associated risks with the TL in these areas where additional miitgation will need to be considered for this species. Given the VU status for Great Hornbill, the importance/sensitivity of this biodiversity feature is considered 'Medium'. **Bats:** ■ There is limited evidence of risks posed by transmission lines to bats, although electrocution of large bat species, particularly fruit bats (such as 'Flying Foxes' which are unlikely to occur in the area), has been identified as an issue associated with some distribution lines (Bennun *et al.,* 2021). ■ Since the bat species recorded are largely small insectivores of LC, bat collisions with the transmission lines and possible electrocution risks are considered largely insignificant for this project.			
1f Vehicular collisions with wildlife	**Construction phase:** Construction vehicles accessing and working within the site pose a risk of colliding with species utilizing the habitats and crossing roads between habitats. Some species may also be attracted to access roads created as easy corridors to move between areas and these animals are likely to be more at risk. Slower moving and more sedentary species such as reptiles (e.g. tortoises) and amphibians are likely to be at a greater risk of being injured or killed by moving vehicles, even at low speeds, particularly as cold-blooded species such as reptiles may utilize roads for sunning themselves. Given that some of these species are CR and EN, the importance associated with these species is considered 'High'. Vehicular collisions, whilst probable, are likely to be localised, manageable and therefore also unlikely to diminish populations of the identified species (magnitude of effect considered 'small'). **Operational/Maintenance phase:** This impact will probably be even less significant during operation, when only small operations, maintenance and security teams would probably utilise the access roads, and not all the time.	Species	High	Small
1g Dust pollution caused by	**Construction phase:**	Species	Low	Negligible

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
earthworks and vehicle/machinery operation	Construction activities and operations are known to increase levels of dust due to vehicles travelling on informal dirt roads and through the creation of bare surfaces where vegetation clearing and bulk earthworks take place. Where large quantities of dust are released, this can smother plant parts and reduce photosynthetic activity, however this is likely to be a highly localised impact. Faunal impacts are also likely to be insignificant. Impacts of increased dust will also be limited to particularly windy periods and when vehicles drive along dirt roads, and the magnitude of effect is therefore likely to be 'negligible'. **Operational/Maintenance phase:** This impact will probably be less significant during operation, when only small operations, maintenance and security patrol teams would probably utilise the roads, and not all the time.			
1h Water and soil pollution caused by potential accidental spills of hazardous substances	**Construction phase:** Fuels, oils and other chemical substances required by construction crews operating at the site of the WF will be liable to accidental spillage, and even improper disposal, unless carefully managed. This will be most relevant to sensitive species of amphibians and any fish present in watercourses which are naturally the most prone areas to water pollution impacts - given their inherent level of connectivity in the landscape and location at topographic low points. During rainfall events, contaminants could also be washed into adjacent terrestrial habitats and soils that have been subject to pollution could hinder natural plant growth. While the likelihood of significant spills occurring for a project of this nature can be considered low typically (magnitude of effect considered 'small'), where spills of hydrocarbon products and other hazardous substances do happen these can be particularly devastating and long-lasting and may require considerable remediation efforts. **Operational/Maintenance phase:** This impact may be relevant to maintenance activities, but these are likely to be limited, with insignificant quantities of fuel, oil, etc. stored and handled during the operational phase.	Habitat & Species	Medium	Small
1i Soil erosion and sedimentation of	**Construction phase:**	Habitat	Medium	Small

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
watercourses	Soil erosion and loss of topsoil is generally considered a significant risk given the high rainfall, steep topography and erodible nature of soils in the region (National University of Laos, 2008). Soil erosion and sedimentation is likely to be most relevant to watercourses (small mountain streams and the larger rivers in valley bottom areas) and specifically where these are crossed by new access roads. Erosion of stream beds and banks would alter the morphology of these ecosystems and potentially reduce habitat availability for aquatic and sub-aquatic species such as fish and amphibians, and certain reptiles. Bare surfaces and open excavations can also be sources of sediment in themselves and excessive sediment can blanket vegetation and habitats, leading to altered instream habitat/biotopes and possibly affecting fish spawning sites and amphibian habitats important for completing species' life stages. The magnitude of effect has been rated as 'small' given the small size of the affected watercourses (small mountain streams) and the potential ease of mitigation. **Operational/Maintenance phase:** Although operational activities are unlikely to initiate any new erosion/sediment effects in themselves, erosion/sediment related impacts initiated during the construction phase may be prolonged and extend into operations unless properly addressed during the construction phase.			
1j Disturbance and nuisance caused by increased noise, light and/or vibrations	**Construction phase:** General nuisance and disturbance as a by-product of construction activities, including that associated with increased noise / vibrations from heavy construction machinery and artificial light. There are few studies available on the distance to which fauna are typically displaced during the construction phase of wind turbine projects. The displacement of fauna during construction is considered to be mostly associated to noise (for birds and non-volant mammals) and vibrations (herpetofauna). Locally common species are likely to be less sensitive to noise/light disturbance can probably become habituated at the site. Based on literature such as Kwon *et al.* (2018), there is a strong possibility that species could be disturbed by noise up to a radius of approximately 250m from the construction site, and outside of the 250m, noise level from construction should have been attenuated to background noise levels, with the exception of when piling occurs in which case which the disturbing zone could be larger. Given that the turbines are high in number and clustered relatively close together in areas, this could in theory render relatively areas susceptible to indirect disturbance but this may be more localized.	Species	Medium	Small

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
	Operational/Maintenance phase: Artificial light impacts during operation are likely when specific facilities such as substations may need to be well-lit for safety and security purposes. This can also attract certain species of insects, which can lead to increased activity by insectivorous species such as bats and small reptiles. Noise and visual disturbance from operating wind farms may not pose as much immediate risks to non-volant fauna, so they show less avoidance behaviors and can be habituated to the disturbances quite easily (Kopucki & Mróz, 2016[1]). The magnitude of effect is likely to remain 'small' given the temporary nature of construction activities and low intensity of operational activities anticipated.			
1k Barriers or interference with species movement	**Construction phase:** Artificial barriers to species movement, such as roads, will be initiated during construction and will continue as long as infrastructure is in place during operations. **Operational/Maintenance phase:** Migratory bird species are likely to be the most affected by wind farm barrier effects, however no IBAs for migration are found within 50km of the proposed WF project and extensive field surveys did not indicate significant migratory or congregatory populations, suggesting that there is likely to be little effect on bird populations in terms of altered species movement. Whilst there is some evidence of broad front raptor migration in the area, all raptor species involved are species of LC and will probably be largely unaffected. Bats may avoid the wind turbine locations but equally they may be attracted to feed around these areas in the case of insectivores, where artificial light and disturbance may attract greater concentrations of insects to the WF. Barrier effects may also affect terrestrial species such as mammals if wind farms are fenced, particularly for larger migratory mammals (which is not so problematic for this project). It is therefore unlikely that Project will have any population level effect on species movement (magnitude of effect will be 'small').	Species	High	Small
Indirect Impacts: *associated indirectly with the main project activities and operations*				
2a Increased susceptibility of forest habitat to	**Construction phase:**	Habitat	Medium	Small

