BPP Vinh Chau Wind Power Project, Vietnam

Environmental and Social Impact Assessment: Volume 3

BPP Vinh Chau Wind Power Limited Liability Company

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BPP Vinh Chau Wind Power Project, Vietnam

Environmental and Social Impact Assessment: Volume 3

Mark Watson
General Director

ERM Vietnam
7th Floor, Saigon Finance Centre
09 Dinh Tien Hoang, Dakao Ward
District 1, Ho Chi Minh City
Vietnam

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Acronyms and Abbreviations

Name	Description
AOI	Area of Influence
ASEAN	Association of Southeast Asian Nations
BaU	Business as Usual
CH4	Methane
CMS	Central Monitoring System
CO2	Carbon Dioxide
CSR	Compensation, Support and Resettlement
DMS	Detailed Measurement Survey
DoNRE	Department of Natural Resources and Environment
DWT	Deadweight tonnage
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement, and Construction
EPFIs	Equator Principle Financial Institutions
EPs	Equator Principles
ERM	Environmental Resources Management
ESIA	Environmental and Social Impact Assessment
ESMP	Environment and Social Management Plan, Health and Safety
FGD	Focused Group Discussion
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIIP	Good International Industry Practice
Hz	Hertz
IA	Impact Assessment
IFC	International Finance Corporation
IFC PS	International Finance Corporation – Performance Standard
IoL	Inventory of Loss
ISO	International Organisation for Standardisation
IUCN	International Union for Conservation of Nature
kg	Kilogram
km	Kilometre
kV	Kilovolt
LEP	Law on Environment Protection
m	Metre
m/s	Metre Per Second
m^2	Square metre
MoNRE	Ministry of Natural Resources and Environment
MW	Megawatt
N2O	Nitrous Oxide
NGO	Non-Governmental Organisation
NOx	Nitrogen Oxides
O&M	Operation and Maintenance
PAP	Project Affected People
PC	People's Committee
PM	Particulate Matter
RE	Renewable Energy
rpm	Revolutions Per Minute
SEA	Strategic Environmental Assessment
SOx	Sulphur Oxides
TL	Transmission Line

TSP	Total Suspended Particles
US$	United States Dollar
VOC	Volatile Organic Compounds
WTG	Wind Turbine Generator

9. ENVIRONMENTAL IMPACT ASSESSMENT

This chapter presents an assessment of impacts for key environmental aspects identified during the scoping process (see Chapter 5). The impact assessment (IA) method is described in Chapter 4. The outcomes of the assessment will inform the development of the Environmental and Social Management Plan (ESMP), which will be used for the implementation and management of potential impacts to acceptable levels.

9.1 Air Quality Impact

9.1.1 Summary of Scope of Assessment

The assessment of potential air quality impacts associated with the Project considers:

- Sources, nature and quantity of emissions to air;
- A qualitative assessment of preparation and construction phase impacts;
- An assessment of potential impacts on relevant air sensitive receptors (ASR) and ambient air quality in the study area; and
- Mitigation measures to reduce the impacts where necessary.

Activities causing the potential impacts to air quality and stakeholders, who are identified as receptors of the impacts, are listed in Table 9-1.

Key impacts of the Project to ambient air quality are mainly caused by preparation and construction activities. Potential impact during the operation phase is minor and was scoped out in Chapter 5. The processes and activities that will result in emissions to air to be considered include:

- On site earthworks, clearing of land, material handling, stockpiling, vehicle use on unpaved surfaces, and construction of the main infrastructure;
- Operation of associated facilities such as the batching plant;
- The use of diesel powered vehicles and equipment; and
- Transportation of wind turbines, equipment, workers and material.

9.1.2 Relevant Guidelines and Criteria

9.1.2.1 Vietnamese Regulations

- Circular No.16/2009/TT-BTNMT dated October 7, 2009 of Ministry of Natural Resources and Environment on guiding the implementation of National Technical Regulations on Environmental Protection;
- QCVN 05:2013/BTNMT - National Technical Regulation on Ambient Air Quality; and
- QCVN 06:2009/BTNMT - National Technical Regulation on Hazardous Substances in Ambient Air.

9.1.2.2 International Guidelines

- IFC Performance Standard 3: Resource Efficiency and Pollution Prevention requires the Project to consider ambient conditions and apply technically and financially feasible resource efficiency and pollution prevention principles and techniques that are best suited to avoid, or where avoidance is not possible, minimise adverse impacts on human health and the environment; and
- IFC General EHS Guidelines (Section 1.1, 2007): Air Emissions and Ambient Air Quality contains common techniques for emission management that can be applied to a range of industry sectors.

The guideline provides suggested approaches for the management of potentially significant emission sources and includes specific guidance for monitoring and assessment of impacts.

Table 9-1 Scope of Air Quality Impact Assessment (AQIA)

Phases	Potential Activities	Potential Impacts	Potential Consequences	Receptor
Preparation and Construction	On site earthworks, clearing of land, material handling, stockpiling, vehicle use on unpaved surfaces, and construction of the main infrastructure.	Adverse effect on ambient air quality and human health due to the mechanical generation of coarse dust particles (2.5 - 20 µm) distributed by wind. Dust deposition and/or visible dust plumes can cause nuisance, affecting local amenities and quality of life.	■ Annoyance and nuisance to the general public as a result of dust deposition on properties, dwellings, cultural heritage sites and places of business; ■ Increased effects of morbidity/ reduced health due to exposure to dust and exhaust emissions.	■ Nearby residents ■ Construction workers
	Exhaust emissions from non-road mobile machinery (NRMM) and on-site vehicles.	Adverse effect on ambient air quality and human health from exhaust emissions comprising NO_x, NO_2, CO, SO_2, PM_{10} and $PM_{2.5}$.		
	Exhaust emissions from vehicles on the public highway.	Adverse effect on ambient air quality and human health from exhaust emissions comprising NOx, NO_2, CO, SO_2, PM_{10} and $PM_{2.5}$.		
	Transportation of equipment, workers and materials, including on unpaved access road.	Adverse effect on ambient air quality and human health due to the mechanical generation of coarse dust particles (2.5 - 20 µm) distributed by wind. Dust deposition and/or visible dust plumes can cause nuisance affecting local amenities and quality of life.		

9.1.3 Assessment of Impacts

9.1.3.1.1 Potential impact

Construction phase activities including ground excavation, material transfer, material stockpiling, and construction of the main infrastructure including the power plant and associated facilities have the potential to generate TSP and particulate matter (PM_{10}). The main impacts that may arise from construction activities included in the scope of the AQIA include:

- Increased dust (e.g. PM_{10}) from ground preparation, work sites and material / equipment transportation; and
- Exhaust emissions (e.g. CO, NO_X) from movement and operation of construction vehicles, machinery and other heavy equipment such as bulldozers, excavators, compactors and back-up diesel generator.

Emissions to air during the construction phase can vary substantially and will largely depend on the activity being undertaken, the duration of the activity, the size of the site, the meteorological conditions, the proximity and sensitivity of the ASR, and the adequacy of the mitigation measures in place to reduce emissions.

9.1.3.1.2 Existing Controls

The mitigation measures identified in the locally approved regulatory EIA include:

- Vehicles and machine should have a valid operation certificate provided by the Vietnam Register Department;
- Transport vehicles should be fully covered to prevent scattering materials to the roads;
- Water should be sprayed on the construction site and along the transport roads regularly;
- Fences should be installed around the construction areas to reduce dust dispersion in a large area;
- Concrete mixture should to be placed at least 200 m from the office or residential area; and
- Trees should be planted around the Project area to offset emissions generated by the plant.

9.1.3.1.3 Significance of Impacts

The Institute of Air Quality Management (IAQM)[1] screening criteria states that a detailed assessment will normally be required where there is:

- A human receptor within:
  - 350 m of the boundary of the site; or
  - 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).
- An ecological receptor within:
  - 50 m of the boundary of the site; or
  - 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

The scoping study and aerial imagery of the site suggests that there are residential areas and sensitive social receptors such as schools and spiritual sites located in the vicinity of the Project site. In addition to this, there are a number of households living within the Project's boundaries. A detailed assessment is therefore presented below.

[1] Institute of Air Quality Management Guidance, https://iaqm.co.uk/guidance/

9.1.3.1.3.1 Determining the Magnitude of the Impact

Methodology

The IAQM defines the dust emission magnitude based on the scale of the anticipated works. The criteria for estimating the magnitude of dust impacts from demolition[2], earthworks[3], construction[4] and track-out[5] as per the IAQM guidance note is presented in Table 9-2 and is used to inform the impact assessment.

Table 9-2: Dust Emission Magnitude

Activity	Impact Magnitude		
	Small	**Medium**	**Large**
Demolition	Total building volume <20,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10 m above ground, demolition during wetter months.	Total building volume 20,000 m^3 – 50,000 m^3, potentially dusty construction material, demolition activities 10-20 m above ground level.	Total building volume >50,000 m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >20 m above ground level.
Earthworks	Total site area <2,500 m^2, soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4 m in height, total material moved <20,000 tonnes, earthworks during wetter months.	Total site area 2,500 m^2 – 10,000 m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4 m - 8 m in height, total material moved 20,000 tonnes – 100,000 tonnes.	Total site area >10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8 m in height, total material moved >100,000 tonnes.
Construction	Total building volume <25,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber).	Total building volume 25,000m^3 – 100,000m^3, potentially dusty construction material (e.g. concrete), on site concrete batching.	Total building volume >100,000 m^3, on site concrete batching, sandblasting.
Track-out	<10 HDV (>3.5 t) outward movements in any one day, surface material with low potential for dust release, unpaved road length <50 m.	10-50 HDV (>3.5 t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 m – 100 m.	>50 HDV (>3.5 t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m.

[2] Demolition is any activity involved with the removal of an existing structure (or structures). This may also be referred to as de-construction, specifically when a building is to be removed a small part at a time.

[3] Earthworks covers the processes of soil-stripping, ground-levelling, excavation and landscaping.

[4] Construction is any activity involved with the provision of a new structure (or structures), its modification or refurbishment. A structure will include a residential dwelling, office building, retail outlet, road, etc.

[5] Track-out is the transport of dust and dirt from the construction/demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the network. This arises when heavy duty vehicles (HDVs) leave the construction/demolition site with dusty materials, which may then spill onto the road, and/or when HDVs transfer dust and dirt onto the road having travelled over muddy ground on site.

Assessment

According to the FS report and regulatory EIA of the Project, the total amount of soil excavation required for the Project in Phase 1 is estimated to be about 1,766 m^3 with an embankment amount of 792 m^3. This will be distributed scattered among seven wind turbine locations. The total amount of soil to be dug for the transmission line tower measures approximately 5,981 m^3. Therefore, according to the magnitude level defined in Table 9-2, the magnitude of impact for dust generation is considered as **small**.

9.1.3.1.3.2 Determining the Sensitivity of the Area

Methodology

The IAQM defines the sensitivity of the area based on receptor type and the number of receptors within a certain distance from the source. Residential properties, schools, and hospitals are classified as high sensitivity to dust soiling and health effects. Locations where there are particularly important plant species (i.e. rice paddy) are classified as medium sensitivity. The criteria for estimating the sensitivity of the area as per IAQM guidance is presented in Table 9-3, Table 9-4 and Table 5-4. The guidance provides a screening criterion of 350 m and 50 m from the construction site and access road respectively, beyond which impacts are not considered likely.

Table 9-3: Criteria for Assessing the Sensitivity of the Area to Dust Soiling Effects on People and Property

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Note: For track-out the distances should be measured from the side of the roads used by construction traffic. Without site specific mitigation, track-out may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider track-out impacts up to 50 m from the edge of the road.

Table 9-4: Criteria for Assessing the Sensitivity of the Area to Human Health Impacts

Receptor Sensitivity	Annual Mean PM_{10} concentration	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	>32 µg/m^3	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32 µg/m^3	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28 µg/m^3	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24 µg/m^3	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>32 µg/m^3	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	28-32 µg/m^3	>10	Medium	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	24-28 µg/m^3	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
	<24 µg/m^3	>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Low	-	>=1	Low	Low	Low	Low	Low

Note: For track-out the distances should be measured from the side of the roads used by construction traffic. Without site specific mitigation, track-out may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider track-out impacts up to 50 m from the edge of the road.

Table 9-5: Criteria for Assessing the Sensitivity of the Area to Ecological Impacts

Sensitivity of the Area	Distance from the Source (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Assessment

The scoping study identified that there are a number of potential sensitive receptors in the vicinity of the Project area that may be impacted by dust and air emissions from the Project's construction activities, including:

- Residential area, schools, spiritual sites which are located about 500 – 700 m from the nearest wind turbine. According to criteria defined in Table 9-3 and Table 9-4, the sensitivity of human health and property are **Low**.

- Some households living within the Project boundary. The closest house to a wind turbines and transmission line tower is estimated to be about 50 m - 100 m away. Due to the small amount of excavation work and the number of households living within a 50 m radius of the wind turbines and transmission line tower, the sensitivity of human health and property for these receptors are **Medium**.
- A mangrove site at the coastal area near the Project site, which is located about 500 m to the closest wind turbine. According to the criteria defined in Table 9-5, the sensitivity of this mangrove site due to air impacts of the Project is **Low**.

9.1.3.1.3.3 Impact Significance

The assessment has indicated that the impacts to air quality from Project construction activities are expected to be localised, periodic, and temporary, occurring over approximately 12 months of the construction phase. Therefore, the impact magnitude is considered **Small**. The overall significance of air impact during construction phase of the Project is illustrated in Table 9-6.

Table 9-6 Impact on Air Quality during Construction Phase

Impact	Impact on air quality due to emissions (dust and gaseous pollutants) from construction				
Impact Nature	**Negative**	Positive	Neutral		
	Increased dust and gaseous pollutants are considered **Negative**.				
Impact Type	**Direct**	Indirect	Induced		
	Nearby residential areas are **directly** impacted by increased dust and gaseous pollutants.				
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
	Impacts are **temporary** and only present when stated activities are ongoing during the construction phase. The construction is expected to take approximately 12 months.				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area and the immediate surroundings.				
Impact Scale	The impact scale is **Small** due to the relatively small fraction of the resource likely to be impacted.				
Impact Frequency	Air quality impacts are **continuous** for short periods (e.g. land preparation activities), though there will be continuous impacts for longer periods for some activities, such as the operation of the concrete batching plant.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	The impact magnitude is **Small**.				
Vulnerability of Receptors	Low	**Medium**	High		
	Residential areas, construction workers and farm houses near the Project area may be inadvertently affected.				
Significance	Negligible	**Minor**	Moderate	Major	
	The significance is **Minor.**				

9.1.3.1.3.4 Additional Mitigation and Management Measures

The following additional mitigations measures are based on ESIA requirements to minimise impacts associated with air emissions:

- Develop and implement a Traffic Management Plan to reduce the impacts of dust and emissions from transport vehicles;
- Cover construction material trucks during transportation;

- Control the speed limit of trucks and other vehicles, so as not to exceed 10 km/hr within the Project's boundaries;
- Areas of construction, stockpile areas and other exposed soils should be designated as such in order to minimise vehicle movements over these areas;
- No open burning on the construction site. If required, cleared vegetation should be transferred to competent non-hazardous waste disposal contractors, composted or reused for stabilisation purposes.

9.1.3.1.3.5 Monitoring and Auditing

Records of vehicle maintenance, dust control activities and regular inspection on site should be recorded.

9.1.3.1.3.6 Residual Impact

With the implementation of the above mitigation measures, the residual impacts are expected to be **Negligible**.

9.2 Noise Impacts

9.2.1 Summary of Scope of Assessment

The key features of the Project that are likely to cause elevated noise and vibration include:

During the construction phase:

- Land preparation and civil works such as land clearance, demolition, earthworks;
- Substation, transmission line and laydown area construction;
- Operation of associated facilities such as the batching plant; and
- Transportation of equipment, workers and materials.

During the operation phase:

The key features of the Project that are likely to cause elevated noise during the operational phase are the WTGs and substation. The cumulative noise levels from the Project's WTGs together with operational WTGs on neighbouring wind farms were also assessed.

9.2.2 Relevant Guidelines and Criteria

9.2.2.1 Vietnamese Regulations

- QCVN 26:2010/BNTMT: National Technical Regulation on Noise - Permissible Exposure Levels of Noise in the Workplace; and
- QCVN 27:2010/BTNMT: National Technical Regulation on Vibration.

9.2.2.2 International Guidelines

- International Organization for Standardization (ISO) 9613-2:1996 (ISO 9613:2) - *Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2: General Method of Calculation*;
- IFC Performance Standard 3: Resource Efficiency and Pollution Prevention requires the Project to consider ambient conditions and apply technically and financially feasible resource efficiency and pollution prevention principles and techniques that are best suited to avoid, or where avoidance is not possible, minimise adverse impacts on human health and the environment;

- IFC General EHS Guidelines (Section 1.7, 2007): Noise provides recommended ambient noise level and control measures and;
- IFC Environmental Health and Safety Guidelines for Wind Energy (2015) provides EHS guidelines for onshore and offshore wind energy facilities. It covers environmental impacts and provides associated recommendations for mitigation measures in the areas of noise and visual impact, biodiversity, water quality, shadow flicker, etc.