[1] Kopucki, R. & Mróz, I. (2016). An assessment of non-volant terrestrial vertebrates response to wind farms: a study of small mammals. *Environmental monitoring and assessment*, vol. 188, no. 2, p. 122. Available online at: https://www.researchgate.net/publication/292186245_An_assessment_of_non-volant_terrestrial_vertebrates_response_to_wind_farms-a_study_of_small_mammals

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
disturbance	Whilst disturbance is initiated during construction, this impact is principally a long-term effect that continues into the operational phase. **Operational/Maintenance phase:** Where less impacted and largely contiguous areas of older growth (primary) forest will be traversed by the transmission line and access roads, the disturbance caused will also increase susceptibility to the effect of other forms of natural disturbance, such as increased exposure to wind (especially during storms) along the newly created forest edges which would not yet have developed sufficient low ground cover to provide shelter from wind impacts. The magnitude of effect will likely remain 'small', as only localised sections of mostly fragmented and degraded forest habitats are likely to be affected.			
2b Introduction of alien plant species and/or disturbance leading to invasion by alien plants and weeds	**Construction phase:** The movement of vehicles, people and equipment into and through the project area may facilitate the introduction of Invasive Alien Plants (IAPs) to the area, or contribute to the spread of existing IAP species, primarily through the transport of seed attached to machinery, soils, clothing, etc. The disturbance created by vegetation clearing and earthworks may also create suitable conditions for IAPs and weeds to become established and possibly spread into adjacent habitats. IAPs can have far reaching detrimental effects on native biota and are widely accepted as being a leading cause of biodiversity loss. Key species are likely to be related to those introduced by Laotian plantation programmes (production forestry), and include *Eucalyptus* spp., *Acacia* spp., *Elaeis guineensis* (Oil palm), *Hevea brasiliensis* (Rubber tree) and *Jatropha* spp. (Tong, 2009[1]) although there may be other key plants. The Global Register of Introduced and Invasive Species v1.1 (Pagad, 2020[2]) has recorded 297 species of invasive alien plants for Lao PDR and can be accessed online to view species details.	Habitat & Species	High	Small

[1] Tong, P.S. (2009). Lao People's Democratic Republic: Forestry Outlook Study. Asia-Pacific Forestry Sector Outlook Study II, Working Paper Series. No. APFSOS II/WP/2009/17. Food and Agriculture Organization (FAO) of the United Nations, Regional Office for Asia and the Pacific. Bangkok, 2009. Available online at: https://www.fao.org/3/am612e/am612e.pdf

[2] Pagad, S. (2020): Global Register of Introduced and Invasive Species- Laos. v1.1. Invasive Species Specialist Group ISSG. Dataset/Checklist. Available online at: https://cloud.gbif.org/griis/resource?r=griis-laos&v=1.1

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
	Operational/Maintenance phase: The introduction of invasive alien plants into the lesser disturbed and ecologically important forest ecosystems can have a significant and lasting negative effect on the habitat and plant communities, that can extend well past the construction phase unless controlled. However, with mitigation this will probably be localised and therefore the magnitude of effect is considered 'small'.			
2c Reduced habitat connectivity caused by fragmentation of habitat	**Construction phase:** Whilst indirectly related to the destruction of vegetation and habitat during construction phase of the project, a reduction in habitat connectivity is a long-term and possibly a permanent effect in many cases, extending past construction and into the operational phase. **Operational/Maintenance phase:** New planned access roads can potentially fragment the remaining contiguous forest habitats and contribute to further fragmentation of areas already degraded and with patchy cover. Fragmentation of habitat can result in a landscape that has a lower capacity to support wildlife, preventing regular movement of species, limiting access to critical resources or increasing the energy required to take advantage of resources (Cornwall & Davis, 2003[1]). This is likely to be the most significant for migratory species, and given that large populations of migratory species have not been highlighted for the project area (and that additional habitat fragmentation impacts are unlikely to be severe), the magnitude of effect is considered 'small'.	Habitat & Species	High	Small
2d Loss of ecosystem services	**Construction phase:** Key ecosystem services are thought to be provided by the natural (and to a lesser extent, modified) forest habitats, and relate mainly to timber and non-timber products that are important for sustaining local livelihoods of the communities in the area that are dependent on these resources. A reduction in forest extent through destruction and degradation could contribute to a diminished supply of key provisioning and	Habitat	Medium	Small

[1] Cornwall, C. and Davis, M.K. (2003). *Fencing guidelines and specifications for conservation easements*. Sonoma Ecology Center, Santa Rosa, California. USA. July 2003.

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
	regulating/supporting services, however the linear nature of the more significant forest losses is likely to be more of a forest connectivity issue and have less of an overall effect on reducing key forest-related services. Any loss of ecosystem services is likely to be minor ('small' magnitude of effect). **Operational/Maintenance phase:** Whilst there is a possibility that development can restrict access to natural areas by local communities, the opposite is likely to be the case for this project, with increased accessibility likely to result, meaning that local communities can potentially make increased usage of forest resources and products. As discussed elsewhere in this chapter (under impact 3a below), this comes with its own unique set of unintended consequences on the local biodiversity values of the project area.			
Induced Impacts: *typically not directly attributable to the project and related activities*				
3a Increased hunting/harvesting pressure due to enhanced accessibility to the area	**Construction phase:** Whilst this induced impact is linked to the construction of new access roads, it is principally a long-term impact associated with the increased access created to the project area throughout its operation. **Operational/Maintenance phase:** Improved accessibility to the area gained via the various access roads planned could facilitate increased access to remote areas by local communities wishing to hunt wildlife for bush meat and collect forest products for subsistence and economic reasons. The more remote and less impacted forest areas in the north and east of the project, are likely to host larger populations of forest-dependent RDL CR and EN species at risk of being hunted further, and are considered to be 'High' importance habitats and receptors. Most of the concession area at lower elevations has long standing patterns of settlement supported by tracks and trail, timber use and agricultural settlement leading to habitat fragmentation and reduced biodiversity value. An existing and long-established vehicle road with settlements lies close to both the north-western array and the northern part of Phou Kounking. These northern areas have a well-developed trail system within the mountain range, and agricultural settlements at lower elevations that have been	Species	High	Small

Impact	Description	Receptor	Perceived Importance / Sensitivity of Habitat and/or Species	Magnitude of Effect
	present since at least 1985.At the southern end of Phou Kounking there are a number of small settlements at low elevations, and a well-developed foot trail up the central ridge that turns east at the steepest point of the mountain, and continues onto the town of Dak Cheung. There is recent evidence in the low southern section of the mountain of access tracks cut to facilitate reported illegal gold mining. The wind farm access roads have the potential to increase access to the higher elevations of the forest, both in terms of the quantity and quality of the access available, including increased vehicular access. Without proper controls this could lead to increased pressure on both wildlife and habitat, however it is recognised that access control will be a priority as recommended in the local EIA mitigation recommendations. Bearing in mind the existing extent of hunter access to the Project area and the implementation of access controls, particularly for vehicles using new WF access road, the magnitude of effect has been regarded as 'small', also since controls on vehicle access would probably restrict hunter access to the existing informal trails and paths primarily.			

Scoped out / Excluded impacts: Note that the following potential biodiversity-related impacts were initially identified for the project, however a decision was made to exclude them from the assessment of impact significance, with the reasons for excluding impacts provided:

Increased risk of fire – whilst fires can have negative impacts on habitats such as forests that are adapted to lack of fire, the project in itself is unlikely to pose a significant risk of fire. This risk, albeit low, can be readily mitigated through simple controls and preventative measures during construction and operation.

Trophic cascade effects – behavioral changes in species can result in cascading effects on the various trophic levels, however these are typically not well- documented or understood and any species-level effects would be purely theoretical and conceptual at this stage and cannot be determined with any high level of confidence or accuracy/ long-term species monitoring at the site will be required to study such effects of the project.

8.4.3.4 *Alternatives* and *Existing* Controls

Several project alternatives have already considered within the context of avoiding impacts to biodiversity where possible (detail in ***Chapter 4*** of the ESIA):

- Through a process of avoiding impacts where possible (according to the application of the mitigation hierarchy), the extent of forest destruction and disturbance has been minimized.
- Project alternatives considered included alternative power generation, site selection, technology and locations for infrastructure development. Turbine layout has been optimized from 240 turbines to 148 turbines, reducing the project footprint quite substantially as well as the areas required for temporary works (laydown areas, installation areas, access roads and WTGs).
- Clustering of turbines as far as possible will reduce the overall area over which the footprint occurs and reduce the number and length of access roads.
- The original transmission line planned to the Ban Lak 25 substation was amended to connect to Thanh My substation in Vietnam, reducing the overall length of the line considerably, thereby reducing overall extent of natural forest clearing and avoiding impacts to two important KBAs.
- Two alternative transmission line alignments were considered, with the first option selected, resulting in more favorable conditions for construction and maintenance of turbines and facilitating shorter access routes to the towers, reducing the overall area of environmental impact due to road construction.
- The potential to avoid of locating infrastructure within the particularly sensitive, less disturbed high elevation Montane Forest habitat on the ridgeline associated with Survey Block 4 (Phou Kounking) was also considered by ERM. This is detailed in the Briefing Note to IEAD dated 11 March 2022. Given the significant contribution the high elevation turbines within Survey Block 4 make to the viability of the Monsoon WF project, avoidance of the area described may not be entirely possible.
- Avoidance of the Wet Evergreen Forest habitat in the north-east will not be entirely possible, as this large contiguous belt of vegetation runs along a roughly west to east corridor, which the proposed transmission line to Vietnam will need to traverse at some point. Alignment as far as practically possible with more degraded forest habitat associated with the existing road through this forest unit has however been suggested, rather than creating an entirely new corridor through the less disturbed forest.

Other relevant management measures, controls and embedded mitigation confirmed for the Project and identified in the local EIA (2020), as relevant to biodiversity impact mitigation, have also been acknowledged (with reference to sections ***3.6, 3.7, 3.8, 8.3.2.2, 8.3.3.2***, ***8.3.4.4***, ***8.3.5.1*** and ***8.3.6.2*** of the ESIA). These are summarized below.

Pre-construction Phase controls:

- Clearly define the construction zone(s) and access routes,
- Toilets for workers to be provided,
- Use of modern equipment and vehicles,
- Prepare and implement a water use plan if required,
- Implement an appropriate wastewater treatment system as required (wastewater will be treated initially by wastewater treatment tank before using the service of the septic service company for disposal),
- Prepare a Waste Management Plan, and
- Prior to commencement of work, all contractors would be required to provide detailed site-specific plans as relevant to the project.

Construction Phase controls:

- Limit clearance of vegetation to the development footprint only,
- No burning of cleared vegetation,
- Avoid earthworks in forest areas as much as possible,
- Avoid earthworks during heavy rainfall to reduce erosion risk,
- Backfilling, levelling and compaction of excavations and trenches to occur as soon as possible after completion of earthworks using subsoil initially stripped,
- Coordinate construction activities to minimize stockpiling requirements,
- Stockpiling of construction materials to be at least 30m from waterways,
- Construct suitable drainage systems,
- Avoid earthworks at the sides of streams to reduce erosion and sedimentation risk to watercourses,
- Undertake erosion protection for all foundations,
- Control sedimentation,
- Implement dust suppression on surfaces which could be a source of dust,
- Proper storage of construction material in designated areas (bunded areas, hardstands with roofs),
- Proper solid waste collection, temporary storage and disposal at suitable facilities offsite,
- Hazardous waste to be temporarily stored prior to transported off-site to an appropriate or licensed waste disposal contractor,
- Construction noise mitigation and management measures to be implemented,
- Conduct noise monitoring,
- Conduct water quality monitoring,
- Water for construction to be sourced from public water utilities,
- Fencing and/or security to prevent community members from accessing the construction site,
- Vehicles to be properly maintained,
- No washing of vehicles and equipment in rivers or streams, and
- Conduct regular audits and inspections of the construction area.

Post-construction:

- Restoration to be done post-construction to return the landscape to as close to its original state as possible.

Operational/Maintenance Phase controls:

- Install, inspect and maintain fire protection equipment,
- Emergency plan to be prepared,
- Maintenance and cleaning work annually along the RoW area of the transmission line route, and
- Access controls and security during operation of the WF.

8.4.3.5 *Biodiversity* Impact Significance

The significance of the various impacts to biodiversity has been assessed using the approach and methods contained in Step 4 of the section on approach/methods, with the results presented in ***Table***

8.49. This has taken into account the alternatives already considered and existing controls identified (see ***section 8.4.3.4***).

Where considered relevant and necessary, additional mitigation measures aimed at avoiding, minimizing and remediating impacts (aligned with the mitigation hierarchy) have been included in the impact significance assessment contained in ***Table 8.49***. Repetition of the existing controls has been avoided.

Taking into account the recommended best/good practice mitigation measures, residual impacts have also been rated, with further details in ***section 8.4.3.7***.

Table 8.49: Biodiversity Impact Significance Assessment for the Monsoon WF project

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
1a	**Physical destruction and/or disturbance of vegetation**	Plant species (EN)	High	Small	Moderate	Construction Operation	**Pre-construction:** ■ Implement appropriate biodiversity buffer zones (development 'set-backs') from core areas of primary forest identified. ■ Undertake micro-siting of wind turbines and substations to avoid the least impacted primary forest communities as far as possible. ■ Micro-routing of access roads around particularly sensitive biodiversity features, which can also be a proactive way of mitigating impacts to forest habitat. ■ Compile an appropriate Construction Method Statement for working in natural forest habitats (for implementation where construction in/through forests is planned). ■ Adhere to applicable national environmental laws, specifically those governing the protection and management of wildlife and natural forests ("*Wildlife and Aquatic Animal Law*" and "*Forestry Law*") and ensure that any necessary permitting/licensing processes of planned activities in natural forests. ■ Compile a suitable post-construction rehabilitation plan for temporary areas used during construction.	Moderate* [*assuming no avoidance or offsetting]