Table 9-7 Scope of Noise Impact Assessment

Phases	Potential Activities	Potential Impacts	Potential Consequences	Receptor
Construction (onshore wind farm and substation activities)	Land preparation and civil works such as land clearance, demolition, earthworks	■ Short-term increase in noise levels	■ Potential consequences to human health can vary, depending on other factors such as noise level, human health conditions and age. ■ Some studies showed that noise exposure had associated with hearing loss (ADLWD 2019), tinnitus, hypertension, vasoconstriction and other cardiovascular adverse effects (University of California 2019), changes in immune system and birth effects (Passchier 2000). ■ Chronic noise exposure can cause in sleep disturbances and increased rate of diabetes.	■ Nearby residents ■ Construction workers
	Substation, transmission line and laydown area construction			
	Operation of associated facilities such as the batching plant			
	Transportation of equipment, workers and materials			
Operation (onshore wind farm and substation activities)	The WTGs and the onshore substation will be sources of noise during the operation of the Project	■ Long-term increase in noise levels		

9.2.3 Assessment of Impacts

9.2.3.1 Construction Phase

Potential impact

The following sources of impact were identified:

- Site preparation and building construction works associated any permanent facilities;
- Construction and installation of the internal electrical network (between turbines) and any associated transmission lines; and
- Construction works associated with internal access roads.

Potential consequences to human health can vary, depending on other factors such as noise level, human health conditions and age. Some studies showed that noise exposure was associated with hearing loss (ADLWD 2019), tinnitus, hypertension, vasoconstriction and other cardiovascular adverse effects (University of California 2019), changes in immune system and birth effects (Passchier 2000). Chronic noise exposure can cause sleep disturbances and increased rates of diabetes.

Existing Controls

The mitigation measures identified in the locally approved regulatory EIA include:

Construction Phase

- Construction activities will be scheduled so as to avoid night time periods. No noisy activities will be undertaken at night;
- Planning will be undertaken to reduce the number of construction equipment operating at any one time, where possible;
- A reasonable construction plan will be prepared to shorten the construction time;
- Boarding around the Project worksites will be installed right from the beginning of the construction phase to limit noise and dust emissions from the Project to the surrounding area;
- Large sources of noise such as concrete mixing plants, mobile equipment, generators, etc., will be located at appropriate locations within the worksite, as far away from the receptors as possible; and
- Methods and devices that generate low noise and vibrations will be used.

Significance of Impacts

Table 9-8 Impacts on Noise during Construction Phase

Impact	Disturbance and potential health impact			
Impact Nature	**Negative**	Positive	Neutral	
	Disturbances and potential health impacts are considered **Negative**.			
Impact Type	**Direct**	Indirect	Induced	
	Exposure to noise causes **direct** disturbance and potential health impacts.			
Impact Duration	Temporary	**Short-term**	Long-term	Permanent
	The impact duration is **Short-term.**			
Impact Extent	**Local**	Regional	Global	
	Impacts are within the Project area.			

Impact Frequency	Construction noise will be generated during works and are not anticipated to occur continuously for entire daytime, evening or night time periods. As such, impact frequency is expected to be intermittent over approximately 12 months of the construction period.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	The impact magnitude is **Small**.				
Vulnerability of Receptors	Low	**Medium**	High		
	The identified receptors are mostly residential in nature, and they may be more vulnerable in the night time due to sleep disturbance impacts, than during the day time when most of the construction works will typically be carried out. The overall vulnerability is therefore **Medium**.				
Significance	Negligible	**Minor**	Moderate	Major	
	The significance is **Minor.**				

Additional Mitigation and Management Measures

The following additional mitigations measures are based on ESIA requirements to minimise impacts associated with noise:

- During construction of the Project, good-practice construction noise mitigation and management measures should be implemented to reduce noise levels and minimise any impacts as far as practicable. A range of mitigation and management measures are available and those that are considered feasible, reasonable and practical to implement for specific tasks should be considered, for example:
  - Avoid unnecessary noise due to idling diesel engines and fast engine speeds when lower speeds are sufficient;
  - Ensure all machines used on the site are in good condition, with particular emphasis on exhaust silencers, covers on engines and transmissions and squeaking or rattling components. Excessively noisy machines should be repaired or removed from the site; and/or
  - Ensure that all plant, equipment and vehicles movements are optimised in a forward direction to avoid triggering motion alarms that are typically required when these items are used in reverse.
- During the construction design, choose appropriate machines for each task and adopt efficient work practices to minimise the total construction period and the number of noise sources on the site. Select the quietest item of plant available where options that suit the design permit.
- High noise generating construction works and activities should be limited to the IFC daytime period (7AM to 10PM), and work should be avoided on Sundays or public holidays if possible.
- Any works that are required during the IFC night time period (10PM to 7AM) should be justified and task-specific noise mitigation and management measures should be implemented to reduce noise impacts to acceptable levels. These additional measures should consider the potential for sleep disturbance impacts that could occur during the night time period due to “peak” or “maximum” noise level events e.g. metal on metal contact, or general clangs and bangs.
- Works associated with transmission line and access road construction often require activities in closer proximity to receptors that are not affected by construction works at wind turbines, or permanent facilities. In these circumstances task-specific noise mitigation and management measures should be implemented (when works are close to receptors) to reduce noise impacts to acceptable levels.
- Construction road traffic and heavy vehicle movements have the potential to generate “peak” or “maximum” noise level events and these should be limited during the night time period, and avoided

if possible. Where possible, significant noise generating vehicle movements should be limited to the daytime period. Where it is not possible for this to occur drivers should be instructed to arrive and depart as quietly as possible. Whilst on-site and in close proximity to receptors the drivers should be instructed to implement good-practice noise management measures to reduce peak noise levels and minimise any impacts as far as practicable. During the works, instruct drivers to travel directly to site and avoid any extended periods of engine idling at or near residential areas, especially at night.

- If any validated noise complaints are received, the problem source and any potential noise reducing measures should be identified and evaluated for implementation during the works. If the noise complaint cannot be validated, no further mitigation or management measures are required.

Monitoring and Auditing

No additional noise monitoring during construction is recommended.

Residual Impact

With the implementation of the above mitigation measures, the residual impacts would be expected to be **Negligible.**

9.2.3.2 Operation Phase

Potential Impact

The WTGs and substation will be sources of noise during the operation of the Project. As described below, noise impacts from WTG (and substation) emissions are limited to one of the 543 receptors assessed.

The worst-case noise impact from the BPP Project Wind Farm has been predicted for receptors in NCA1 and NCA2, where operational levels of 52 dBA and 54 dBA have been predicted at receptors MH158 and MH77 respectively. Receptors in NCA1 and NCA2 have been assessed to be the most affected as they are the closest to the BPP Project. These are the worst-case emissions and levels vary depending on wind speed. At receptor MH158 the predicted cumulative noise levels from the Phase 1 and/or Phase 1 to 3 operations (and nearby Bac Lieu project) were marginally (1 dBA) above the wind speed-based noise limits. At this receptor there is only 0.1 dBA difference in predicted noise levels for Phase 1 or Phase 1 to 3 operations, due to its close proximity to and subsequent influence of Phase 1 turbines. Differences in noise levels of less than approximately 2 dBA are generally imperceptible in practice, an increase of 2 dBA is hardly perceivable. Given this and the very localised noise issue at MH158, recommendations for noise reducing mitigation are not warranted. Recommendations for, management measures, safeguards and/or provisions for monitoring are however necessary and have been provided below.

Predicted cumulative noise levels from the BPP Project Wind Farm and Bac Lieu project were below the compliance limits at all other representative receptors. The predicted noise levels of the BPP Project at receptors in NCA3 and NCA4 much lower than NCA1/2 and are well below the compliance limits. The worst-case predicted noise levels are at SS12, SS9, SS11 and SS13 are 38 dBA, 39 dBA, 29 dBA and 27 dBA respectively.

Impacts from the BPP Project substation were minimal and did not substantially influence compliance. For this reason, impacts have not been assessed separately. Impacts from the Bac Lieu project were minimal and did not influence compliance at any receptor and again for this reason impacts have not been assessed separately.

Potential nuisance impacts to humans are associated with impulsive or tonal characteristics of noise emitted from the wind farm. Similar to construction noise impacts, potential consequences to human health due to chronic exposure can vary depending on noise level, existing human health conditions and age.

Existing Controls

The mitigation measures identified in the locally approved regulatory EIA include:

- The Siemens SG 4.5-145 WTGs to be installed for the Project are low noise generating turbines.

Significance of Impacts

Table 9-9 Impacts on Noise during Operation Phase

Impact	Disturbance and potential health impact				
Impact Nature	**Negative**	Positive	Neutral		
	Disturbance and potential health impacts are considered **Negative**.				
Impact Type	**Direct**	Indirect	Induced		
	Exposure to noise causes **direct** disturbance and potential health impacts.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	The impact duration is **Long-Term** during the Project lifetime**.**				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area.				
Impact Frequency	While operational noise levels may occur intermittently or continuously depending on wind conditions and WTG operations, disturbance and potential health impacts are not likely to occur as operational noise levels are predicted to be only marginally above (1 dBA) or below the compliance limits.				
Impact Magnitude	Positive	**Negligible**	Small	Medium	Large
	The impact magnitude is **Negligible**.				
Vulnerability of Receptors	Low	**Medium**	High		
	The vulnerability of receptor is **Medium** as explained above.				
Significance	**Negligible**	Minor	Moderate	Major	
	The significance is **Negligible.**				

Additional Mitigation and Management Measures

The following safeguards are provided:

- **Prior to operation:** if the turbine selection and/or layout are to be changed, and noise levels are anticipated to increase, then compliance with the noise limits documented in this report would need to be reassessed.
- **During operation:**
  - If the turbines change, and noise levels are anticipated to increase, then compliance with the noise limits documented in this report would need to be reassessed.
  - Routine maintenance of wind turbines should also be conducted, with specific attention to equipment degradation that may cause further noise impacts. Any equipment that is abnormally noisy should be evaluated and repaired as necessary to return emissions to typical operating performance.

Monitoring and Auditing

It is recommended that if any repeated/validated noise complaints are received then compliance monitoring should be undertaken at the most affected receptors in NCA1 and NCA2 (MH158 as a minimum) to confirm predicted noise levels. Where noise monitoring occurs the work should be scoped

and then conducted by a suitably experienced person. The purpose of the monitoring is to understand in-situ levels and to provide a comparison to predicted levels (from this ESIA) so that any additional controls be identified and then implemented if it is feasible, reasonable and practical to do so. If this is required:

- All Project / site noise levels should be measured in the absence of any influential source not associated with the Project.
- If the measured site noise levels are below the predicted values and comply with the applicable thresholds, limits or criteria identified for each noise aspect, no further noise control is required.
- If the measured site noise levels are above the predicted noise levels or the applicable thresholds, limits or criteria identified for each noise aspect, further noise control should be considered.

If levels are measured to be above the applicable noise limits then use of Noise Reduction System (NRS) operational modes should be considered where exceedances exist from WTG noise. Details on NRS modes can be found in the Siemens Gamesa Developer Package SG 4.5-145(2018).

Residual Impact

The residual impacts associated with noise from the operation of the Project WTGs and substation are considered negligible.

9.3 Freshwater Quality

9.3.1 Summary of Scope of Assessment

Activities causing potential impacts to freshwater quality and stakeholders who are identified as receptors of the impacts are all listed in Table 9-10.

- Construction Activities:
  - Land preparation and civil works;
  - Wind turbine foundations, substation, transmission line, laydown area and office construction;
  - Operation of associated facilities such as the concrete batching plant;
  - Waste and wastewater management from construction activities and workers' activities; and
  - Hazardous storage and handling.
- Operation Activities: In the operation phase, a key source of impact on water quality will be domestic wastewater from operation staff. Given that there will be only 10 staff working at the wind farm in operation phase, the amount of sewage and its impact will be minor and therefore was scoped out.

9.3.2 Relevant Guidelines and Criteria

9.3.2.1 Vietnamese Regulations

- Circular No.16/2009/TT-BTNMT dated October 7, 2009 of Ministry of Natural Resources and Environment on guiding the implementation of National Technical Regulations on Environmental Protection;
- QCVN 08:2015/BTNMT - National Technical Regulation on Surface Water Quality;
- QCVN 09-MT:2015/BTNMT - National Technical Regulation on Groundwater Quality;
- QCVN 14:2008/BTNMT - National Technical Regulation on Domestic Wastewater Discharge;
- Decree No. 149/2004/ND-CP: Government Decree on Regulation on Licensing of Water Resources Exploitation, Extraction and Utilisation and Wastewater Discharge in Water Sources; and
- Decree No. 67/2003 regarding Environmental Protection Fees and Charges for Wastewater.

9.3.2.2 International Guidelines

- IFC Performance Standard 3: Resource Efficiency and Pollution Prevention requires the Project to consider ambient conditions and apply technically and financially feasible resource efficiency and pollution prevention principles and techniques that are best suited to avoid, or where avoidance is not possible, minimise adverse impacts on human health and the environment;
- IFC Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources recognises that protecting and conserving biodiversity, maintaining ecosystem services and sustainably managing living natural resources are fundamental to sustainable development;
- IFC General EHS Guidelines (Section 1.3, 2007): Wastewater and Ambient Water Quality contains guidelines for projects that discharge process water, wastewater from utility operations or storm water to the environment. The guidelines provide suggested approaches for the management of wastewater, including water conservation, wastewater treatment, storm water management and wastewater and water quality monitoring;

- IFC General EHS Guidelines (Section 1.4, 2007): Water Conservation contains general recommendations for water conservation programs, water monitoring and management programs and process water reuse and recycling; and
- IFC General EHS Guidelines (Section 4.0, 2007): Construction and Decommissioning provides specific guidance on prevention and control of community health and safety impacts that may occur during new project development. It covers various aspects of the environment, including noise and vibration, soil erosion, air quality, solid waste, hazardous materials, wastewater discharge, etc. It also covers occupational and community health and safety.

Table 9-10 Scope of Freshwater Quality Impact Assessment

Phases	Potential Activities	Potential Impacts	Potential Consequences	Receptors
Construction	Land preparation and civil works	■ Increased turbidity due to sediment washed into fresh water bodies; ■ Increased contaminants washed / seeped into fresh water bodies; and ■ Waste discharged from construction activities.	■ Pollution of freshwater sources that are used for activities such as drinking, irrigation, fishing and maintenance of aquaculture farms; and ■ Freshwater aquatic life could be affected due to increased turbidity and pollution.	Locals that are dependent on bodies of fresh water. Freshwater aquatic flora and fauna.
	Turbine foundations, substation, transmission line, laydown area and office construction			
	Operation of associated facilities such as the concrete batching plant			
	Waste and wastewater management from construction activities and from workers' activities			
	Hazardous storage and handling			

9.3.3 Assessment of Impacts

9.3.3.1 Construction Phase - Pollution of Freshwater (Turbidity and Discharge)

Potential Impacts

- Increased turbidity due to sediment washed into fresh water bodies;
- Increased contaminants washed / seeped into fresh water bodies; and
- Waste discharged from construction activities

Existing Controls

The mitigation measures for nearshore construction and waste management identified in the locally approved regulatory EIA include:

- Construction waste (i.e. stone, sand) will not be dumped into the water source. These types of waste are used for levelling purposes only, the rest is collected and transported to the designated area.
- Disposal of household waste from worker camp and site into water sources is prohibited. Domestic waste will be collected, transported and handled by the local waste collection team.
- There will be six portable toilets arranged to collect workers' waste water.
- An urban environmental company will be hired to collect waste on a periodic basis of every two months; and
- Internal rules and activities will be established for environmental protection, including regarding the littering and disposal of waste.

Significance of Impacts

Table 9-11 Impacts on Freshwater Quality during Construction Phase

Impact	Impact on freshwater quality due to onshore construction activities				
Impact Nature	**Negative**	Positive	Neutral		
	Increased pollution of freshwater quality is considered **Negative**				
Impact Type	**Direct**	Indirect	Induced		
	Pollution in fresh water sources directly affect locals who are dependent on fresh water bodies.				
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
	The impact duration is **Short-term** and only present when stated activities are ongoing during the construction phase. Onshore activities, including the renewal of access roads and construction of the transmission line, will take approximately 16 months.				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area and its immediate surroundings.				
Impact Scale	The impact scale is **Small** due to the relatively small fraction of the resource likely to be impacted.				
Impact Frequency	The impacts are **continuous** during nearshore construction activities.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	The impact magnitude is **Small**.				