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
							Construction: ■ Avoid locating construction camps and material/equipment laydown areas within or near mapped forest areas. ■ Look at a single construction camp, sited in a least sensitive and already disturbed area and avoid developing multiple camp sites if possible. ■ Use existing access roads or upgrade existing roads wherever possible before considered new access road construction. ■ Reduce the road width and construction corridor for roads and transmission lines through the older growth and less impacted, contiguous forests. ■ Avoid locating pylons supporting transmission lines within stream/river beds, rather place these away from the stream banks and ensure the line is suspended across the stream/river channel for the entire span of the stream/river. Take into account any dynamic environments such as large rivers which could flood or where the channel could change course through channel switching and result in damage to pylons. Place pylons above known river floodlines or flood risk areas. ■ Where known species of protected/RDL plant species occur and are at risk of being destroyed, prepare and implement a protected plant rescue and translocation plan and programme. ■ Limit the clearing of natural vegetation, particularly in forests, to the absolute minimum necessary to adequate complete	

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
							the works whilst not comprising on health and safety requirements or laws. ■ Demarcate the construction zone or servitude for corridors on a map and on the ground clearly using high visibility tape for instance, to avoid impacting on sensitive areas outside of the permitted construction area. ■ Rehabilitate and revegetate temporary-use, construction site camps and lay down areas as soon as reasonably practicable after construction activities have been completed. ■ Implement relevant construction standards (e.g. Construction Code of Practice for the Sustainable Use of Soils on Construction Sites' – DEFRA, 2009[1]). **Operation:** ■ Develop and implement access management plans and controls to avoid access and unnecessary disturbance of sensitive forest habitats	
1b	**Reduction in habitat for supporting key RDL species**	Forest habitat / Plant & Animal species (CR, EN)	High	Small	Moderate	Construction Operation	**Pre-construction:** ■ See mitigation measures recommended for impact 1a above. ■ Creation of suitable alternative habitats or enhancement of existing ones to support displaced species. **Construction:** ■ See mitigation measures recommended for impact 1a above.	Moderate* [*assuming no avoidance or offsetting]

[1] DEFRAL Department of Environmental, Food and Rural Affairs. (2009). Construction Code of Practice for the Sustainable Use of Soils on Construction Sites Available online at: https://www.assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/716510/pb13298-code-of-practice-090910.pdf

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
							■ Sweep through areas prior to construction to flush animals from habitats likely to be directly affected. ■ Schedule habitat clearance, grading and road construction activities outside of key species' breeding periods where known. **Operation:** ■ Consider options to rehabilitate degraded areas that were previously forest, through a reforestation and tree-planting project - potentially a community reforestation project could be investigated.	
1c	**Illegal hunting/poaching and collection of forest resources**	Plant & Animal species (CR, EN)	High	Small	Moderate	Construction Operation	**Construction:** ■ Illegal activities such as hunting of wildlife or collecting of forest species is to be discussed with construction workers and such activities are to be prohibited. **Operation:** ■ Access controls to be implemented to limit access to areas of high sensitivity (e.g. older growth, less impacted forest areas).	Insignificant* [*assuming hunting/poaching controls implemented]
1d	**Bird & bat collisions with wind turbines resulting in injury or mortality**	Bird & Bat species (NT)	Medium	Small	Minor	Operation	**Operation:** ■ Locate wind turbines away from the less disturbed primary forest habitats, as far as possible. ■ Implement an annual monitoring plan focused on investigating fatalities during period of heightened bird/bat activity (seasonally relevant). ■ Given the constraints in predicting bat fatality impacts prior to operation of the WF (see Table 8.48), it will be necessary to undertake further operational monitoring to	Insignificant* [*assuming operational controls implemented where necessary, based on monitoring outcomes]

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
							confirm operational impacts and to inform appropriate mitigation options. ■ Prepare an adaptive management plan to be informed by long-term annual bat/bird carcass monitoring, to determine where additional mitigation may be necessary for specific turbines/clusters of turbines, such as: adjusting turbine cut-in speeds (increased) for site-specific and seasonal bat activity peaks, feathering of turbine blades, auditory deterrents and/or painting of alternate turbine blades to increase visibility for birds. ■ Habitat enhancement for bats (e.g. creation of pools) and provision of bat-boxes in areas under IEAD control, may serve to reduce the number of bats in the wind farm area and therefore reduce collision risks.	
1e	**Bird & bat collisions with transmission lines or electrocution resulting in injury or mortality**	Bird & Bat species (VU)	Medium	Small	Minor	Operation	**Operation:** ■ Implement safe distribution lines, with insulation and spacing of conductors that eliminate electrocution risk for birds. ■ Allow for a minimum spacing of 1m between power cables to safeguard known bat species from electrocution risk. ■ Markers such as coloured balls to be attached to conductors to improve visibility for birds where necessary and technically feasible. ■ Installing flight diverters (hanging or spiral diverters) along all transmission line routes in the vicinity of natural forest habitat and between larger forest patches where birds are likely to move locally, with spacing	Insignificant* [*assuming operational controls implemented where necessary, based on monitoring outcomes]

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
							according to international good practice guidance (e.g. APLIC, 2012[1]). ■ Installing flight diverters along the entire transmission line length is unlikely to be feasible technically and financially, and in this case it is recommended that a more pragmatic approach, such as the approach taken by 'LIFE ENERGY'[2] in Slovakia's lowlands, whereby the most dangerous sections of TL are identified through field assistant monitoring and flight diverters installed ion the hazardous sections. ■ Provide deterrents at key positions along the transmission lines where visibility is poor and particularly where less disturbed, larger forest habitats are encountered (e.g. line markers / flight diverters at 15m intervals where hornbill activity has been recorded associated with Wet Evergreen Forest habitat). This will also be based on an adaptive management approach and implemented on a case-by-case basis for specific sections of powerline where high fauna mortalities due to collisions are recorded in long-term annual monitoring.	
1f	**Vehicular collisions with wildlife**	Animal Species (CR, EN)	High	Negligible	Minor	Construction Operation	**Pre-construction:** ■ Use existing access roads or upgrade existing roads wherever possible before considered new access road construction. ■ Shepherding protocol to be prepared and implemented where road construction takes place, to check areas to be worked in prior	Insignificant* [*assuming traffic controls implemented]

1 APLIC (Avian Power Line Interaction Committee), 2012. Reducing Avian Collisions with Power Lines: The State of the Art in 2012. Edison Electric Institute and APLIC. Washington, D.C.