Vulnerability of Receptors	Low	**Medium**	High	
	The vulnerability of receptors is **Medium** as pollution of water resources will affect those locals that use fresh water bodies for activities such as drinking and irrigation.			
Significance	Negligible	**Minor**	Moderate	Major
	The significance is **Moderate.**			

Additional Mitigation and Management Measures

The following additional mitigation measures are based on ESIA requirements to minimise impacts associated with freshwater quality:

- Select appropriate methods and equipment to reduce disturbances (e.g. turbidity, oil leakages, contaminants etc.) to fresh water; and
- Supervise implementation of proposed mitigation measures by Contractors.

Monitoring and Auditing

No additional specific monitoring or auditing is recommended.

Residual Impact

With the implementation of the above mitigation measures, the residual impacts are anticipated to be **Negligible**.

9.4 Biodiversity Impacts

In accordance with IFC PS1 and PS6, the impact assessment process aims to predict and assess potentially adverse impacts and risks to biodiversity values due to the existence of the Project, in either its contruction or operation phase. The direct and indirect Project-related impacts are based on the baseline studies which have been documented in Volume 2. The key objectives of this section comprise:

- Defining and conducting impact analysis to assess the extent and complexity of potential adverse impacts;
- Developing mitigation measures to avoid and minimise potential adverse impacts to biodiversity, with a priority given to impacts on features of significant biodiversity value; and
- Determining significant residual impacts after implementing mitigation measures need to be considered.

9.4.1 Summary of Scope of Assessment

According to the baseline data presented in Volume 2, Project activities could possibly cause adverse impacts on avifauna as well as terrestrial flora. The assessment includes potential impacts within the EAA, including both natural and modified habitats. Additionally, Table 9-12 generally defines the potential threats to biodiversity values that are likely to occur as a result of Project activities. These threats to biodiversity are derived from IFC PS6 and relate to the activities that are likely to occur during construction and operation phases.

Table 9-12 Potential Threats to Biodiversity Values

Term	Description
Habitat Loss *Loss of terrestrial at footprint of transmission line infrastructure and turbines*	■ Permanent loss of habitat or species due to permanent or temporary site activities.
Disturbance or displacement *Disturbance or displacement of individuals from light; noise and/or vibration impacts*	■ Disturbance to, or displacement/exclusion of a species from foraging habitat due to construction activities, and operation and maintenance activities. ■ Impacts from light, noise and vibration sources on in vicinityhabitats causing disturbance and displacement and changes in behaviour.
Barrier creation and edge effects	■ Creation of barriers to the movements of avifauna and plants with limited powers of dispersal because of the transmission line. ■ Impacts that occur when a habitat is exposed to a different adjacent habitat type or structure. These impacts can include increased risk of parasitism or disease, increased risk of predation, adverse microclimate conditions (including drying out and subsequent fire risk), and competition from invasive species.
Degradation *Degradation of habitat from dust; water pollution; or invasive species*	■ Disturbance or damage to adjacent habitat and species caused by changes in microclimate, vulnerability to predation and invasion and overall changes in conditions that can lead to a change in the community and its values for flora and fauna. This can include increased exposure to noise, light and dust. ■ Introduction or spreading of alien species during the construction works.
Mortality *Mortality – vehicle strike, hunting and poaching, transmission line, turbine strike*	■ Mortality of individual fauna species as a result of vehicle or machinery strike or falling debris during clearing activities. ■ Mortality to individual fauna species as a result of worker influx and hunting/poaching of extant fauna. ■ Mortality due to collision and electrocution with transmission line.

Table 9-13 scopes likely impacts during the construction and operation phases of the Project. The impact assessment for these impact types are further assessed in subsequent sections.

Table 9-13 Scoping of Potential Impacts during Project Phases

Impact	Construction Phase	Operation Phase
Habitat loss	Yes	Continuing from construction phase
Disturbance or displacement	Yes	Reassessed for operation phase
Barrier creation and edge effects	Yes	Continuing from construction phase
Degradation	Yes	Continuing from construction phase
Mortality	Yes	Reassessed for operation phase (birds and bats)

Note:
***Yes**: considered to be likely impacts during the phase.*
***No**: considered to be no impacts or negligible impacts during the phase.*
***Continuing from construction phase**: impact is likely to continue from the construction phase and the mitigations outlined are appropriate to manage impacts during construction, operation.*
***Reassessed for operation phase**: impact is likely to be different during the phase and hence is reassessed based on the likely impacts. Additional mitigations may be outlined to apply to this phase.*

9.4.2 Relevant Guidelines and Criteria

9.4.2.1 Vietnamese Regulations

- The Law on Environmental Protection (LEP) No. 55/2014/QH13 dated June 23, 2014 is the main piece of environmental legislation currently in force for the local regulatory EIA;
- The Law on Forest Protection and Development No. 29/2004/QH11 dated December 3, 2004 on the management, protection, development and use of forests; and forest owners' rights and obligations;
- Decree No. 99/2010/ND-CP dated September 24, 2010 on the policy on payment for forest environment services;
- Decree No. 23/2006/ND-CP dated March 3, 2006 on the implementation of the Law on Forest Protection and Development;
- Decree No. 18/2015/ND-CP and No. 19/2015/ND-CP dated February 14, 2015 on environmental protection planning, strategic environmental assessment, environmental impact assessment and environmental protection plans;
- Decree No. 06/2019/ND-CP dated January 22, 2019 of the Government on the management of endangered, precious and rare forest plants and animals and implementation of the Convention of International Trade in Endangered Species of Wild Fauna and Flora; and
- The Law of Biodiversity No. 20/2008/QH12 dated November 13, 2008 on biodiversity conservation and sustainable development.

9.4.2.2 International Guidelines

- IFC Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources recognises that protecting and conserving biodiversity, maintaining ecosystem services and sustainably managing living natural resources are fundamental to sustainable development;

Vietnam has also ratified several international conventions including:

- UNEP Convention on Conservation of Biological Diversity (CBD), ratified in 1994;
- CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), an international agreement between governments which aims to ensure international trade in specimens of wild animals and plants does not threaten their survival. This came into force in Vietnam in 1994; and
- RAMSAR (the Convention on Wetlands of International Importance), an intergovernmental treaty providing the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. This came into force in Vietnam in 1989.

9.4.3 Impact Assessment Criteria

So as to assess the significance of impacts due to the Project before and after mitigation, the following IA matrices have been used to classify the severity of impacts. The matrix for habitat classification is presented in Table 9-14, while Table 9-15 defines the criteria that will be used to evaluate the significance of the impacted species. The matrices outline the sensitivity of the receptors based on IFC PS6 thresholds and the magnitude of effect, which is based on changes to ecological conditions due to the Project.

Table 9-14 Habitat Impact Assessment – Significance Criteria

Habitat Sensitivity/Value		Magnitude of Effect			
		Negligible	**Small**	**Medium**	**Large**
		Effect is within the normal range of variation	Affects a small area of habitat, but without the loss of viability/function of the habitat	Affects a sufficient proportion of the habitat to the extent 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.	Affects the entire habitat or a significant proportion of the habitat to the extent that the viability/function of the entire habitat is reduced and the long-term viability of the habitat and the species dependent on it are threatened.
Low	Habitats with no or local designation/ recognition; habitats of significance for species of Least Concern (LC); habitats which are common and widespread within the region.	Negligible	Negligible	Minor	Moderate
Medium	Habitats within nationally designated or recognised areas; habitats of significant importance to globally Vulnerable (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; nationally threatened or unique ecosystems.	Negligible	Minor	Moderate	Major
High	Habitats within internationally designated or recognised areas; habitats of importance to globally Critically Endangered (CR) or Endangered species (EN); habitats of importance to endemic and/or globally restricted-range species; habitats supporting globally significant concentrations of migratory species and/ or congregatory species; highly threatened and/or unique ecosystems, areas associated with key evolutionary species.	Negligible	Moderate	Major	Major

Table 9-15 Species Impact Assessment – Significance Criteria

Species Sensitivity/Value		Magnitude of Effect			
		Negligible	**Small**	**Medium**	**Large**
		Effect is within the normal range of variation.	Affects a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself	Affects a sufficient proportion of a species population that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long-term viability of that population or any population dependent on it.	Affects an entire population or species at sufficient scale to cause a substantial decline in abundance and/or change in distribution beyond with natural recruitment (reproduction, immigration from unaffected areas) so that that it may not return that population or species, or any population or species dependent upon it, to its former level within several generations, or when there is no possibility of recovery.
Low	Species which are included on the IUCN Red List of Threatened Species as Least Concern (LC).	Negligible	Negligible	Minor	Moderate
Medium	Species included on the IUCN Red List of Threatened Species as Vulnerable (VU), Near Threatened (NT) or Data Deficient (DD). Species protected under national legislation. Nationally restricted range species. Nationally important number of migratory or congregatory species.	Negligible	Minor	Moderate	Major
High	Species included on the IUCN Red List of Threatened Species as Critically Endangered (CR) or Endangered (EN). Species having a globally Restricted Range (i.e. plants endemic to a site or found globally at fewer than 10 sites, fauna having a distribution range (or globally breeding range for bird species) of less than 50,000 km^2. Internationally important numbers of migratory or congregatory species. Key evolutionary species.	Negligible	Moderate	Major	Major

9.4.4 Impact Assessment

9.4.4.1 Mortality - Birds

Potential Impacts

Impacts on avifauna from construction activities are anticipated to be minor so no further assessment has been conducted for the construction phase. The key impacts are mainly due to hunting and poaching by the workforce, and collision with vehicles. Based on the results of the field surveys and interviews, local people do not hunt or poach fauna but there is some risk that construction workers do this. This will be assessed in more detail in the following section.

On the other hand, the transportation route of the wind turbines from Cai Cui Port to the Project site will pass through mostly residential areas, thus the probability of fauna impact due to collision with vehicles is likely to not be significant and is scoped out.

The key potential impacts from the operation of the Project's wind turbine generators on mortality of avifauna during the operation phase encompass:

- Collision and electrocution of avifauna with the transmission line; and
- Collision of avifauna with turbines.

Potential Consequences

- Reduced populations, particularly of long-lived, slow-reproducing species and wide-ranging or migratory species; and
- Loss or extinction of terrestrial fauna, especial species listed in the IUCN Red List;

Significance of Impacts

The majority of bird fatalities which could occur due to the operation of the windfarm is due to collision, hunting and poaching, thus this part of the ESIA concentrates on collision-risk assessment. The significance of avifauna collision with turbines during the operation phase (Table 9-16) is considered **minor.**

Bird mortality is considered a likely result of hunting and poaching by labour forces during construction phase, since there is a mangrove area located near to the Project which comprises various habitats for a range of species, especially birds and mammals. However, there are no species identified as Critically Endangered (CR) or Endangered (EN). Furthermore, this kind of impact can be prevented through the implementation of appropriate policy by the client, thus this impact is considered **minor.**

Fatality rates due to collision risk generally depends on the characteristics of the wind turbines and the presence of artificial light sources at or near the turbine. Flight heights and bird traffic need to be taken into consideration when evaluating mortality due to substantial risk collision of avifauna with wind turbines.

The Rotor swept zone (RSZ) traverses the height of 25 m to 175 m vertically, thus it is likely that the highest risk of collision of avifauna and wind turbines takes place in band 2 (35 -150 m). As indicated by the results of the field survey, flights within band 1 (<35 m) account for 83 percent and 93 percent of total recorded flight times in the dry and wet season respectively; flights in band 2 (35-150 m) account for just a small amount. Therefore there is a low density of species active in the RSZ which are likely to collide with wind turbines, and this is considered to be of low risk.

With respect to flock size, the field survey indicated a small number of individuals in flock during both wet and dry seasons. Flocking behaviour was observed in phase 1 of the Project[6] location (vantage point V3), with an average number of observed birds (flock size) of 7.7 (±SE=0.88). The flock size relates to the abundance, distribution and bird flux over the migration period. A smaller flock size means a lower collision risk.

As for conservation species, the results of the field survey indicated that the birds that generally flew at the height of 35 m-150 m (band 2), which coincided with the RSZ, are listed as Near Threaten and Least Concern in IUCN Redlist. These species include Eurasian Curlew *Numenius arquata* [IUCN NT], Little Cormorant *Microcarbo niger* [IUCN LC], Grey Heron [IUCN LC], Little egret *Egretta garzetta* [IUCN LC], Chinese pond heron *Ardeola bacchus* [IUCN LC], Black-shoulder kite *Elanus caeruleus* [IUCN LC], Edible-net swiftlet *Aerodramus fuciphagus* [IUCN LC], Common tern *Sterna hirundo* [IUCN LC], Black-wing stilt *Himantopus himantopus* [IUCN LC], Black-crowned Night-heron *Nycticorax nycticorax* [IUCN LC], and Oriental darter *Anhinga melanogaster* [IUCN LC; VN RB VU].

The prevailing weather conditions generally influence the collision probability. Specifically, collision risk will be higher during the monsoon season when wind speed is low enough to allow a small number of seabirds to forage near wind turbines, or to fly higher than 35 m. In the dry season, the wind may be too strong for most bird species to fly out to the open sea, or to fly at high attitudes, thus it is likely there will be lower collision rates in this season. Migrating birds generally arrive in flocks during the wintering period, however this behaviour was not observed during the field surveys. Migrating birds were observed to generally fly below the RSZ.

Collision and electrocution at power lines pose a threat to avian fauna and mortality can have significant population-level impacts. Power line collisions occur when birds fly into the wires; electrocutions occur at poles when a bird completes a circuit by touching two energized parts or an energized and grounded part[7].

Transmission line collision risk may arise due to limited-visual ability of birds. A very wide visual field may compromise the capacity of most birds to detect obstacles in the air. Almost all birds do not have the ability to estimate the distance to a specific object due to the lateral position of the eyes, and that frontal binocular vision is important to birds only when it comes to controlling the bill and spotting close objects[8]. Nonetheless, the impact magnitude of this effect is anticipated as **negligible** or **minor** due to small-scale flock sizes, low density of species and because there is no species affected considered to be of conservation significance.

In terms of electrocution, power poles in flat landscapes lacking trees are particularly attractive to birds to use as perches[9], which creates a greater risk of electrocution. However, there is a mangrove area located in the Project's proximity which bird species are more likely to utilise for perching than the power poles. In addition to this, there is a low density of bird populations so it is highly unlikely that any species would be forced to use power poles. Consequently, the risk of electrocution mortality is regarded as **minor.**

Table 9-16 Bird Mortality Impact Assessment

[6] The investment license for this phase was issued by the Soc Trang Province People's Committee on 21 May 2019. A regulatory EIA of the Project for Phase 1 was prepared in accordance with the Vietnamese National Regulation on Environmental Protection and was approved by the Soc Trang Department of Natural Resources and Environment on 1 August 2019.

[7] Loss, S. R., Will, T., & Marra, P. P. (2014). Refining estimates of bird collision and electrocution mortality at power lines in the United States. PLoS One, 9(7).

[8] Bernardino, J., Bevanger, K., Barrientos, R., Dwyer, J. F., Marques, A. T., Martins, R. C., ... & Moreira, F. (2018). Bird collisions with power lines: State of the art and priority areas for research. Biological Conservation, 222, 1-13.

[9] Lehman RN, Kennedy PL, Savidge JA (2007) The state of the art in raptor electrocution research: A global review. Biol Conserv 136: 159–174.

Impact Type	**Direct**	Indirect	Induced		
	These impacts relate to collision risk of the transmission line and turbines.				
Impact Extent	**Local**	Regional	International		
	Impacts are restricted to the location of the transmission line and 21 wind turbines.				
Impact Duration	Temporary	Short-term	**Long-term**		
	These impacts relate to collision risk during the construction and operation of the transmission line and turbines, thus the impacts are long-term.				
Impact Frequency	The transmission line and turbines will be operational 24 hours a day. Impact frequency is expected to be intermittent over the operation phase. However, the likelihood of occurrence, and thus collision, of substantial numbers of species is low because of the relatively small footprint of the Project compared to the extent of occurrences (EOOs).				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	As parts of the habitat of these species will be impacted by the wind turbines posing a collision risk, the collision risk should be assessed. However, as the likelihood of collision for a substantial portion of populations is low, it may affect a small proportion of the populations but does not substantially affect other species dependent on them, or the populations of the species themselves.				
Receptor Sensitivity	Low	**Medium**	High		
	Species include one Near Threatened species (Eurasian Curlew *Numenius arquata*) and other Least Concern species listed in the IUCN Redlist.				
Impact Significance	Negligible	**Minor**	Moderate	Major	

Existing Controls

According to the regulatory EIA, these mitigation and management measures were proposed:

- Establish Passive Acoustic Monitoring (PAM);
- 30-minute observation before starting works; and
- 20-minute period of Cut-in.

Additional Mitigation and Management Measures

The following mitigation measures will be applied during the construction phase:

- Hunting and poaching will be prohibited for Project staff, workers, all contractors and personnel engaged in or associated with the Project, with penalties levied, including fines and dismissal, and prosecution under the relevant laws for clearing vegetation.

The following mitigation measures will be applied during the operation phase:

- Limit the operation of turbines when winds are not sufficient; eliminate “free-wheeling” (free spinning of rotors under low wind conditions when turbines are not generating power);
- Avoid artificial light sources if possible, especially steady or slow blinking lights. White and stable light can attract insects and predatory birds to the area. If lights are used, use red or white blinking or pulsing lights; timers, motion sensors, or downward-hooded lights will be utilised to help to reduce light pollution;
- Consider installing bird flight diversion on transmission lines to reduce collision if necessary;
- Ensure power towers and transmission lines meet safety standards to minimise risk of electric shock to birds and bats;

- Use bird deflectors on the length of the power line. Deflectors increase line visibility by thickening the appearance of the line for easier detection by avifauna;
- Minimise the vertical spread of power lines. Having lines in a horizontal plane reduces collision risk; and
- Manipulate the habitat to influence flight activity and bird behaviour, e.g. place tree lines under high voltage lines to increase visibility.

Monitoring and Auditing

Supervise the implementation of anti-hunting and poaching policy for all labour forces frequently: daily during construction phase and quarterly during operation phase.

Significance of Residual Impact

A collision risk assessment may be required to further quantify the significance of impact to birds. In general, mitigation measures are designed to reduce the occurrence of collision. With the implementation of existing controls and additional mitigation measures, the impact significance is expected to be **Minor**.

9.4.4.2 Mortality – Bats

Potential Impact

During the construction phase bat fatality may occur due to vehicle or machinery strike. However, bats found within the Project area and its proximity do not fly a large distance, thus the impacts of vehicle or machinery strikes may not happen or if so, will rarely happen, thus this impact will be scoped out.

Key potential impacts from the operation of WTGs on bat mortality during operation phase include:

- Collision and electrocution of bats with the transmission line; and
- Collision of bats with turbines.

Potential Consequence

- Reduced populations, particularly of long-lived, slow-reproducing species and wide-ranging or migratory species
- Loss or extinction of terrestrial fauna, especial species listed in the IUCN Red List

Significance of Impact

As with Section 9.4.4.1, collision-risk assessment will be evaluated as the key factor causing high mortality rates. The operation of wind turbines also may also cause barotrauma for bats but these impacts are considered negligible.

The risk of turbine collision impact on bats has been assessed using a species-based risk assessment informed by species ecology and biology. Based on available information on the 43 bat species that may occur within the Project Area and its proximity, the risk of turbine impact on each species was evaluated and is presented in Table 9-17 below. Bat species that may occur in the Project Area and its vicinity are small-bodied species that are unlikely to fly far in the open sea against strong wind. Since all Project turbines will be located offshore, the impact generally decreases.

It was ascertained through both a desktop study and field survey that three high-risk bat species exist within the Project Area, including the Common bent-wing bat *Miniopterus schreibersii* [IUCN NT], Lyle's flying fox *Pteropus lylei* [IUCN VU], and Large flying fox *Pteropus vampyrus* [IUCN NT]. The remaining bat species are listed as LC in the IUCN Red-list. The Common bent-wing bat *Miniopterus schreibersii* can reach a height of up to 2,600 m, and forages in a variety of open and semi-open natural and artificial habitats including suburban areas. The Common bent-wing bat feeds mainly on moths and occasionally

on flies. It is a colonial species that roosts mostly in caves and mines; in winter, it hibernates in underground sites. Lyle's flying fox *Pteropus lylei* possibly inhabits mangrove area, glides up to 1,370 m and feeds in orchards. In terms of the Large flying fox *Pteropus vampyrus,* the elevation of this fruit bat ranges from 0-1,250 m. This tree roosting species is tolerant to some habitat disturbance; it occurs in primary, and secondary forest and uses adjacent agricultural areas for feeding.

The three species therefore do not forage at sea and hence would not fly through the Project's RSZ. However, the diet of the Common bent-wing bat *Miniopterus schreibersii* [IUCN NT] consists of insects such as flies, which are easily attracted to lighting from wind turbines, thus potential negative impacts on this particular bat species need to be considered. Individuals may, from time to time, travel along the shoreline between habitat patches to forage. Bat fauna however are unlikely to be encountered 1.5 km offshore and near to the proposed wind turbines.

The significance of bat collision with the turbines (Table 9-18) is considered to be **minor.**

Table 9-17 Results of Species-based Risk Assessment Matrix

	Risk of Turbine Impact		
Factor	**Low risk**	**Medium Risk**	**High Risk**
Habitat preference	Bats preferring cluttered habitat	Bats able to exploit background cluttered space	Bats preferring open habitat
Echolocation characteristics	Short range High frequency Low intensity Detection distance ~15m	Intermediate – more plastic in their echolocation	Long range Low frequency High intensity Detection distance ~80m
Wing shape	Long wing loading Low aspect ratio Broadest wing	Intermediate	High wing loading High aspect ratio Narrow wings
Flight speed	Slow	Medium	Fast
Flight behaviour and use of landscape	Manoeuvres well Will travel in cluttered habitat Keeps close to vegetation Gaps may be avoided	Some flexibility	Less able to manoeuvre May avoid clustered habitat Aerial hawker Feeds in open habitat
Migration	Local or regional movements	Regional migrant in some parts of range	Long-range migrant in some parts of range
Species or taxa that match at least one criterion	*Hipposideros cineraceus* *Hipposideros pomona* *Cynopterus brachyotis* *Cynopterus sphinx* *Eonycteris spelaea* *Macroglossus minimus* *Macroglossus sobrinus* *Megaerops niphanae* *Myotis horfieldii*	*Hipposideros armiger* *Hipposideros diadema* *Hipposideros galeritus* *Hipposideros larvatus* *Megaderma lyra* *Megaderma spasma* *Rhinolophus acuminatus* *Rhinolophus affinis* *Rhinolophus microglobosus*	*Taphozous longimanus* *Taphozous melanopogon* *Taphozous theobaldi* *Miniopterus magnater* *Pipistrellus coromandra* *Pipistrellus javanicus* *Pipistrellus tenuis* *Scotophilus kuhlii* *Myotis hasseltii*

	Risk of Turbine Impact		
Factor	**Low risk**	**Medium Risk**	**High Risk**
	Pteropus hypomelanus *Pteropus vampyrus* *Pteropus lylei* *Rousettus amplexicaudatus* *Rousettus leschenaultii* *Rhinolophus malayanus* *Rhinolophus stheno* *Kerivoula hardwickii* *Kerivoula picta* *Murina cyclotis* *Miniopterus schreibersii* *Tylonycteris pachypus* *Glischropus tylopus* *Tylonycteris robustula*	*Myotis horsfieldii* *Myotis muricola*	
	Total: 23 species	Total: 11 species	Total: 9 species

Table 9-18 Bat Collision Impact Assessment

Impact Type	**Direct**	Indirect	Induced		
	These impacts relate directly to collision risk of the turbines.				
Impact Extent	**Local**	Regional	International		
	Impacts are restricted to the location of the transmission line and 21 wind turbines.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	These impacts are related to the collision risk during the construction and operation of the transmission line and turbines, and are therefore long-term.				
Impact Frequency	The transmission line and turbines will be operational 24 hours a day. Impact frequency is expected to be intermittent over the operation phase.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	There are a small number of potential roost features, of low quality. It may affect a small proportion of populations, but does not substantially affect other species dependent on them, or the populations of the species themselves.				
Receptor Sensitivity	Low	**Medium**	High		
	The species identified are listed as NT/ VU in IUCN Red List and are most likely to forage over terrestrial areas.				
Impact Significance	Negligible	**Minor**	Moderate	Major	

Existing Controls

According to the regulatory EIA, these mitigation and management measures for bat collision were proposed:

- Establish PAM;
- 30-minute observation before starting works; and
- 20 minutes period of Cut-in.

Additional Mitigation and Management Measures

To ensure that the impacts of the Project on bat species are of an acceptable level, the following mitigation measures are proposed:

- Limit the operation of the turbines when winds are not sufficient; eliminate “free-wheeling” (free spinning of rotors under low wind conditions when turbines are not generating power).
- Habitat modification measures are to be used within the shoreline adjacent to the Project area to introduce deterrents and reduce bat foraging opportunities. These measures are to include:
  - Ensuring all-night lighting of turbines consists of LED lights (LED lights may deter some bat genera) (Spoelstra et al., 2017[10]); and
  - Using lights that have low ultraviolet wavelengths both onshore and offshore (this reduces insect congregations around lights that bats typically forage on).

Monitoring and Auditing

Adaptive management is to occur in relation to managing impacts on bat populations. Ongoing monitoring is recommended to refine the understanding of bat utilisation of the Project area and efficacy

[10] Spoelstra, K. et al. (2017). Response of bats to light with different spectra: light-shy and agile bat presence is affected by white and green, but not red light. *Proceedings of the Royal Society B: Biological Sciences, 284*(1855), 20170075. doi: 10.1098/rspb.2017.0075

of the recommended mitigation strategies during operations. If conservation significant species are detected or monitoring indicates particular turbines have a higher strike risk, additional mitigation measures are to be considered and/or implemented. A suitably qualified ecologist is to be employed to undertake the monitoring and advise on the adaptive management strategy.

Significance of Residual Impact

The residual impact significance is likely to be **negligible**.

9.4.4.3 Habitat Loss

Potential Impacts

The current habitat area will be occupied by infrastructure. Particular factors that could negativively affect the habitat area include:

- Tree/ land clearance; and
- Construction of new facilities.

Potential Consequences

- Loss of habitat within the Project area and its vicinity could occur; and
- It could negatively affect the density of bats in the vicinity.

Significance of Impacts

The geospatial assessment undertaken to define natural habitat and modified habitat has classified the majority of the terrestrial portion of the Project Area as modified habitat. It is noted that the mangroves (natural habitat), are located outside of the Project area. The field survey identified 15 mangrove species of conservation concern. Of which, there is one (1) species *Ceriops decandra* listed as a Near-threatened species in IUCN Red-List and 14 other species listed as Least Concern in the IUCN Red-List. Therefore, the Project may have a limited impact on that habitat's loss of vegetation.

Due to the substation being located in modified area, only construction of the transmission line may lead to the permanent-direct loss of habitat within the footprint of the transmission line towers (0.266 ha). The vegetation area that will be affected within the Right of Way (ROW) comprises 6822.4 m^2 of perennial crop area and 5816.6 m^2 of annual crop land[11], both of which are considered to be modified habitat. As the vegetation within the ROW will be cleared, it is not considered to be substantial. Only the locations of the transmission line tower footings, access road and any laydown areas will be cleared of vegetation during the construction phase. The areas that will be occupied by laydown areas and access roads are 1.616 ha and 6.245 ha respectively. However, the laydown areas and access roads will utilise land which is used by local people and is considered as modified habitat, thus no natural habitat will be adversely effected.

There is mangrove area located in the proximity of the Project area, thus birds species can utilise this area to roost and forage during the winter period. There is a sea dike (2-3m height) along the Project area dividing the Project site and mangrove separately, thus clearance of area is unlikely to adversely affect the roosting and foraging sites of birds. In addition, no roosting or foraging habitat for migratory birds is present within the Project area, although Important Bird Areas (IBAs) including Bac Lieu, Bac Lieu Sanctuary, Lung Ngoc Hoang National Park, Tra Cuu Important Birds Area, and Chua Hang Important Area are nearby (18 – 45 km away). Given that these IBAs are not contiguous habitats with the Project area, impacts on habitats associated with these IBAs are considered unlikely to occur and the Project area is not expected to play an important role in maintaining the value of the IBAs for biodiversity.

[11] EIA, 2019

Some bird species are likely to fly through the Project area to forage, so some disturbance to flight behaviour is possible and may occur during construction and operation (see impact assessment for disturbance in Section 9.4.4.4), but no direct impact to species populations and habitat is expected due to the Project.

With respect to the four bat roosting sites (as confirmed in field survey), impacts can be considered negligible. Of these sites, the No Pol Pagoda had three *Cynopterus sphinx* [IUCN LC] species roosting under palm trees; the Riddhi Muni Sakor Dom Thnots Pagoda had 12 *Cynopterus sphinx* species; and Sluice Gate No. 8 had the *Myotis muricola* [IUCN LC] and *Taphozous theobaldi* [IUCN LC]. Three roosting sites were located nearby to the Project area, at around a 200 m distance from the Project's boundaries (except for one roosting site in Sluice Gate No.8 which is within the Project area) but all roosting places were in modified habitat. The majority of bat species were classified as "no large-bodied flying fox, feeding on fruits with long-distance movements of up to 50 m", thus the magnitude of impact is expected to be negligible as the impact is within the normal range of variation in terms of habitat loss.

Disturbance effects will be assessed in Section 9.4.4.4

Table 9-19 Loss of Terrestrial Habitat Impact Assessment

Impact Type	**Direct**	Indirect	Induced		
	The existence of the Project's footprint directly replaces terrestrial habitat.				
Impact Extent	**Local**	Regional	International		
	Impacts on terrestrial habitat are localised.				
Impact Duration	**Temporary**	Short-term	Long-term		
	The footprint of the transmission line towers and substation will result in a permanent loss of habitat, as well as temporary laydown areas causing temporary loss of habitat.				
Impact Frequency	The impact is considered a one-off event.				
Impact Magnitude	Positive	**Negligible**	Small	Medium	Large
	The footprint of habitat loss is approximately 0.09 km^2 within the terrestrial area for the ROW, substation and access roads. The area of natural habitat loss due to the presence of transmission line, substation and access roads is not significant since the majority of the Project's footprint passes through modified areas.				
Receptor Sensitivity	Low	**Medium**	High		
	The species identified are listed as NT/ VU and LC in the IUCN Red List and are most likely to forage over terrestrial areas.				
Impact Significance	**Negligible**	Minor	Moderate	Major	

Existing Controls

Existing controls were identified to mitigate this impact in the locally approved regulatory EIA and include:

- Minimising unnecessary clearance of plants where the area is outside of ROW and power poles.

Additional Mitigation and Management Measures

The following mitigation measures will be applied during construction and continue during operation if necessary:

- The laydown areas will not be located within natural habitat area;
- Where possible, transmission line tower footings will be located outside natural habitat;
- Clearing vegetation outside of designated areas will be prohibited for Project staff, workers, all contractors and personnel engaged in or associated with the Project, with penalties levied, including fines and dismissal, and prosecution under the relevant laws for clearing vegetation;

- The planned vegetation clearance area for the construction works shall be clearly identified and marked to avoid accidental clearing;
- The Project owner shall provide training to staff and workers on all policies, regulations and information concerning restrictions related to unauthorised clearing of vegetation, as well as the punishment that can be expected if any staff or worker or other person associated with the Project violates such rules and regulations. Once construction is complete, the laydown area will be re-instated to pre-construction land type; and
- All land rehabilitation will be undertaken using native indigenous species.

Monitoring and Auditing

The following measures will be applied:

- Regular (weekly) checks during construction are to occur along all Project boundaries to ensure compliance with clearing within marked boundaries;
- Records are to be kept and regularly reviewed (trimonthly) for implementation of the workforce training program for fauna/flora awareness; and
- Monitoring if rehabilitation success/failure is to occur on all replanting sites. Monitoring is to consist of regular inspections trimonthly) to determine plant establishment. Where plant establishment is determined to have failed, reestablishment is to occur.

Significance of Residual Impact

The application of the mitigation measures is likely to reduce the impact due to loss of habitat within the Project area to **negligible** during construction and operation. It is not considered necessary for the Project to require compensation measures or biodiversity offsets to achieve no-net-loss. The total habitat losses due to the Project are calculated at < 0.9 km^2 terrestrial habitats.

9.4.4.4 Disturbance or Displacement

Potential Impact

As mentioned in Section 9.4.4.3, disturbance and displacement can occur as an indirect consequence of Project activities through habitat loss.

Potential Consequences

- Species avoid the vicinity of the wind power facility; and
- A decrease in the overall quality of remaining habitat.

Significance of Impact

Disturbance and displacement may arise from substantially-increased activity by people at the Project site during construction and operation, especially in areas where there was little human activity before the Project existed. The noise and visual disturbance (moving rotor blades) or merely the presence of these vertical structures are likely to impact the abundance of birds.