2 LIFE ENERGY: Protecting birds from the dangers of power lines. Online article available at: https://www.cinea.ec.europa.eu/news-events/news/protecting-birds-dangers-power-lines-2021-09-01_en

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
							to construction and remove or shepherd wildlife to safety in adjoining forest or habitat. **Construction & Operation:** ■ Limit vehicle speed on site for construction vehicles and vehicles accessing the site (set speed limit at less than 15 km/hr). ■ Place appropriate limits on the number of vehicle movements to and from the wind farm (e.g. maximum of 5 vehicles allowed within a 1-hour window). ■ Restrict vehicles to the use of only authorised access roads. ■ Restrict activities to day time hours when visibility is good.	
1g	**Water and soil pollution caused by potential accidental spills of hazardous substance**	Habitat / Plant & Animal species	Medium	Small	Minor	Construction	**Construction:** ■ Employ best practice measures in handling and storing fuels, oils and chemicals liable to spillage. ■ Always use drip trays when temporarily storing or handling fuels or when servicing/repairing vehicles on site. ■ Pollution monitoring plan to be compiled and implemented, with a focus on watercourse monitoring. ■ Prepare an emergency spill response plan. Clean-up any spills immediately. ■ Emergency spill kit provision and training. ■ Remediate any soils, watercourses or habitats where spills take place. ■ Inform the relevant authorities as soon as any significant or major spill event takes place.	Insignificant* [*assuming controls implemented to limit risk of spills]

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
							■ Disposing of waste into the environment is prohibited. Waste products to be transported to registered waste facilities only for proper disposal. ■ Burial or burning of waste to be prohibited.	
1h	**Dust pollution caused by earthworks and vehicle/machinery operation**	Forest habitat / Plant species	Medium	Negligible	Insignificant	Construction	**Construction:** ■ Avoid earthworks during particularly windy periods. ■ Employ dust suppression on bare soil surfaces exposed to wind and dirt roads used by heavy construction vehicles. ■ Cover soil stockpiles during windy periods. ■ Use a cover/tarp when transporting soil/sand.	Insignificant* [*assuming controls implemented to limit risk of spills]
1i	**Soil erosion and sedimentation of watercourses**	Streams / Rivers	Medium	Small	Minor	Construction	**Pre-construction:** ■ Implement best practice stream crossing design and construction, taking into account the sizing of any pipe culverts and placement on the channel bed and not at height. This is to be informed by good practice guidelines for the design of river crossings, such as SEPA (2010[1]). ■ Compile an appropriate Construction Method Statement for working in watercourses (for implementation at all stream crossings). This is to be informed by	Insignificant [*assuming controls implemented to limit risk of erosion and sedimentation]

[1] SEPA: Scottish Environmental Protection Agency. (2010). Engineering in the Water Environment: Good Practice Guide: River Crossings. Second Edition. November 2010. Available online at: https://www.sepa.org.uk/media/ 151036/wat-sg-25.pdf

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
							good practice guidelines on construction methods, such as SEPA (2009[1]). ■ Compile a suitable post-construction rehabilitation plan for stream beds and banks modified but not entirely transformed by construction activities. **Construction:** ■ Implement relevant construction standards (e.g. 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites': publishing.service.gov.uk). ■ Cross streams at right-angles only. ■ Do not place more fill material within the stream channel than what is necessary. Remove any excess fill or material from the channel bed, taking care not to disturb the natural channel bed and bank profiles. ■ Only one stream crossing to be constructed at a time as the construction front progresses. ■ Avoid any unnecessary crossings of streams/rivers and stick to only the planned and agreed to crossings. ■ Any bare soil surfaces need to be revegetated as soon as practically possible to reduce erosion risk. ■ Install sufficient drainage works under all access roads, to reduce freshwater habitat fragmentation, avoid flooding land and damaging nearby waterbodies.	

[1] SEPA: Scottish Environmental Protection Agency. (2009). Engineering in the Water Environment: Good Practice Guide: Temporary Construction Methods. First Edition. March 2009. Available online at: https://www.sepa.org.uk/media/150997/wat_sg_29.pdf

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
1j	**Disturbance and nuisance caused by increased noise, light and/or vibrations**	Animal species	Medium	Small	Minor	Construction Operation	**Construction:** ■ Limit construction activities to day time hours to limit impacts to nocturnal species. ■ Maintain vehicles and equipment in good working condition. ■ Use noise minimizing technology where possible. ■ Aim lights away from forest habitats. ■ Utilize suitable screens to block visual impacts at construction camp sites. ■ Use low intensity lights where possible. ■ Enforce good conduct by construction workers, including prohibition of hunting, trapping, fishing, and general harassment of wild animals. **Operation:** ■ Enforce good behavior by employees, including prohibition of hunting, trapping, fishing, and general harassment of wild animals. ■ Use low intensity lights where possible.	Insignificant* [*assuming controls implemented to limit disturbance]
1k	**Barriers to or interference with species movement**	Animal species (CR, EN)	High	Small	Moderate	Construction Operation	**Pre-construction:** ■ Consider alternative wind farm layouts to minimise barriers to species movement. The alignment of turbines parallel to and not across known bird flight paths or general flight directions should be investigated. ■ Arrange turbines in clusters to reduce overall footprint. ■ Maintain connectivity around or across linear infrastructure (roads primarily) through use of appropriate animal crossings suitable for small mammals and slow-moving reptiles such as tortoises in particular.	Minor* [*assuming controls implemented

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
							■ Look at a single construction camp, sited in a least sensitive and already disturbed area and avoid developing multiple camp sites. ■ Use existing access roads or upgrade existing roads wherever possible before considered new access road construction. ■ Develop protocols for capturing or herding animals found in construction areas where these unable to exit by themselves. Species considered to be dangerous or poisonous/venomous to be handled by professionals. **Construction:** ■ Sequencing of construction activities to avoid construction activities and multiple teams at multiple sites, to reduce the impact spread and rather concentrate temporary impacts at key points and advance to new areas only once construction at the previous site has been completed. This can assist with permitting species movement and migrations in advance of the project activity moving to their habitat, preserving corridors at all times. ■ Avoid locating construction camps and material/equipment laydown areas within or near forest areas. ■ Any temporary excavations, fences or stockpiles of soil and materials must be removed from site once construction is complete. **Operation:** Avoid placing impermeable fences that could interfere with species movement.	

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
2a	**Increased susceptibility of forest habitat to disturbance**	Forest habitat / Plant species (EN)	Medium	Small	Minor	Operation	**Operation:** ■ Rehabilitate forest edges impacted and exposed to disturbance. *See mitigation measures recommended for impact 1a and impact 1b, above.*	Minor* [*assuming rehabilitation of disturbed areas]
2b	**Introduction of alien plant species and/or disturbance leading to invasion by alien plants and weeds**	Forest habitat / Plant species (EN)	High	Small	Moderate	Operation	**Operation:** ■ Compile a suitable Invasive Alien Plant (IAP) species control plan and programme to eradicate dense colonies of alien plants and control the spread of minor species and weeds. ■ Implement IAP species control plan and programme. ■ Monitor IAPs.	Minor* [*assuming IAP control plan implemented]
2c	**Reduced habitat connectivity caused by fragmentation of habitat**	Animal species (CR, EN)	High	Small	Moderate	Construction Operation	**Construction:** ■ See mitigation measures recommended for impact 1a and 1b above. ■ Rehabilitate degraded areas that were previously forest to re-connect patches of habitat. **Operation:** *See mitigation measures recommended for impact 1a and 1b above.*	Minor* [*assuming controls implemented to limit disturbance]
2d	**Loss of ecosystem services**	Forest habitat	Medium	Small	Minor	Construction Operation	**Construction & Operation:** *See mitigation measures recommended for impact 1a, 1b, 2a, 2b and 2c (above).*	Insignificant* [*assuming controls implemented to limit disturbance]
3a	**Increased hunting/harvesting pressure due to enhanced**	Animal species (CR, EN) / Plant	High	Small	Moderate	Construction Operation	**Construction:** ■ Most turbines are located in areas of existing disturbed landscapes and the design of the wind farm avoids more intact habitat blocks wherever possible. Eight	Moderate* [*assuming standard access controls and