The Important Bird Areas (IBAs) surrounding the Project area consist of Chua Hang, Tra Cuu, Lung Ngoc Hoang National Park, Bac Lieu Bird Sanctuary and Bac Lieu (within a 50 km radius). The bird species detected in the dedicated field survey are likely to glide between IBAs. The presence of the Project will likely make the birds avoid the vicinity of the wind farm area in the short-term, and in the worst case the area will become unattractive to bird species in the long-term. Consequently, the disturbance and displacement may cause the birds to move to adjacent areas without any considerable effects on the population. The extent of range disturbance will depend on the fundamental-

characteristics of the species and availability of preferred habitat[12]. It is likely that the birds may move to areas where conspecifics already occur, with increased competition and lower survival as possible outcomes. Other results suggest that disturbance can lead to reduced breeding productivity, decreased survival or a reduction in available habitat.[13]

The IBAT indicates that there are likely to be occurrences of some mammals and herpetofaunas. Of which, there is a mammal species was identified can be occur within EAA which is the Hairy-nosed Otter *Lutra sumatrana* [IUCN EN, VNRB EN]. As the Hairy-nosed Otter *Lutra sumatrana* [IUCN EN, VNRB EN] used to be found in peat swamp forests of U Minh Thuong Nature Reserve, it is also possible it inhabits mangroves and estuaries along the coast. The noise and electromagnetic fields (EMF) of the Project potentially endangers the Hairy-nosed Otter, since the mangrove neighbours the Project boundary. Due to illegal hunting and poaching however, the Hairy-nosed Otter is under increasing threat throughout the entire Mekong Delta. In addition, no specific evidence demonstrates the presence of this species in the mangrove area near the Project, thus it considered this species will be mostly unaffected and the disturbance and displacement magnitude is consider to be minor. Of the reptiles identified in the area, the Common Water Monitor *Varanus salvator* [IUCN LC] is semi-aquatic and inhabits primary forest as well as mangrove swamps. Therefore, it may utilise the mangrove habitat close by the Project area and is likely to be impacted adversely by noise and EMF also. Consequently, this pattern results in a minor impact magnitude.

It is understood that displacement can impact the abundance of a species, with low-mobilisation species more likely to be impacted negatively, and ground dwelling fauna in particular. In spite of that, almost all ground dwelling fauna in the area will likely inhabit the mangrove instead of the Project area, since the majority of the Project area is modified habitat. Hence, the impact magnitude is considered to be Minor.

Displacement does not only have the potential to reduce the abundance of a species but it can also potentially increase its abundance. While some species may reduce their habitat use in the Project area, other species that mightn't have previously occurred there may be attracted to the transformed habitat. However, due to the small-scale of the study area and given that almost all identified species are likely to use a wide-range of habitats, displacement impact is categorised as Negligible.

Table 9-20 Disturbance or Displacement Impact Assessment

Impact Type	**Direct**	**Indirect**	Induced		
	These impacts relate to habitat loss and are therefore indirect.				
Impact Extent	**Local**	Regional	International		
	Impacts are restricted to the location of the transmission line and 21 wind turbines.				
Impact Duration	Temporary	Short-term	**Long-term**		
	These impacts relate to habitat loss during the construction and operation of the transmission line and turbine, and are therefore long-term.				
Impact Frequency	The transmission line and turbines will be operational 24 hours a day. Impact frequency is expected to be intermittent throughout the operation phase.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	There are a small number of potential roost features of low quality in the Project area. Habitat loss may affect a small proportion of populations, but would not substantially affect other species dependent on it, or the populations of the species themselves.				
Receptor Sensitivity	Low	**Medium**	High		
	Species include one Near Threatened species (Eurasian Curlew *Numenius arquata*) and other Least Concern species listed in IUCN Redlist.				

[12] Rydell, J. (2012). The Effect of Wind Power on Birds and Bats: A Synthesis. Naturvårdsverket.

[13] Powlesland, R. G. (2009). Impacts of wind farms on birds: a review. Science for conservation, (289).

Impact Significance	Negligible	**Minor**	Moderate	Major

Existing Controls

The local EIA proposed a 20 minute Cut-in period for the wind turbine operation of the Project, to minimise any disturbance and displacement impacts to natural habitat during the operation phase.

Additional Mitigation and Management Measures

The following additional mitigation and management measures were also proposed:

- Implementation of mitigation measures mentioned in Section 9.4.4.3 to minimise habitat loss; and
- Implementation of a wildlife shepherding protocol during clearance and construction activities.

Monitoring and Auditing

No specific monitoring is proposed.

Significance of Residual Impact

The residual impact significance is likely to be **negligible**.

9.4.4.5 Barrier Creation and Edge Effects

Potential Impact

The construction and operation of infrastructures potentially causes barrier creation and edge effects to the local habitat in the vicinity of the Project area.

Potential Consequence

Result in lower long-term survival and breeding success.

Significance of Impacts

A barrier effect is defined as any obstacle (including project components) that acts as a barrier to an animal's movements, so that they avoid the vicinity of the obstacle and choose another route. With respect to flying animals this change in flying behaviour can be positive, leading to lower risk of collision but at the cost of a longer flight course, meaning more energy and time consumption during the breeding and resting period.

Seabirds identified in study area include the Common Tern *Sterna hirundo* [IUCN LC], and Caspian tern *Hydroprogne caspia* [IUCN LC]. Migrating seabirds usually avoid flying close to wind turbines both in daytime and night time. In daylight, birds react to the presence of obstructions at a distance, on flight paths 1-2 km away from the turbines, and the flying behaviour at night is generally the same with a distance of 0.5-1 km[14].

The impact on longer flight routes is negligible, but the cumulative effect of avoidance behaviour on many wind farms may enhance the risk and long-term consequences such barrier creation and edge effects. Due to the additional distances birds may need to travel to avoid the turbines along the coastline, transit times will be increased.

Edge effects may be generated when vegetation clearing or land disturbance occurs in a currently unmodified environment. The creation of new edges in a landscape has the potential to make areas of natural habitat become vulnerable to impacts such as weed invasion and changes in neighbouring vegetation communities. This has the potential to reduce the value of vegetation (excluding mangroves)

[14] Pettersson, J. 2005. Havsbaserade vindkraftverks inverkan på fågellivet isödra Kalmarsund. Energimyndigheten, Stockholm.

which is categorised as natural habitat. The desktop review for the Project area identified 40 plant species, of which there are 19 mangrove species listed as Least Concern in IUCN Redlist, such as *Rhizophora apiculate,* and *Avicennia marina.* Additionally, the field survey identified 15 species, including one species *Ceriops decandra* which is listed as Near Threatened and 14 other species listed as Least Concern in the IUCN Red List. However, due to a low-density of these species within the study area, and considering that the majority of the Project Area is modified habitat (85.88% of total area), edge effects are not considered to be significant.

All these impacts are expected to be minimal on the species present within the EAA, as these species have relatively large ranges and high mobility. The nature of the impact will be Negative to resident fauna within the Project Area. The impact type is likely to be Indirect, as a consequence of vegetation clearing and habitat disturbance during construction and ongoing during operation. The magnitude of impact is expected to be Negligible as the impacts are likely to be within the normal range of variation. The overall impact significance is therefore considered to be **Negligible.**

Table 9-21 Barrier Creation, Fragmentation and Edge Effects Impact Assessment

Impact Type	Direct	**Indirect**	Induced		
	These impacts are an indirect consequence of vegetation clearing and land disturbance.				
Impact Extent	**Local**	Regional	International		
	Impacts to terrestrial and marine environments are localised and limited to where clearing or land disturbance is required.				
Impact Duration	Temporary	Short-term	**Long-term**		
	These impacts will be introduced during the construction phase and will be maintained throughout the operation of the project.				
Impact Frequency	Construction will occur only once.				
Impact Magnitude	Positive	**Negligible**	Small	Medium	Large
	Impact magnitude is considered **negligible** as the effects are within the normal range of variation.				
Receptor Sensitivity	Low	**Medium**	High		
	Species include Near Threatened species and Least Concern species listed in IUCN Redlist.				
Impact Significance	**Negligible**	Minor	Moderate	Major	

Existing Controls

- Passive Acoustic Monitoring (PAM)
- 30-minute observation before starting works
- 20-minute period of Cut-in

Additional Mitigation and Management Measures

The following mitigation measures will be applied during construction and continue during operation if necessary:

- Disturbed land not required for the operation of the Project will be rehabilitated using native species and by minimising the exposed width of the transmission line ROW.

Monitoring and Auditing

No specific monitoring is proposed.

Significance of Residual Impact

With the implementation of the mitigation measures, the residual impact significance is expected to be **negligible**.

9.4.4.6 Degradation of Habitat

Potential Impact

The construction and operation of infrastructures will potentially cause the degradation of local habitat due to clearance of land cover and top level vegetation from levelling and digging activities.

Potential Consequence

Result in lower long-term survival and breeding success.

Significance of Impact

A range of Project activities have the potential to lead to degradation of flora and fauna habitats including excavation, construction, land clearing, movement of vehicles, barging, drilling, refuelling, hazardous materials storage and maintenance. In general the impacts may result in: dust; runoff; release of potential contaminants; and introduction or spread of invasive species. Construction activities have been assessed for these impact types, including: construction of the access roads, erection of transmission towers, erection of wind turbines and installation of cables/wires and Project-associated infrastructure (such as the substation and laydown area). The type and scale of impacts are variable between activities undertaken in the marine environment and those undertaken on land.

Dust

During construction on land, movement of vehicles, clearing and excavation activities have the potential to generate dust which may settle on vegetation adjacent to the construction area (including access roads). Excessive dust deposition on flora may act to suppress growth through limiting photosynthesis and the dusted foliage may also become unpalatable to foraging fauna. Construction activities will be temporary and dust generation is likely to be localised to active work areas. Rainfall will generally remove dust from foliage. Due to the fauna's relatively large range and high mobility, this may not pose a substantial threat to species.

Release of Contaminants

Accidental release or spill of these materials can be toxic to flora and fauna locally and downstream if substances are released into the aquatic environment. Runoff from construction sites has potential to carry contaminants a substantial distance downstream. Construction activities such as refuelling, storage and other activities that require oil and hazardous substances to be used are undertaken at risk of accidental release. During construction, accidental release or spill of fuels, chemicals and hazardous substances from concrete barges may also impact on fauna.

Invasive Species

Invasive species (flora and fauna) have the potential to be introduced or spread throughout the Project area through increased movement of people, vehicles, machinery, vegetation and soil. Natural Habitat areas are most sensitive to the introduction of invasive species. An increase in the prevalence of weeds or other pests has the potential to reduce the quality of habitat for some native flora and fauna, including conservation significant species. Invasive flora species can rapidly germinate in disturbed areas whereby affecting the ability of native vegetation communities to re-establish. Invasive animals also have the potential to be introduced or increased in abundance. These animals may adversely impact native fauna as a result of increased competition for resources, predation or habitat degradation. While this impact can be significant, the existing environment is already highly modified and invasive species have been recorded as detailed in Volume 2.

The nature of the impact will be Negative to resident fauna within the Project area. The impact type is likely to be Indirect, as a consequence of vegetation clearing and habitat disturbance. The magnitude of impact is expected to be Small as the impacts affect a small area of the habitats, but does not result in loss of viability/function of the habitats. The sensitivity of the receptor is considered to be Medium, as the Project EAA contains habitat of significant importance to globally VU, and NT. The overall impact significance is therefore considered to be **minor**.

Table 9-22 Degradation of Habitats Impact

Impact Type	Direct	**Indirect**	Induced		
	These impacts are an indirect consequence of vegetation clearing and land disturbance.				
Impact Extent	**Local**	Regional	International		
	Impacts to terrestrial and marine environments are localised and limited to where clearing or land disturbance is required.				
Impact Duration	Temporary	Short-term	**Long-term**		
	These impacts will be introduced during the construction phase and degraded areas may take time to recover.				
Impact Frequency	Construction will occur only once.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	Impact magnitude is considered **small** as the impacts affect a small area of the habitats, but does not result in loss of viability/function of the habitats.				
Receptor Sensitivity	Low	**Medium**	High		
	Species include one Near Threatened species (Eurasian Curlew *Numenius arquata*) and other Least Concern species listed in IUCN Redlist.				
Impact Significance	Negligible	**Minor**	Moderate	Major	

Existing Controls

The mitigation measures identified in the locally approved regulatory EIA related to solid waste, waste water, dust, noise and vibration.

Additional Mitigation and Management Measures

The following mitigation measures will be applied during construction and continue during operation if necessary:

- Develop and implement appropriate emergency spills response procedures to avoid and manage accidental spills of any fuels, oils or other chemicals during construction activities.
- Avoid construction in intertidal areas (mangroves) when water is present where possible. Where it is not practical for construction during lowest tide conditions, avoid peak ebb and flow periods when water movement is at its maximum.
- Disturbed land not required for the operation of the Project will be rehabilitated using native species.
- Existing populations and the introduction of new invasive species into natural habitats are to be managed.

Monitoring and Auditing

Monitoring will be required as part of the invasive species management plan and rehabilitation works.

Significance of Residual Impact

The implementation of the mitigation measures are likely to limit the extent of these impacts, reducing the impact magnitude to Negligible. The residual impact significance is **Minor/ Negligible.**

9.5 Visual Impact Assessment

Visual impact assessment means assessing the impacts of the Project on specific views and on the general visual amenity experienced by people. Landscapes are not static but are dynamic, not least due to the range of natural and human factors that define their characteristics, but also due to the many different pressures that have altered landscapes in the past and will continue to do so in the future. Therefore, determining the significance of visual effects identified can be particularly challenging.

9.5.1 Summary of Scope of Assessment

Activities causing the visual impacts and the stakeholders who are identified as receptors of the impacts are all listed in Table 9-28.

The key activities that are likely to negatively impact during the operation phase include:

- Presence of turbines.

Scope of Visual Impact Assessment

Phases	Potential Activities	Potential Impacts	Potential Consequences	Receptor
Operation	Presence of turbines	Visual aesthetics affected	Visual aesthetics affected	Residents living along the coast Tourists visiting the area

9.5.2 Assessment Methodology

Visual impacts relate to changes that arise in the composition of available views as a result of changes to the landscape, to peoples' responses to any changes, and the overall impacts with respect to visual amenity. The methodology followed to identify and assess the significance of and the effect of changes resulting from the Project on both the landscape as an environmental resource in its own right, and on people's views and visual amenity, is presented in the subsequent section. People have different responses to views and visual amenity depending on their context and purpose, with certain activities specifically associated with the enjoyment of the landscape (e.g. the use of footpaths and tourist routes and attractions) generally more susceptible to change. Residents are also considered to be particularly susceptible to change and the combined effects on a number of residents within an area may also be considered.

9.5.2.1 Sensitivity of Receptors

Judgements about the sensitivity of visual receptors should be recorded on a scale (e.g. low, medium and high) with clearly stated criteria. The relative sensitivities of a number of visual receptors are given in Table 9-23, Table 9-24, and Table 9-25.

Table 9-23 High Sensitivity Visual Receptors

Visual Receptors	Sensitivity
Users of all outdoor recreational facilities including public rights of ways, whose interest may be focused on the landscape.	High
Communities, settlements, villages where the development results in changes in the landscape setting and valued views.	High
Occupiers of residential properties with views affected by the development.	High

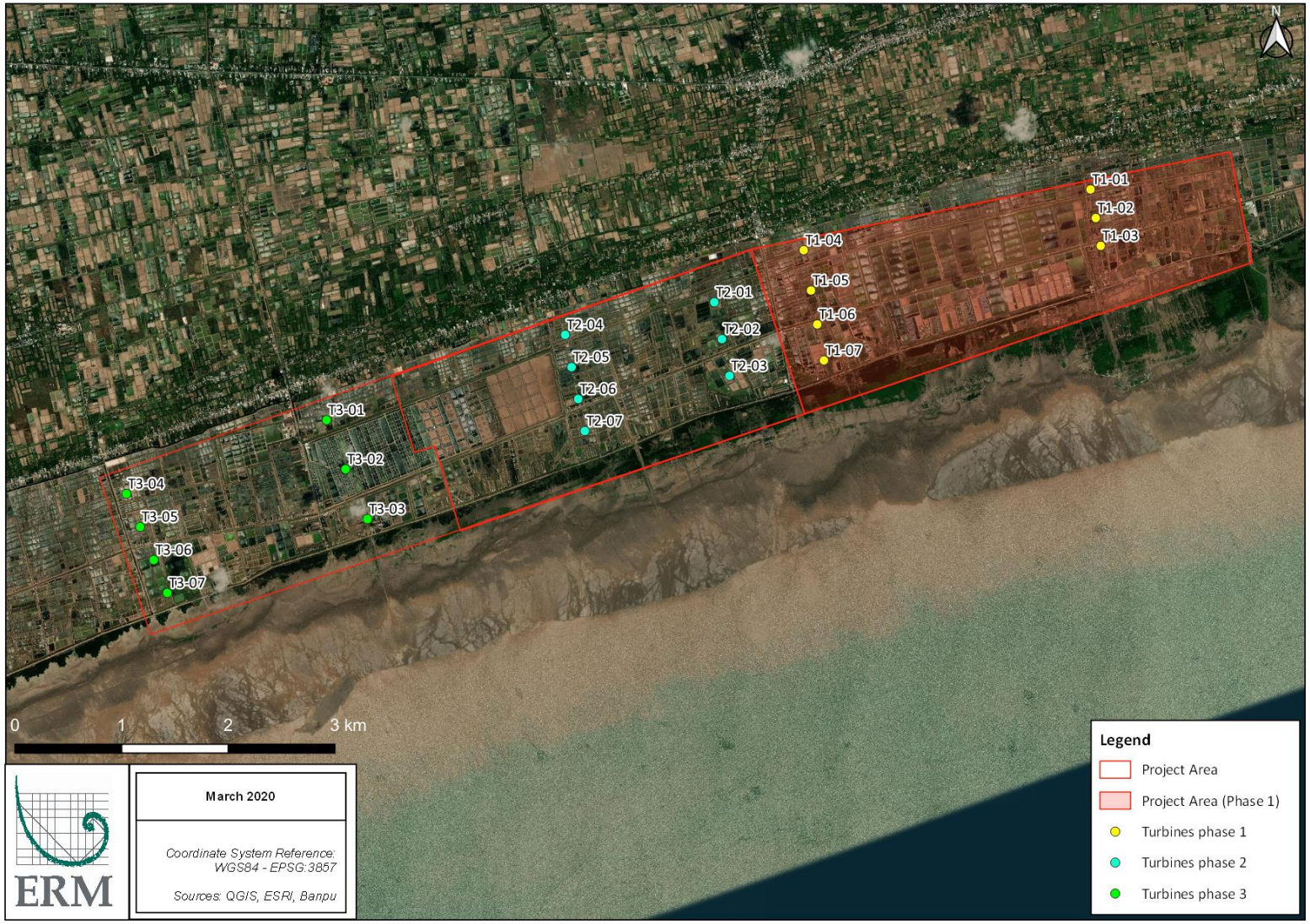


Figure 9-1 View of Proposed Wind Farm

Table 9-24 Medium Sensitivity Visual Receptors

Visual Receptors	Sensitivity
People engaged in outdoor sports or recreation (other the appreciating the landscape).	Medium
People travelling through or past the affected landscape in cars or trains along a recognised scenic route.	Medium
People enjoying passive recreation such as urban viewpoints, locations with scenic views and seating facilities.	Medium