No	Impact Description	Receptor	Biodiversity Importance / Sensitivity	Magnitude of Effect	Pre-mitigation Impact Significance	Project Phases	Mitigation Measures Recommended	Residual Impact
	accessibility to the area	species (EN)					turbines are located on the southern part of the Phou Koungking mountain and during road construction access to these sites from existing settlements and trails will be controlled through site security. ■ Construction workers will be prohibited from hunting or trading in wildlife and forest products, as part of their terms and conditions of employment and will be subject to security checks. **Operation:** ■ Implement access controls including the use of gates, security cameras and security guards at sites of key infrastructure such as substations and the main access roads to turbine clusters. ■ Undertake stakeholder consultation with local villagers regarding access to traditional trails and access to non-timber forest products but prohibiting illegal hunting of protected species.	security are successful at reducing access, but assuming no avoidance of more remote forest areas]

Noteworthy findings from the impact significance assessment include:

1. There will be moderately significant, permanent impacts to the natural forest vegetation communities and habitats, with indirect impacts on forest-dependent species. These may be difficult to mitigate unless the lesser disturbed forest communities are avoided entirely, and residual impact will remain of moderate significance.
2. Linear infrastructure (roads and transmission lines) are likely to have the most notable impacts on forests, particularly for the lesser impacted sections of more contiguous northern Montane Forest and the Wet Evergreen Forest areas in the north and north-east (associated with the planned transmission line alignment towards Vietnam).
3. The most significant impacts are likely to be associated with the access roads and turbines planned in the northern sections of the project area, where the less disturbed and more contiguous older-growth forest compartments have been identified.
4. Increased hunting/harvesting pressure due to enhanced efficiency of access to the area (induced impact) could still remain as moderately significant where access to more remote forest habitats is not avoided, even where controls on access are implemented.
5. All other impacts have been considered to be of Minor to Moderate significance and can be readily mitigated, potentially reducing significance levels to low or insignificant levels.

8.4.3.6 *Summary* of Impact Mitigation

The protection of natural ecosystems and biodiversity generally begins with the avoidance of adverse impacts and where such avoidance is not feasible; to apply appropriate mitigation in the form of reactive practical actions that minimizes or reduces impacts. Mitigation requires proactive planning that is enabled by following the '**mitigation hierarchy'**. The application of the mitigation hierarchy is intended firstly, to avoid disturbance and/or loss of ecosystems, and where this cannot be avoided, to minimise, rehabilitate, and then finally offset any remaining significant residual impacts. The mitigation hierarchy has been applied as follows:

- Mitigation aimed at the avoidance of impacts has already been considered, with a reduction in the number of turbines, efficient clustering of turbines and realignment of transmission lines and roads to avoid sensitive forest areas and KBAs undertaken where possible. This is documented in the preceding section and serves to reduce forest habitat loss significantly as well as avoiding impacts to key biodiversity as far as possible.
- Another avoidance measure considered is the potential avoidance of locating infrastructure within the particularly sensitive, less disturbed high elevation Montane Forest habitat on the ridgeline associated with Survey Block 4 (Phou Kounking). This is detailed in the Briefing Note to IEAD dated 11 March 2022.
- The engineers from Wind Pioneers ran an analysis and concluded that the relocation of the turbines would be detrimental to the overall feasibility of the project from the perspective of the proportional energy generation contribution from these particular WTs. The WTs in question are positioned in an area with sustained high wind velocities, making these the best performing of the entire WF project and critical to the feasibility and technical/financial success of the project. IEAD therefore considers it a necessity to retain the WT locations as relocating these will result in an estimated delivery of 30 to 99 GW below the expected energy generation to Vietnam as stipulated in IEAD's Power Purchase Agreement with EVN.
- Given the significant contribution the high elevation turbines within Survey Block 4 make to the viability of the Monsoon WF project, it has been demonstrated that avoidance of the area described will not be possible, and in this case minimization of impacts will need to be considered through micro-siting of turbines, control of access and agreement with local communities on sustainable access and use. Where infrastructure that is considered critical to the successful implementation of the project and realisation of its goals and objectives overlaps with more

ecologically important and sensitive forest habitats, there will be a greater contribution to residual impacts on forest habitat and targets required to meet a net positive (or at least no net loss) biodiversity outcome. This would also need to be taken into consideration from a long-term costs perspective.

- Avoidance of the Wet Evergreen Forest habitat in the north-east will not be possible entirely, as this large contiguous belt of vegetation runs along a roughly west to east corridor, which the proposed transmission line to Vietnam will need to traverse at some point. However, there appears to be more degraded forest habitat associated with the existing road through this forest unit, and it is therefore recommended that consideration be given to routing the power line as far as possible along the existing disturbed infrastructure corridor created by major road routes, rather than creating new corridors through undisturbed forest. By aligning roads and power lines with existing disturbances (such as existing roads/transport corridors), the project can minimize further impacts to forest habitat and species.
- Existing mitigation measures and controls (from the local EIA) are designed to reduce construction and operational phase impacts and these will be supplemented with the additional mitigation measures contained in the ESIA (***Table 8.49***), in order to minimize and remediate/rehabilitate impacts as far as possible. These measures will likely be the most easily implementable and successful in terms of reducing the significance of residual impacts for the following to relatively minor and acceptable levels:
    - Illegal hunting/poaching of wildlife,
    - Collision risk for birds/bats (wind turbines) and other wildlife (vehicular collisions),
    - Water and soil pollution,
    - Dust pollution,
    - Soil erosion and sedimentation,
    - Nuisance disturbance,
    - Forest disturbance,
    - Impacts to ecosystem services,
    - Invasive Alien Plant impacts, and
    - Reduced habitat connectivity.

Despite the avoidance of impacts through project design and realignment considerations and the recommendation of good practice controls and site-specific mitigation to reduce impact extent, potential and/or intensity, there are still residual impacts of moderate and major significance that are not easily mitigatable (see ***section 8.4.3.7***).

8.4.3.7 *Residual* Impacts to Biodiversity

Residual impacts of major significance that are likely to remain after other forms of mitigation have been considered (avoidance, minimization, and restoration) include:

1. Transformation or modification of areas of natural forest vegetation, providing key habitat for RDL forest-dependent species and considered ‘critical habitats’ (direct and indirect impacts); and
2. Loss of RDL species through increased hunting/harvesting pressure due to enhanced accessibility to the area (induced and cumulative impacts assessed).

That these impacts are likely to result in a net biodiversity loss unless adequately mitigated through an appropriate biodiversity compensation strategy.

Importantly, the mitigation of impacts needs to align with the requirements of the ADB SPS (2009) regarding ‘natural habitats’ and ‘critical habitats’, both of which are represented in the project area and will be affected to varying degrees:

1. **Natural Habitats**

"*In areas of natural habitat, 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.

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."