Table 9-25 Low Sensitivity Visual Receptors

Visual Receptors	Sensitivity
People engaged in outdoor sports or recreation (other the appreciating the landscape).	Medium
People travelling through or past the affected landscape in cars or trains along a recognised scenic route.	Medium
People enjoying passive recreation such as urban viewpoints, locations with scenic views and seating facilities.	Medium

9.5.2.2 Magnitude of Visual Effects

There is no standard methodology for the scale or magnitude of effects on views and visual amenity. However, it is generally based on the:

- Scale of change relating to the loss or addition of features in the view, including the proportion of the view occupied by the proposed development;
- Degree of contrast or integration of any new feature or changes in the composition of the view;
- Duration of the effect, whether temporary or permanent, intermittent or continuous;
- Angle of view in relation to the main activity of the receptor;
- Distance of the viewpoint from the Project; and
- Extent of the area over which the changes would be visible.

As there is likely to be a variation in the degree of visibility of the Project, it is helpful to categorise these variations.

Box 4.1 Points to consider during the visual aesthetics assessment

The extent of the view that would be occupied by the Project: full, partial, glimpse etc. The distance of the viewpoint from the Project and whether the viewer would focus on the Project due to proximity or the Project would form one element in a particular view.	The proportion of the Project or particular features that would be visible: full, most, small amount, none. Whether the view is transient or one of a sequence of views as from a moving vehicle or footpath.

Consideration may also be given to the time of day and seasonal differences in effects. The worst case may need to be demonstrated (i.e. during winter, when the extent of leaf cover is minimal). The typical criteria and thresholds in determining the magnitude of effect on visual receptors are set out in

Table 9-26.

Table 9-26 Visual Magnitude of Effect

Visual magnitude of effect	Typical criteria and thresholds
Negligible	A change which is barely or rarely perceptible, at very long distance, or visible for a short duration, perhaps at an oblique angle, or which blends in with the existing view. The change may be short term.
Small	A subtle change in the view, at long distances, or visible for a short distance, perhaps at an oblique angle, or which blends in with the existing view. The change may be short term.
Medium	A noticeable change in the view at an intermediate distance, affecting a substantial part of the view, part a more wide-ranging, less concentrated change across an expansive area. The change may be medium to long term and may not be reversible.
Large	A clearly evident change in the view at a close distance, affecting a substantial part of the view, continuously visible for a long duration, or obstructing important elements of the view. The change may be medium to long term and would not be reversible.

9.5.2.3 Significance of Visual Effects

When determining the significance of visual effects, the following is taken into account:

- Large scale changes which introduce new discordant or intrusive elements into the view are more likely to be significant than small changes or changes involving features already present in the view;
- Changes in views from recognized and important viewpoints or amenity routes are likely to be more significant than changes affecting less important paths and roads; and
- Changes affecting large numbers of people are generally more significant than those affecting a relatively small group of users. However, in wilderness landscapes the sensitivity of the people who use the areas may be very high and this will be reflected in the significance of effect.

The significance matrix below illustrates the relationship between the sensitivity of a visual receptor and the magnitude of the visual effect. The significance of a visual effect may be adverse or beneficial dependent upon the nature of the change. Each case is assessed on its own merits using professional judgement and experience, and there is no defined boundary between levels of effects. What level of effect constitutes a significant effect will vary on a project by project basis.

Figure 9-2 The Significance matrix that illustrates the relationship between the sensitivity of a visual receptor and the magnitude of the visual effect

		Sensitivity of Visual Receptor		
		Low	Medium	High
Magnitude of Visual Effect	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

9.5.3 Project Characteristics

Visual impacts relate to changes that arise in the composition of available views as a result of changes made to the landscape for the Project, to peoples' responses to any changes, and the overall impacts with respect to visual amenity.

The Project will be developed in three phases which comprises of seven (7) wind turbines for each phase and 21 wind turbines for the entire development. Hub height of the proposed wind turbine (Siemens SG 4.5-145) is 127.5 m. The wind farm is spread across an aerial distance of approximately 11 km (NE to SW).

From the technical specifications of the Siemens SG 4.5-145, tower type is tubular steel tower and turbines have rotating blades of ~71 m length. The typical turbine colour is Light grey or Payrus white.

9.5.4 Site Setting

Based on a review of the Project site and surroundings from satellite imageries and field survey work done by ERM Vietnam, the proposed Project is surrounded by the East Vietnam Sea in south, south-east and south-west directions. This site includes mainly shrimp farms and densely populated residential areas in the north. Densely residential area presents along the HL31 provincial road which is about 100 m to the proposed Project area. In the east and west, the Project is surrounded by salt pans and scattered residential dwellings. The residential area has been observed to comprise of residential dwellings (one to two storeyed) as well as community infrastructure such as schools, religious/cultural, restaurants and health centres, which have been located within the Project's footprint. The Project area includes a number of shrimp ponds and boat anchoring sites and some waterway channels where local people anchor their fishing boats. There is a mangrove area along the coastal line of the study area. However, the Project area already has a precedent in the form of an operational wind farm - the Bac Lieu wind farm, located approximately ~6.5 km from the proposed Project site.

9.5.5 Receptors

The receptors in the Project area are mostly people occupying individual houses and these have been elaborated on in Table 9.29 in order to establish the extent of shadow flicker impacts. Other receptors may include road users and tourists visiting the area. However, the nature of impact varies based on the outdoor activities of the residents and tourists in the community and the view shed[15]. Following a desktop review and judging by information available, it is understood that there are no historically or culturally relevant structures associated with the landscape of the Project area.

Figure 9-3 Social and Residential receptors in the vicinity of the Project area

[15] The view shed is the area in which the Project could create a recognisable visual impact for a viewer.

Figure 9-4 Environmental receptors in the vicinity of the Project area

9.5.6 Assessment of Impacts

9.5.6.1 Operational Phase – Visual Impact

Potential impact

Assessment from Google imagery shows that the turbine locations WTG1-1, WTG1-3, WTG1-6, WTG2-1, WTG2-4, WTG3-1, WTG3-3, which are close to the residential area (~ 350 m – 400 m), will have a direct impact on the visual aesthetics of the area or on its people. Some of the scattered residential dwellings around the Project area will also have direct impact on the visual aesthetics. People engaged in fishing activities around the Project site will also have temporary visual impact.

Other WTGs are located ~600-800 m from the main residential area along the road, and may have transient impact on the people traversing along the road. There is dense mangrove forest along the coastal line from the Project area following salt pans, which may make the turbines visually noticeable from a distance.

Existing Controls

There are no existing mitigation and management measures proposed in the regulatory EIA.

Significance of Impacts

Analysis of Sensitivity of Visual receptors

The visual receptors in this case are residents in houses and within the Project's area of influence, fisherman, people engaged at salt pans, tourists and people traversing the roads in the Project area. As discussed earlier, the Project area has importance with respect to the landscape of the area as a tourist place/scenic view. Also, the change is expected not to be new or unprecedented due to existing similar projects in the area (another wind turbine project is operational nearby). Therefore, the sensitivity of visual receptors is considered **Medium**.

Visual Magnitude of the Effect

Considering the number of turbines (21), site settings and existing wind farms in the area, the visual magnitude of the effect is assessed as medium as the Project will result in the noticeable change of the view at an intermediate distance, affecting a substantial part of the view, but a more wide-ranging, less concentrated change across an expansive area. The change may be medium to long term and may not be reversible.

Table 9-27 Impacts on Visual Aesthetics during Operation Phase

Impact	Impact on visual aesthetics during operation				
Impact Nature	**Negative**	Positive	Neutral		
	Change of views and landscape are considered **Negative**				
Impact Type	**Direct**	Indirect	Induced		
	Turbines will be present in the landscape.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	The impact duration is **Long-term** - for as long as the turbines are in operation, but not irreversible.				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area viewshed.				
Impact Scale	The impact scale is **Medium** as the visual impact will be noticeable enough to affect residents, fisherfolk and tourists of the tourist/ scenic area.				
Impact Frequency	The impact is **continuous** during the day.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
	The impact magnitude is **Medium**.				
Vulnerability of Receptors	Low	**Medium**	High		
	The vulnerability of receptor is **Medium** as explained above.				
Significance	Negligible	Minor	**Moderate**	Major	
	The significance is **Moderate.**				

Additional Mitigation and Management Measures

The following additional mitigation measures are based on ESIA requirements to minimise impacts associated with visual aesthetics:

- Use of materials that will minimise light reflection should be used for all Project components.
- Bright patterns and obvious logos should be avoided.
- The replacement of wind turbines with visually different wind turbines can result in visual clutter, so replacing wind turbines with the same or a visually similar model over the lifetime of the Project may be an important requirement.
- Maintain a uniform size and design of turbines (e.g. type of turbine and tower, as well as height)
- Minimise presence of ancillary structures on the site by minimising site infrastructure, including the number of roads, as well as by burying collector system power lines, and avoiding stockpiling of excavated material or construction debris.
- Erosion measures should be implemented and cleared land should be promptly re-vegetated with local seed stock of native species.
- Existing vegetation should be retained to the greatest extent possible. Vegetation should be retained along roads and around turbine pads, substations, and other Project infrastructure.

Monitoring and Auditing

No additional specific monitoring or auditing is recommended.

Residual Impact

With the implementation of the above mitigation measures, the residual impacts would be expected to be **Minor**.

9.6 Shadow Flicker Impact

Shadow flicker is a term used to describe the pattern of alternating light intensity observed when the rotating blades of a wind turbine cast a shadow on a receptor under certain wind and light conditions. Shadow flicker occurs under a limited range of conditions when the sun passes behind the hub of a wind turbine and casts an intermittent shadow over neighbouring properties.

9.6.1 Scope of the Assessment

Activities causing the shadow flicker and the stakeholders who are identified as receptors of the impacts are all listed in Table 9-28.

The key activities that are likely to negatively impact during the operation phase include:

- Wind turbine generator spinning.

9.6.2 Relevant Guidelines and Criteria

9.6.2.1 Vietnamese Regulations

There are no requirements and regulations specific to shadow flicker in Vietnam-based environmental policies and legislations.

9.6.2.2 International Guidelines

- IFC Environmental Health and Safety Guidelines for Wind Energy (2015) provides EHS guidelines for onshore and offshore wind energy facilities. It covers environmental impacts and provides associated recommendations for mitigation measures in the areas of noise and visual impact, biodiversity, water quality, shadow flicker etc.

In the Vietnam context, at present, there is neither regulation nor decided level of shadow flicker identified as causing a significant effect[16]. Internationally, the Danish Wind Industry Association note on their website that in Germany, the rule of thumb is that 30 hours shadow flicker a year received at a property is acceptable[17]. The 'Wind Energy Development Guidelines, 2006' published by the Irish Government Department of the Environment, Heritage and Local Government recommend that shadow flicker at neighbouring offices and dwellings within 800 m should not exceed 30 hours per year. A threshold of 30 hours per year has therefore been considered and applied for this assessment.

Box 2.1 International Guidelines for Shadow Flicker Assessment

According to the German guidelines, the limit of the shadow is set by two factors:

- The angle of the sun over the horizon must be at least 3 degrees;
- The blade of the WTG must cover at least 20 percent of the sun.

The maximum shadow impact for a neighbour to a wind farm according to the German guidelines is:

- Maximum 30 hours per year of astronomical maximum shadow (worst case);
- Maximum 30 minutes worst day of astronomical maximum shadow (worst case); and
- If automatic regulation is used, the real shadow impact must be limited to 8 hours per year.

In **Sweden and Denmark** there are no official guidelines as yet on shadow flickering, but for practical purposes, 10 hours (Denmark) and 8 hours (Sweden) real case (weather-dependent) shadow impact is used as the limit. In the UK, no official limits are in force, however an assessment must be made at all dwellings within ten rotor diameters of the turbine locations (PPS22 (2004) for England), TAN8 for Wales). In Ireland, a worst-case 30 hours per year, 30 minutes per day limit has been set.

[16] Assumption based upon review of the Vietnam Environment Administration website.

[17] www.windpower.org

Shadow flicker has been elaborated upon in the EHS guidelines for wind energy, by the International Finance Corporation (IFC), dated August 7, 2015[18] and have been elaborated here. They are as follows:

- Shadow flicker occurs when the sun passes behind the wind turbine and casts a shadow. As the rotor blades rotate, shadows pass over the same point causing an effect termed shadow flicker. Shadow flicker may become a problem when potentially sensitive receptors (e.g. residential properties, workplaces, learning and/or health care spaces/facilities) are located nearby, or have a specific orientation to the wind energy facility.
- Potential shadow flicker issues are likely to be more important in higher latitudes, where the sun is lower in the sky and therefore casts longer shadows that will extend the radius within which potentially significant shadow flicker impact will be experienced.
- Where there are nearby receptors, commercially available software can be used to model shadow flicker in order to identify the distance to which potential shadow flicker effects may extend. The same software can typically also be used to predict the duration and timing of shadow flicker occurrence under real weather conditions at specific receptors located within the zone of potential shadow flicker impact.
- If it is not possible to locate the wind energy facility/turbines such that neighbouring receptors experience no shadow flicker effects, it is recommended that the predicted duration of shadow flicker effects experienced at a sensitive receptor not exceed 30 hours per year and 30 minutes per day on the worst affected day, based on a worst-case scenario.

[18] EHS guidelines for wind energy, August 7, 2015.
http://www.ifc.org/wps/wcm/connect/2c410700497a7933b04cf1ef20a40540/FINAL_Aug+2015_Wind+Energy_EHS+Guideline.pdf?MOD=AJPERES.

Table 9-28 Scope of Shadow Flicker Assessment

Phases	Potential Activities	Potential Impacts	Potential Consequences	Receptor
Operation	■ Wind turbine generator spinning during operation	■ Spinning of turbine blades cause shadows to flicker during the day	■ Shadow flicker could lead to stress and headaches; and ■ Shadow flicker in the range of 2.5-50 Hertz could lead to seizures in epileptics and scare away livestock	The maximum horizontal distance between a receptor affected by shadow flicker and turbine location has been identified as being equal to the diameter of the turbine multiplied by ten. In this instance, maximum turbine rotor diameter is 145 m; and therefore an area envelope of 1,450 m from the nearest turbine is used in shadow flicker analyses. For this impact assessment, the shadow flicker receptors considered are those that fall within 1,300 m to 2,000 m from centre of the Project area to cover larger area.

9.6.3 Impact Assessment Methodology

9.6.3.1 Occurrence of Shadow Flicker in Regards to Wind Farms

Shadow flicker is most pronounced at sunrise and sunset when shadows are the longest, and at high wind speeds (faster rotating blades leading to faster flicker). A UK government report recommends that for inhabitants near wind turbines, shadow flicker should be limited to 30 hours in a year and 30 minutes in a day. There is anecdotal evidence internationally that shadow flicker could lead to stress and headaches. There is also a fear that shadow flicker, especially in the range of 2.5-50 Hertz (2.5-50 cycles per second) could lead to seizures in epileptics and may also scare away livestock.