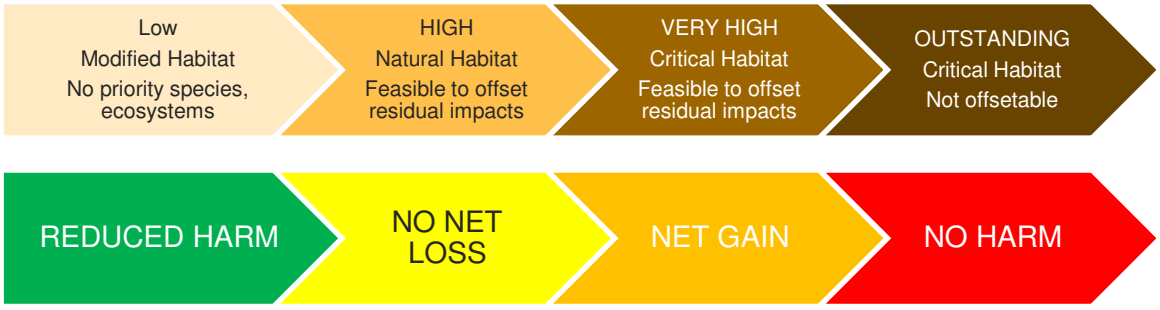
2. **Critical Habitats**

"*No project activity will be implemented in areas of critical habitat 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 species6 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."

Such goals may also depend on the biodiversity significance of the area. This is summarized in the graphic in ***Figure 8.57***.

Figure 8.57: Diagram illustrating the process of identifying, measuring and mitigating impacts to biodiversity towards achieving no net loss or net gain outcomes



Source: adapted from Benunn et al., 2021

Biodiversity offsets are typically required in certain situations to compensate for residual impacts to ecosystems and biodiversity, and only once all other forms of mitigation have been considered. Offsets are therefore normally only considered as the 'last resort option in the mitigation hierarchy'. The trigger for offsets is linked to the significance of residual negative impacts of development on biodiversity: where residual impacts are of high enough relative significance, offsets to compensate for biodiversity loss should be explored. Furthermore, the outcomes of the CHA (***Appendix G***) require that a Biodiversity Action Plan (BAP) be compiled to align with the ADB SPS and to include

options to offset residual impacts so as to achieve at the minimum a 'no net loss' or potentially a 'net gain' outcome in terms of biodiversity.

In terms of compensating for residual impacts, it is possible that a biodiversity offset could secure the necessary conservation gains required to ensure a net gain or at a minimum at no nett loss scenario for the project. Indeed, there is much opportunity in the local area to contribute to forest habitat and species conservation in a meaningful way. It is therefore recommended that an initial BAP be compiled and used to inform the development of a detailed offset plan and programme for implementation. Some initial ideas for the BAP and biodiversity offsetting that have been identified are follows:

- KfW Bank in collaboration with the World Wildlife Fund (WWF) are currently involved in several projects in Lao PDR, supported under the International Climate Initiative (IKI) of the Laos Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMU). Two forest corridors[110] have been identified in the Annamite Mountains region, with the objective of project work being to preserve species diversity and biodiversity through planned and focused conservation activities.
- To support its conservation objectives, WWF-Laos launched a Community-based Forest Restoration and Management for Livelihood programme[111], in partnership with Provincial Agriculture and Forestry Department (PAFO) of Sekong and Salavan province. The WWF-Laos Forest Programme aims at halting deforestation and ensuring Laos' forests are effectively protected or under improved management. The project looks not only at restoring and protecting forests and corridors, but also enhancing the income of the area's culturally diverse people who depend on forests for their livelihoods, through forest protection and sustainable use of forest resources and preserving the unique species diversity. One of the priority landscapes of WWF-Laos is the Central Annamites Landscape (CAL), covering southern Laos and part of Vietnam.
- There may be an opportunity for the Monsoon WF project to assist with financing or supporting these existing projects, programmes and already well-rooted conservation initiatives as a form of biodiversity offset mitigation.
- There may be key opportunities to support the existing Protected Area network, or local KBAs (Key Biodiversity Areas) which should be investigated further. Such an example could include working with the Lao PDR Ministry of Natural Resources and Environment (MoNRE) to create a protected area covering the mountain area in Survey Blocks 3 & 4, using the data collected for the Monsoon WF application to support such a designation.
- Habitat enhancement through restoring connectivity in areas suffering from high levels of fragmentation such as within the Dak Cheung KBA.
- Development of a sustainable timber and NTFP harvesting strategy.
- Implementing an Agroforestry support programme.

Initial comments received from the ADB support the general approach that offsets to compensate for biodiversity losses need to be additional, and not within existing conservation areas or overlapping existing initiatives (i.e. to avoid a 'double-dipping' scenario whereby the conservation gains from a site serve two or more purposes). Bearing this in mind then, the most logical way to offset forest habitat loss (which is the most significant direct impact of the project) is through an offset designed to restore key ecological linkages between the patchy forest cover in the vicinity of the project infrastructure,

[110] KfW, 2022. Accessible online at: https://www.kfw.de/stories/environment/nature-conservation/laos-forest-protection/

[111] WWF, 2022. Accessible online at: https://www.wwf.org.la/projects/forest_restoration_and_management_/

with a focus to restore larger, more contiguous areas of forest cover, which will also likely improve habitat availability and movement of fauna utilising the forests.

Initial estimates of anticipated natural forest habitat loss were undertaken to inform the impact assessment (based on anticipated WT locations, substation positions, access road widths and TL corridor widths), which were determined to be conservatively in the region of approx. 150 ha of natural forest loss for the project (see impact 1a in **Table 8.48**). This has been split also between the loss of Montane Forest and Wet Evergreen Forest, as follows:

- Preliminary estimated loss of natural Montane Forest habitat = 140 ha
- Preliminary estimated loss of natural Wet Evergreen Forest habitat = 10 ha

Given that Lao PDR do not have a national offset policy in place at the moment to guide the development of biodiversity offsets in the country, the approach taken by ERM for the 'Nam Ngiep 1 Hydropower Project Biodiversity Offset' (ERM, 2014[112]) was used to determine preliminary offset targets for the Project. This was based on the guidelines and methodology contained in the 'Biodiversity Offset Design Handbook' (BBOP, 2012)

The following no-net-loss biodiversity offset rules have been recommend for the project (in line with ERM, 2014 and BBOP, 2012):

- Offsets should be 'like-for-like' with trading only permitted within the same land class type;
  If this is not possible offsets should address the same features and habitats within the broader landscape area;
- Environmental contributions for specific programs can be used to substitute for the direct management of biodiversity;
- Incremental loss and fragmentation of biodiversity values is to be avoided;
- Management of offset sites can be used to improve biodiversity values, however this may not replace actions that are already funded;
- Areas with existing or potential land uses that are likely to be in conflict with the objectives of biodiversity offsets will need to be avoided (mining, forestry leases;
- Offsets to be located in close proximity to the impacted area as possible, such that the gains of offset mitigation are retained in the local area impacted and not transferred to elsewhere;
- Location of offsets in the landscape that facilitate connectivity with adjacent habitats are considered preferable;
- Large offset sites that are connected to existing protected areas are also seen as preferable;
- Also, sites similarly used by comparable ethnic groups sharing similar cultural values will be of preference;
- Fairness and equity should be ensured for affected stakeholders; and
- Offsets chosen should be permanent and ongoing in perpetuity.

Initially, the biodiversity offset metric used to calculate habitat targets has been based on the Habitat Hectare Equivalents model of BBOP (2012), which considers habitat type, extent and condition for both the impacted areas and candidate offset receiving sites with the residual habitat hectare loss calculated by multiplying loss extent by land condition value (see table below):

112 ERM, 2014. Nam Ngiep 1 Hydropower Project: Biodiversity Offset Design Report. Unpublished report prepared for the Nam Ngiep 1 Power Company Ltd. July 2014. Project no.: 0200749.

Habitat Type	Preliminary Estimated Loss (A)	Land Class Condition, Value (B)	Residual Impact Habitat Hectares (C = A x B)	Offset Target (habitat hectares)
Montane Forest	140 ha	High / natural, 0.8	**112 HH**	112 HH
Wet Evergreen Forest	10 ha	High / natural, 0.8	**8 HH**	8 HH

Given that active reforestation efforts and active management will increase the biodiversity values and condition of target, but with limited evidence of existing conservation management actions undertaken on offsets in Lao PDR, a conservative approach to predict likely gain in terrestrial biodiversity values has been used, based on the approach by ERM (2014). This suggests that gains in condition value relative to the existing value of the site prior to offset intervention, with sites with lower baseline condition likely to have a greater capacity for improvement (ERM, 2014). A conservative estimate of ~38% proportional improvement in condition over a 30-year period from low condition forest has been assumed for the project, based on ERM (2014) (see table below for offset gain calculations).

In order to achieve no net loss of biodiversity through the target of 112 habitat hectares (see table above), a minimum area of 235 ha of low value/poor condition forest will need to be rehabilitated and managed as part of the offset. The highly fragmented landscape associated with the Dak Chung KBA has been identified as a logical starting point for planning an offset, as the site is in close proximity to the impacted forest areas, such that the gains of offset mitigation are retained in the local area impacted and not transferred to elsewhere in the country. There may be key opportunities to support the existing Protected Area network, or local KBAs (Key Biodiversity Areas) which should be investigated further. Such an example could include working with the Lao PDR Ministry of Natural Resources and Environment (MoNRE) to create a protected area covering the mountain area in Survey Blocks 3 & 4, using the data collected for the Monsoon WF application to support such a designation. Rough estimates based on the habitat mapping and classification undertaken for the biodiversity baseline assessment, suggests that for the Dak Chung KBA alone (which has a total extent of 51 km^2 or 51 000 ha) the extent of degraded/low condition forest habitat could easily exceed 50% of the area, or equating to around 25 000 ha. To secure an area of approximately 400 ha which can result in a potential no net loss and evern net-gain in terrestrial biodiversity (see table below) should be relatively easy to achieve for this area alone, as this would be an estimated 1.5% of the Dak Chung KBA.

The target for Montane Forest habitat can therefore be quite readily achieved on dak Chung Plateau, but not for Wet Evergreen Forest. Therefore, a second site will be required to offset the comparatively far lower losses to Wet Evergreen Forest (10 ha, equating to 8 habitat hectare equivalents), with a possible location being the existing forest disturbance caused by the formal road located to the east of the TL in the north-eastern section where this affect Wet Evergreen Forest habitat. Forest restoration along a roughly 4-5 km stretch of road through Wet Evergreen Forest can potentially net a gain of 30 ha of forest. To meet a target of 8 habitat hectare equivalents (see table above) requires the rehabilitation and management of more than 30 ha of low condition forest of this type. The candidate 30 ha forest offset site associated with the road disturbance would net an estimated gain of 8.3 habitat hectare equivalents, which is potentially a no net loss of biodiversity outcome (see Table below).

Habitat Type	Candidate Offset Site Extent (A)	Base Condition Value (B)	Estimated Gain over 20-year period (20%) (C)	Gain Overall D = A x C	Target in habitat hectares / Target Met?
Montane Forest	410 ha	Low, 0.2	**+0.275**	112.8 HH	112 HH, target met
Wet Evergreen Forest	30 ha	Low, 0.2	**+0.275**	8.3 HH	8 HH, target met

As the final positions of WT's and access roads may change through micro-siting to avoid loss of natural forest, and TL corridors are also still to be finalised, the final loss calculations will need to be refined through a more detailed analysis in GIS. This will be used to inform final targets and to determine the proposed boundary of the biodiversity offset to meet targets and thus achieve at least a no net loss, possibly nett gain in biodiversity.

In addition, the following is recommended when developing the offset plan:

- Conservation outcomes are likely to be difficult to achieve without involving the local community. Community restoration / rehabilitation projects should be investigated such that the people who are most dependent on the forest resources in the area are the ones who also can benefit from the project;
- The 'Village Forest Management Planning Guideline' developed through the 'Climate Protection through Avoided Deforestation Project' (2016[113]) supports sustainable use, protection and restoration of village forests in Lao PDR, and may provide a useful reference and guidelines to support offset planning and community forest management;
- It is suggested that the relevant FSC (Forest Stewardship Council) guidelines, norms or standards that focus on natural forest management and impact mitigation be used, where appropriate, to inform the development of the BAP (most notably "FSC Principles and Criteria for Forest Stewardship" - FSC, 2015[114]); and
- Engagement of an appropriate delivery partner with a track record of supporting such biodiversity protection and rural poverty alleviation projects.

Since direct/indirect species impacts are unlikely to be significant for the project to warrant the need for offsetting, there will be no need for a specific species offset for the project. That being said, offsetting potential over-harvesting / over-hunting practises that may be induced by the project will require a different approach, focused more on averting loss of species through measures aimed at ensuring sustainable harvesting practices are followed and ensuring appropriate protection of offset sites from illegal activities.

The next step will therefore be to develop a Biodiversity Action Plan and Offset Strategy for the project, which will require initially that forest habitat losses be more accurately determined using GIS (as a proxy for biodiversity loss of habitat and species). This will first require details on road and corridor width, area of transformation associated with each wind turbine and power substation to be quantified as well as the finalisation of road and transmission line route alignments.

Final revised offset targets can then be determined based on the extent of habitat losses determined, using reasonable and appropriate (scientifically defensible) offset ratios/multipliers for the habitat type in question, which should reflect the ecosystem/habitat threat status and/or conservation/threat status of species likely to be affected. It will be important that cost estimates for implementing the biodiversity offset required to achieve no net biodiversity loss (at a minimum for the Project) be evaluated and understood by all stakeholders during offset planning process, from the perspective of initial costs and the anticipated long-term management of the offset (essentially in perpetuity or for as long the Project infrastructure remains).

[113] Climate Protection through Avoided Deforestation Project. (2016). Village Forest Management Planning Guideline. CliPAD-TC program, a technical cooperation between GIZ, KfW and Lao Government. January 2016. Available online at: https://www.giz.de/en/downloads/Village-Forest-Management-Planning-Guideline.pdf

[114] FSC (2015). Principles and Criteria for Forest Stewardship. Reference: FSC-STD-001 V5-2 EN. Available online at: https://www.fsc.org/en/document-centre/documents/resource/392