An analysis of those conditions that may lead to shadow flicker and the location of potential sensitive receptors (residential and community properties) is provided in this section. The timing and duration of this effect can be theoretically calculated from the geometry of the wind turbines, their orientation relative to nearby houses and the latitude of the potential site, using specialised software such as WindPro 3.3. The results provide the total number of hours in a year when a theoretical shadow flicker will occur. This is most pronounced during sunrise and sunset when the sun's angle is lower and the resulting shadows are longer. However, the actual shadow flicker could be substantially lower compared to theoretical values because shadow flicker does not occur where there is vegetation or other obstructions between the turbines and the shadow receptors; if windows facing a turbine are fitted with blinds or shutters; or if the sun is not shining brightly enough to cause shadows.

It should be noted that the theoretical calculations done by WindPro does take into account the reduction in shadow flicker due to topographic features, however it does not take into account the reduction in shadow flicker due to these onsite factors i.e. vegetation. Simple geometry relating to the position of the sun and the angle of the turbine blades can also eliminate or significantly reduce the effects of shadow flicker. In addition, shadow flicker will only occur inside the properties where the flicker is occurring through openings (e.g. window, door).

9.6.3.2 Considerations and Assumptions for the study

Weather conditions at the site, such as bright sunshine, will greatly enhance the occurrence and intensity of shadow flicker, whereas cloud density, haze or fog will cause a reduction. Receptors further away from the turbines which may have experienced a shadow flicker effect under bright sunshine conditions will, as a result of these weather conditions, experience either no effect or one which is greatly reduced in intensity. The distance between receptors and turbines has a large effect on the intensity of shadow flicker. Shadow flicker intensity can be defined as the difference in brightness between the presence and absence of a shadow at any given location. This study does not examine variations in intensity but rather the occurrence in number of hours shadow flicker may occur, whether or not this is clearly distinct or barely noticeable. The assessment assumes a conservative worst case assuming sun always shining (from sun rise to sun set), turbine always running and rotor oriented perpendicular to neighbour.

It is to be noted that shadow flicker assessment was done, considering Siemens Gamesa SG-4.5-145 wind turbine specifications, which are proposed to be used in this Project. Shadow flicker results and map for the wind turbine model is presented in the Appendix B and Figure 9-5 of the report.

Considering all of the above points, the likelihood of shadow flicker occurring is greatest when the circumstances listed below exist simultaneously.

- The receptor is at a position which is between 130° clockwise (1) and anticlockwise from north and located within 10 turbine rotor diameters of the wind turbine (~1,450 m).
- The sun is shining and visible in the sky in line with the monthly mean sun-shine hours at nearby location.
- The wind speeds are between 3 m/s and 22 m/s and the turbine is therefore in operation.
- The turbine blades are perpendicular to the line between the sun and the observer or receptor most of time.

The turbines (proposed to be used in this Project) being considered operate at a frequency outside the range where negative health effects may result. Potential effects on people are likely to be limited to nuisance.

ERM has not carried out any field visits and all the assessments have been carried out based on desktop studies only.

9.6.3.3 Assessment Methodology and Modelling

Shadow flicker calculations have been made using WindPRO 3.3 software. The model used in this analysis is very conservative and assumes the following conditions:

- The average monthly sunshine hours for Ho Chi Minh City[1];
- The wind turbines have been considered operational with wind speed more than 3 m/s and for the same, based on annual wind rose and wind frequency data (wind mast data shared by client) it has been assumed that about 90 percent time of the year, the wind turbines will be operational;
- The blades of the wind turbines are perpendicular with west-southwest orientation have been considered based on the predominant wind direction available from the wind mast data, which could result in maximum possible size circular/ elliptical;
- There are no trees, or vegetation on the surface which may obscure the line of sight between shadow receptor and turbine;
- The sun can be represented as a single point;
- Flicker is ignored if sun is less than 3° above horizon (due to atmospheric diffusion/ low radiation/ sheltering);
- Sample basis structures/group of residential dwellings identified within 2000 m around the wind turbine locations are considered as shadow receptors.

The following data inputs were used in this study:

- A digital elevation model of the site (National Aeronautics and Space Administration (NASA) Shuttle Radar Topography Mission (SRTM) Data at 30 m resolution);
- Latitude and longitude at centre of the site used to calculate the position of the sun (calculated in GIS using UTM co-ordinates);
- Average monthly sun-shine hours recorded;
  turbine locations – coordinates (provided by the Client);
- Turbine rotor diameter for Siemens Gamesa SG-4.5-145 is considered to be 145 m;
- Height to bottom of Turbine hub is considered to be 127.50 m;
- Tilt angle of the ‘window’ (always assumed vertical);
- Shadow receptors contain on openings measuring 1 m by 1 m facing towards the closest wind turbines; and
- Height above ground level of the ‘window’ is 1 m.

9.6.3.4 Impact Magnitude

The magnitude of the impact is considered to be high in the case of shadow hours per year being > 200 hr/year; medium in the case of shadow hours per year being 200 hr/year < x < 100 hr/year; low in the case of shadow hours per year being 100 hr/year < x < 30 hr/year; and acceptable in the case of shadow hours per year being < 30 hr/year.

9.6.3.5 The model – WindPro Shadow

SHADOW is the WindPro calculation module that calculates how often and in which intervals a specific neighbour or area will be affected by shadows generated by one or more WTGs. These calculations are

[1] https://weather-and-climate.com/average-monthly-hours-Sunshine,Ho-Chi-Minh-city,Vietnam

worst-case scenarios (astronomical maximum shadow, i.e. calculations which are solely based on the positions of the sun relative to the WTG). Shadow impact may occur when the blades of a WTG pass through the sun's rays seen from a specific spot (e.g. a window in an adjacent settlement). If the weather is overcast or calm, or if the wind direction forces the rotor plane of the WTG to stand parallel with the line between the sun and the neighbour, the WTG will not produce shadow impacts, but the impact will still appear in the calculations. In other words, the calculation is a worst-case scenario, which represents the maximum potential risk of shadow impact. A calendar can be printed for any specific point of observation, which indicates the exact days, and time periods where shadow impact may occur.

Apart from calculating the potential shadow impact at a given neighbour, a map rendering the iso-lines of the shadow impact can also be printed. This printout will render the amount of shadow impact for any spot within the project area.

The calculation of the potential shadow impact at a given shadow receptor is carried out simulating the situation. The position of the sun relative to the WTG rotor disk and the resulting shadow is calculated in steps of 1 minute throughout a complete year. If the shadow of the rotor disk (which in the calculation is assumed solid) at any time casts a shadow reflection on the window, which has been defined as a shadow receptor object, then this step will be registered as 1 minute of potential shadow impact. The following information is required:

- The position of the WTGs (x, y, z coordinates)
- The hub height and rotor diameter of the WTGs
- The position of the shadow receptor object (x, y, z coordinates)
- The size of the window and its orientation, both directional (relative to south) and tilt (angle of window plane to the horizontal).
- The geographic position (latitude and longitude) together with time zone and daylight saving time information.
- A simulation model, which holds information about the earth's orbit and rotation relative to the sun.

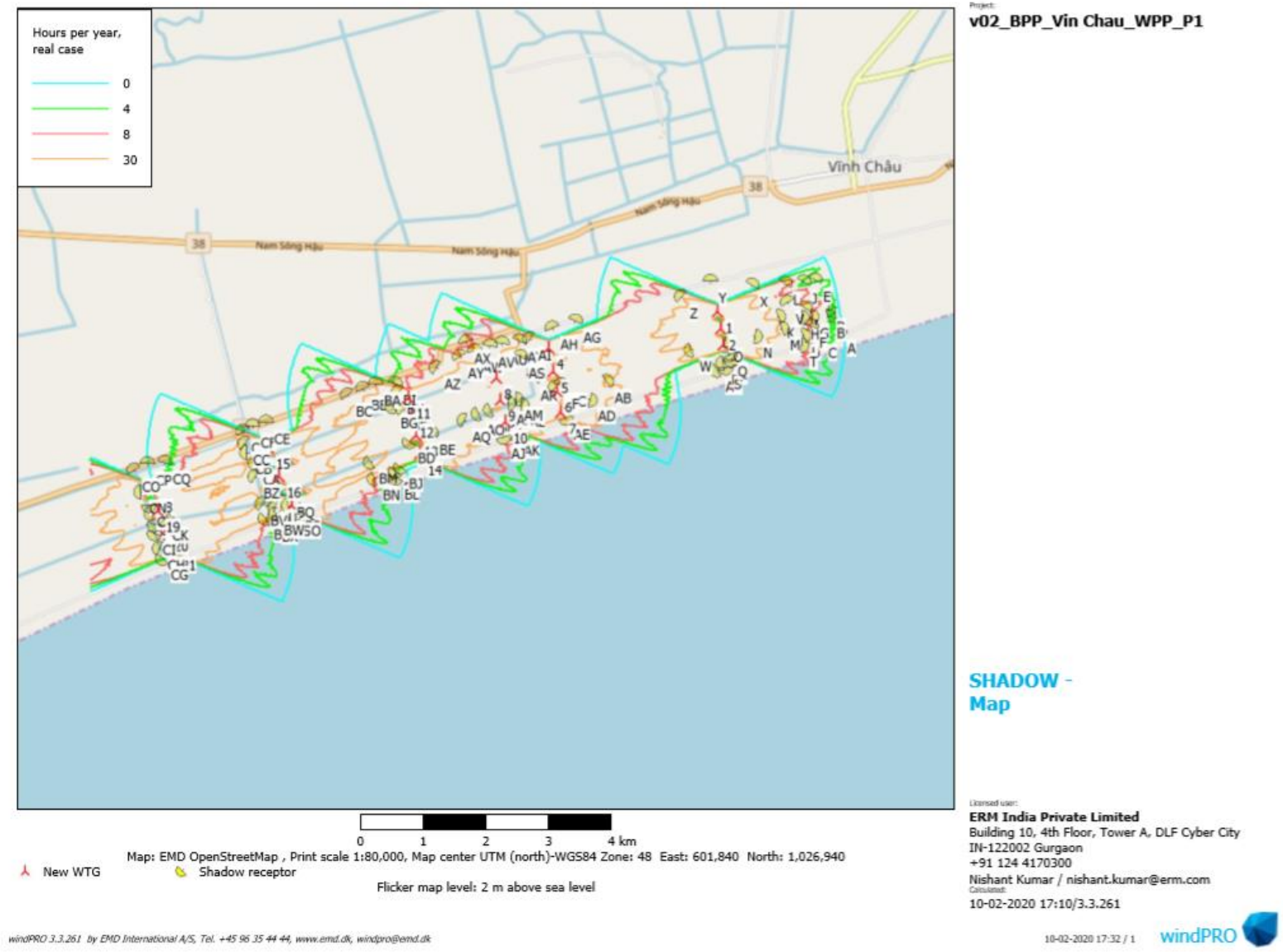
9.6.4 Receptors

The maximum horizontal distance between a receptor affected by shadow flicker and turbine location, for example, has been identified as being equal to the diameter of the turbine multiplied by ten. In this instance, turbine rotor diameter is considered a maximum of 145 m; and therefore an area enveloping 1,450 m from the nearest turbine is used in shadow flicker analyses. However, shadow receptors falling within 800 m from each of the WTGs have been taken into consideration as the impact of shadow flicker reduces with distance. As reported, project will be developed in three phases. Each phase will have seven (7) WTGs. A total of 95 representative receptors have been identified within the study area considering 21 WTG (for all three phases). All the shadow receptors considered in this study are located within 800 m of the nearest WTG locations. Where a cluster of residential dwellings is present, representative sensitive receptors are selected (sample basis).

9.6.5 Shadow Flicker Analysis

The map showing the extent of shadow flicker caused by the proposed Project to corresponding receptors within 2,000 m from the nearest WTG location is shown in Figure 9.3. Calculated shadow flicker at each identified shadow receptor due to the proposed Project (considering Siemens Gamesa SG-4.5-145) is presented in Appendix B. Main shadow results and a shadow graphical calendar illustrating the times of the year where theoretical shadow flicker is predicted to occur at each of the receptors in the analysis are also provided in the Technical Report.

Figure 9-5 Flicker Map showing the turbines and the interactions with the receptors that are located within 2,000 m



9.6.6 Assessment of Impacts

9.6.6.1 Operation Phase – Potential Shadow Flicker Impact Due to the Proposed Project

Potential Impact

The Presence of wind turbines will have an impact on visual aesthetics. It is understood from Google imagery that all the turbine locations would be far away (> 1 km) from the sea wall and > 1.3 km from residences and would not pose direct impacts to the visual aesthetics of the area or the people. However, there may be a transient impact on tourists coming to the area of the sea wall, and there may be a transient impact on the people travelling on the road. The Project area being rural and of a similar elevation may make the turbines visually noticeable from a distance.

Existing Controls

There are no existing mitigation and management measures proposed in the regulatory EIA.

Significance of Impact

Given that the guidelines of 30 hours or less per year is considered to be acceptable, the operation of the wind farm theoretically results in shadow flicker impacts that could be considered as significant for the purposes of this study. As per the above table, magnitude of the impact is considered to be high in case of shadow hours per year is > 200 hr/year, medium in case of shadow hours per year is 200 hr/year < x < 100 hr/year, low in case of shadow hours per year is 100 hr/year < x < 30 hr/year and acceptable in case shadow hours per year is < 30 hr/year.

The results show that theoretical shadow flickers in the real case scenario with high SF impact occurring at three (3) locations, medium SF impacts occurring at eleven (11) locations and low SF impact at 20 locations. In the worst case scenario, high SF impact occurs at 23 locations, medium SF impact occurs at nine (9) locations and low SF occurs at 22 locations.

The maximum shadow flicker occurs at receptor ‘BR (SF 4)’, located close to the wind turbines WTG 3-2 with a maximum of 384:44:00 hr/year followed by receptor ‘CN (SF 26)’, located close to wind turbine WTG 3-4 with a maximum of 274:10:10 hr/ year in real case scenario. The other receptors are highlighted in the Technical Report.

It is relevant to emphasise that predicted hours of shadow flicker effects are real case scenarios with certain assumptions. Assumptions made during the analysis include optimal meteorological, natural light and geometrical conditions for the generation of shadow flicker. The assessment does not account for trees or other obstructions that intervene between the receptor and turbine during times when effects may occur. The assessment calculation is therefore an over estimation in the probability of effects. It should also be noted that for shadow effects to occur, properties need to be occupied, with blinds or curtains open and views to the wind turbine unobstructed.

Considering the small impact magnitude for all shadow receptors in real case scenario, the impact significance is **Moderate**.

Table 9-29 Impact Significance of Shadow Flickering Pertaining to the Project WTGs

Impact	Shadow Flickering during Operation Phase – Real Case Scenario			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Duration	Temporary	Short-term	Long-term	Permanent
Impact Extent	Local	Regional	International	
Impact Scale	Within 1,450 m of the WTGs on the receptors in the NW-SW direction of the WTGs			

Impact Magnitude	Positive	Negligible	Small	Medium	Large
	Impact magnitude varies based on distance of receptors from the WTGs and their orientation. Out of the 95 shadow receptors identified in the study, impact magnitude: ▪ Large/high impact (> 200 hr/year): 3 ▪ Medium impact (200 hr/year < x < 100 hr/year): 11 ▪ Small/low impact (100 hr/year < x < 30 hr/year): 20 ▪ Negligible impact (<30 hr/year): 36 ▪ No impact: 25				
Receptor Sensitivity	Negligible	Low	Medium	High	
	Receptors present within the 1,450 m zone are scattered houses, schools and restaurants				
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Impact Magnitude	Positive	Negligible	Small	Medium	Major
Residual Impact Significance	Negligible	Minor	Moderate	Major	

Additional Mitigation and Management Measures

The following additional mitigation measures are based on ESIA requirements to minimise impacts associated with shadow flicker:

- In case the locations have been finalised by the Project proponent and earmarked for construction, there needs to be close monitoring through engagement with residents during the operational phase where there are predicted impacts from shadow flicker.
- The likelihood of direct line of sight to the location of proposed turbine locations can be assessed visually and the potential for using screening like higher fencing and planting trees can be explored at problem locations. The use of curtains can also be explored.
- If these prove effective and the impacts mitigated, the shutting down of turbines during certain environmental conditions, which meet the physical requirements for theoretical shadow flicker to occur, will not be required.

Monitoring and Auditing

Should the impact of shadow flicker be identified, and the mitigation measures proposed above prove ineffective, further analysis can be carried out to identify the exact timings and conditions under which shadow flicker occurs, and a technical solution sought. This is likely to involve pre-programming the turbine with dates and times when shadow flicker would cause a nuisance for nearby receptors. A photosensitive cell can be used to monitor sunlight, and the turbine could potentially then be shut down, when the strength of the sun, wind speed and the angle and position of the sun combines to cause a flicker nuisance.

Residual Impact

With the implementation of the above mitigation measures, the residual impacts would be expected to be **Minor**.

9.7 Electromagnetic Interference Impact

All transformers and transmission lines, especially high voltage lines, emit a type of low frequency non-ionizing radiation caused by the generation of electric fields, due to electric charges (voltage), and magnetic fields, due to the flow of electrical current through transmission lines, which collectively is referred to as Electric and Magnetic Fields (EMF). Exposure to high levels of EMF can pose a health risk for people. The strength and extent of EMF depends on three things:

- How much current is flowing,
- The voltage and
- Configuration of the wires (e.g. size, wiring phase configuration and separation between the wires).

9.7.1 Summary of Scope of Assessment

Activities causing the potential impacts to electromagnetic interference (EMI) and stakeholders who are identified as receptors of the impacts are all listed in Table 9-31.

The key activities that are likely to negatively impact receptors during the operation phase include electromagnetic interference generated by the wind turbines transformers, transmission line and substation transformers when the wind turbines are in operation (i.e. once electrical current flows through the conductors).

9.7.2 Relevant Guidelines and Criteria

9.7.2.1 Vietnamese Regulations

- Decree No.: 14/2014/ND-CP: Stipulating in detail the implementation of electricity law regarding electricity safety – which states the distance from the lowest point of conducting wire in the state of maximum deflection to the ground is not less than 15 m for 110 kV lines.
- Vietnamese Government Standards regarding Free Space and Minimum Free Distance of High-voltage Transmission Line and Extra High-voltage Transmission Line published by the Electricity Regulatory Authority of Vietnam (ERAV).

9.7.2.2 International Guidelines

As outlined in Volume 2, Section 2.14, electric fields are normally measured in kilovolts per metre (kV/m), while magnetic fields are defined by magnetic flux density, measured in micro-Tesla (μT) or milli-Gauss (mG). The World Bank Group's (WBG) Environmental, Health and Safety (EHS) Guideline[20] for Power Transmission and Distribution (WBG, 2007) refers to the International Commission on Non-Ionizing Radiation Protection (ICNIRP)[21] [22] for health and safety standards relative to exposure to EMF. The World Health Organization (WHO) [23] refers to ICNIRP EMF standards as short-term and high level exposure limits. At present, ICNIRP limits consider the scientific evidence related to possible health effects from long-term, low level exposure to ELF fields insufficient to justify lowering these quantitative exposure limits. The ICNIRP ELF exposure limits are instantaneous and not averaging and it refers to Basic Restrictions and Reference Levels for both magnetic and electric fields under General Public and Occupational exposure conditions (see Table 9-30). Basic Restrictions are the fundamental limits on exposure and are based on the internal electric currents or fields that cause established biological effects in humans. They are impractical to measure. Therefore, Reference Levels of exposure to the external fields, which are simpler to measure, are provided as an alternative means of showing

[20] EHS Guidelines for Power Transmission and Distribution, April 30, 2007

[21] The ICNIRP Guidelines (2010) for limiting exposure to time-varying electric, magnetic and electromagnetic field (up to 300GHz) (http://www.icnirp.de/PubEMF.htm)

[22] These values represent the ICNIRP occupational exposure limits

[23] WHO 2007, Extremely Low Frequency Fields – Environmental Health Criteria, Monograph No. 238 March 2007

compliance with the Basic Restrictions. The Reference Levels have been conservatively formulated such that compliance with the Reference Levels will ensure compliance with the Basic Restrictions. In summary, these limits can be considered as chronic exposure standards and there are no health risks associated with short-term exposure to these levels.

Table 9-30 Basic Restrictions and Reference Levels for Exposure to 50 Hz EMF at the Edge of Right of Way (ROW)

Exposure Characteristics	Electric field (kilo volts per meter, kV/m)	Magnetic flux intensity		
		Micro-Tesla (μT)	Milli-Gauss (mG)	Ampere/m (A/m)
Occupational	10 (i.e. 10,000 v/m)	1,000 (500 prior to 2010)	10,000 (5,000 prior to 2010)	798 (399 prior to 2010)
General Public	5 (i.e. 5,000 v/m)	200 (100 prior to 2010)	2,000 (1,000 prior to 2010)	160 (80 prior to 2010)

Table 9-31 Scope of Electromagnetic Interference Assessment

Phases	Potential Activities	Potential Impacts	Potential Consequences	Receptor
Operation (onshore activities)	Waste, emissions (including electromagnetic interference) and discharge generation, handling and disposal	Electromagnetic fields from transmission line and transformers in substations	Health risks	Receptors along the transmission line and near the substation

9.7.3 Assessment Methodology

The calculation of EMF is one of the factors which must be considered during the design process especially for high voltage transmission lines to determine ROW of the power line such that there will not be danger for the people and surrounding environment.

An Excel-based software developed by Electrical Engineering Portal (EEP) [24] for the calculation of EMF around transmission and distribution overhead lines was used to calculate EMF for the 110 kV transmission line proposed for the current study. The tool can be used to calculate one or two circuit lines in which ground wires can be incorporated for EMF calculations. In addition, the tool allows combining and creating examples of power lines where two independent power lines can interact on each other. The EMF calculations used in this tool uses the analytical approach described in EPRI Red Book "Transmission Line Reference Book". In addition, accuracy of these EMF calculations were checked with other commercial software.

9.7.4 Assessment of Impacts

9.7.4.1 EMF from Transmission Line

Input Data

The input data used for setting up the transmission tower and circuit lines is given in Table 9-32 for Tower 1 and shown in Figure 9-6. All other tower configurations follow the same set of input parameters identified in Table 9-32. The current intensity was calculated from 63MVA (baseline report) and 110 kV voltage. Table 9-32 provides the different tower configurations upon which this assessment is based.

Table 9-32 Transmission Line Parameters

			X [m]	Y [m]	Umax [kV]	I[A]	rA [mm]	dA [mm]	n	Ph-seq
Line 1	Circuit 1	L1	-2.5	20.8	110	573	13.83	0	1	1
		L2	-2.5	14.6	110	573	13.82	0	1	2
		L3	-2.5	8.4	110	573	13.82	0	1	3
		g.w.	-2.5	26	0	0	6.91	0	1	0
		g.w.	2.5	26	0	0	6.91	0	1	0
	Circuit 2	L3	2.5	8.4	110	573	13.82	0	1	3
		L2	2.5	14.6	110	573	13.82	0	1	2
		L1	2.5	20.8	110	573	13.83	0	1	1

X [m] – horizontal length from the middle of the line; Y [m] – height in which wires are suspended; Umax [kV] – maximum permissible line voltage; I [A] – maximum permissible line current (in case of bundle it is; determined for all wires); r_A [mm] – wire radius; d_A [mm] – distance between wires in bundle; n – number of wires in bundle; Ph-seq – phase sequence. 1 – L1, 2 – L2, 3 – L3, 0 – Ground Wire

[24] http://electrical-engineering-portal.com/download-center/electrical-ms-excel-spreadsheets/emf-td-overhead-lines

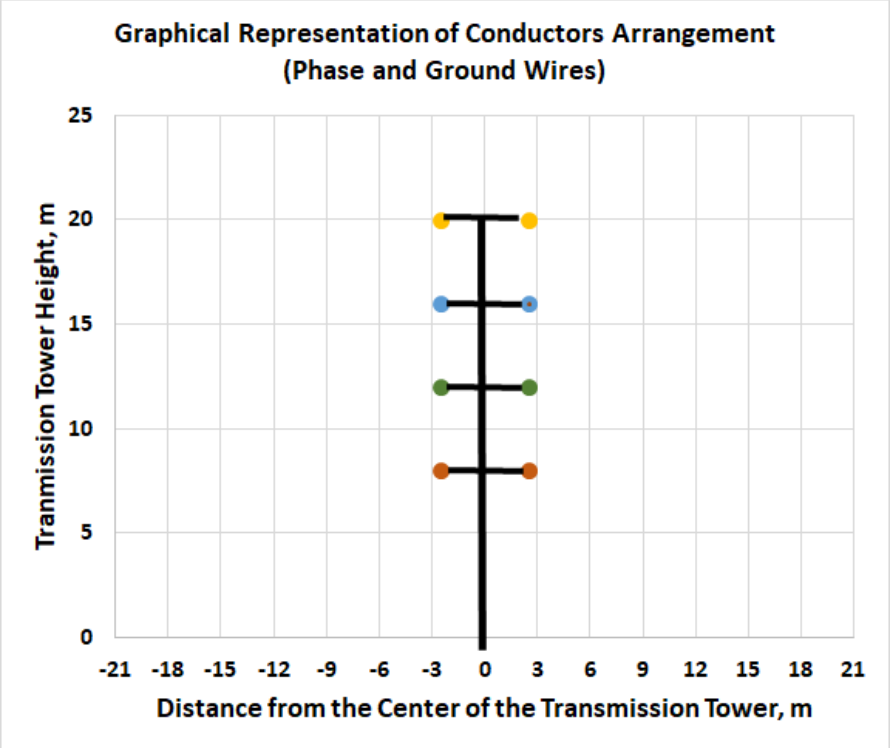


Figure 9-6 Schematic representation of transmission tower with power lines arrangement

The proposed minimum horizontal free space for the 110 kV double-circuit is 21 m (10.5 m on either side of the transmission tower). It is expected that the tower type and land area required for the development of the 110 kV transmission line will comply with the requirements of ERAV and Decree No.: 14/2014/ND-CP, as required. The transmission tower to be constructed will be a tangent suspension tower (0° – 2°) with heights of double circuit wires positioned between 2.8 – 34 m.

Potential impact

- Electromagnetic fields from transmission line.

Existing Controls

The mitigation measures identified in the regulatory EIA include:

- Establishing an adequate ROW width to ensure EMF levels meet international safety standards at the ROW edge. The proposed design indicates a free space and minimum free distance of 21 m around the transmission line (i.e. 10.5 m ROW on either side of the transmission line);
- Compliance with Decree No.: 14/2014/ND-CP, conducting wires at least 15 m above ground level (as such it is expected that conducting wires and L3 phase conductor will be at least 8 m above ground level and the tops of buildings within the ROW);
- Using phase cancellation; and
- Shielding.

Significance of Impacts

Operation of the Electricity Transmission Projects (ETP) will result in the formation of EMF along the transmission line and at the substations. Although high-voltage transmission lines like the ETP do generate higher EMFs, this effect is offset by the fact that the towers are higher, the ROW is wider, and phase cancellation shielding is applied, all of which lower EMF levels, as typically measured at the edge

of the ROW. Figure 9-7 and Figure 9-8 illustrate the variation of EEP model calculated electric and magnetic fields with distance from the transmission line at 1 m above the ground. Figure 9-7 and Figure 9-8 illustrate the variation of EEP model calculated electric and magnetic fields with distance from the transmission line at 1 m above the ground for Tower 1. The maximum electric and magnetic fields are 2.36 kV/m and 16.01 A/m, respectively, for the proposed 110 kV tower configuration directly below the line (at 1 m above the ground surface) and reduce rapidly with distance from the lines.

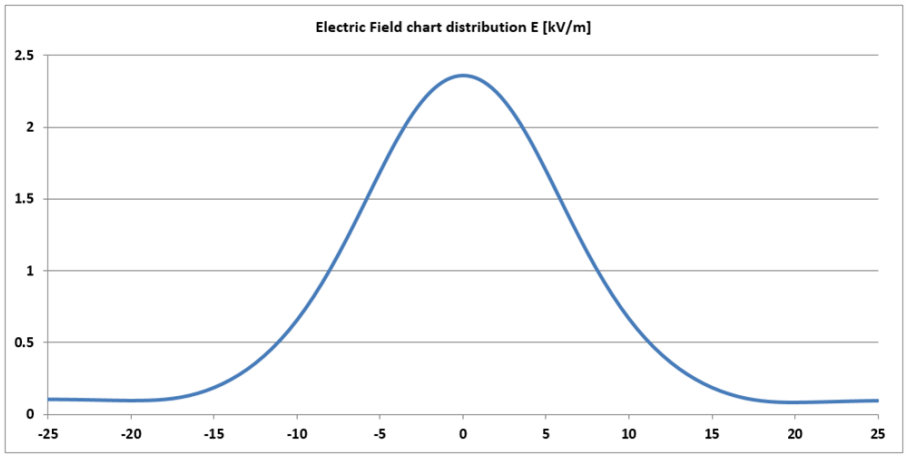


Figure 9-7 Electric Field Distribution for the Proposed Transmission Tower at 1 m above the Ground within the ROW

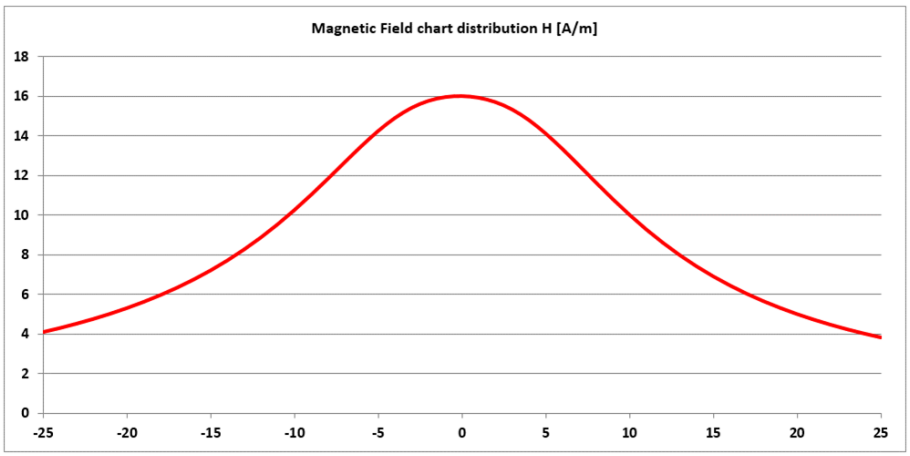


Figure 9-8 Magnetic Field Distribution for the Proposed Transmission Tower at 1 m above the Ground within the ROW

The maximum electric and magnetic fields within the ROW for various transmission towers can occur directly under the conductors and decreases out to the edge of the ROW. The phasing of double circuit that will be used in the proposed transmission line configuration results in cancellation effects for the electric fields resulting in rapid decrease with distance. The maximum calculated electric fields inside the ROW can exceed the recommended ICNIRP occupational exposure limits for some type of transmission towers. However, potential sensitive receptors will not be located within the ROW of the transmission line. EMF impacts of the Project during operation phase will be assessed in Table 9-33.

Table 9-33 Impacts of EMF during Operation Phase from the Transmission Line

Impact	Health impact due to EMF from transmission line		
Impact Nature	**Negative**	Positive	Neutral
	Impact on health is considered **Negative**		

Impact Type	**Direct**	Indirect	Induced		
	Direct impact on health of livelihoods or residences within the ROW				
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
	The impact duration is **Temporary** within the ROW				
Impact Extent	**Local**	Regional	Global		
	Impacts are localised within the ROW.				
Impact Scale	The impact scale is **Small** and limited to the ROW.				
Impact Frequency	The impact frequency is closely related to the operation of the wind farm and substation, and is assumed to be continuous during operation as a worst case.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	The impact magnitude is **Small**.				
Vulnerability of Receptors	**Low**	Medium	High		
	The vulnerability of receptor is **Low** as explained above.				
Significance	**Negligible**	Minor	Moderate	Major	
	The significance is **Negligible**				

Additional Mitigation and Management Measures

Other additional mitigation measures based on ESIA requirements to minimise impacts associated with EMF include:

- Avoid residential buildings, or acquire houses within the ROW, if possible;
- Avoid schools, hospitals, health clinics, and other similar buildings – the ETP alignment avoids these sensitive buildings and maintains at least a 20 m buffer to all schools and health clinics;
- Tower safety features – place warning signs prohibiting climbing on towers and incorporate design elements that prevent climbing of the towers; and
- Emergency contact information – provide signage at each tower with emergency phone numbers.

Electric fields can be easily shielded by trees, fences, buildings and most other structures. However magnetic fields are much more difficult to shield than electric fields.

Monitoring and Auditing

As there is the potential for buildings within the ROW, it is proposed that EMF monitoring is carried out by measuring at discrete distances from the transmission lines within the first year of the operation on a quarterly basis. Should thresholds be exceeded, further mitigation options should be reviewed and considered.

Residual Impact

The residual impact to occupational and public health from the transmission of power through the proposed 110 kV voltage transmission line is considered to be negligible.

9.7.4.2 Substation

Substations are part of the electricity supply network that enables the widespread use of electricity for public and industrial use. Inside the substation, there are switches, connections and a transformer. The transformer steps up voltage coming from wind farms and transforms it to the higher voltage of 110 kV used by transmission lines. The transformer is the main unit where EMF will be of similar magnitude as

the transmission lines and hence it has to be located at a height similar to the transmission line and provide sufficient buffer around it to minimise occupational and public hazards. EMF from other elements in a substation will be small and standard mitigation methods are available to reduce both electric and magnetic fields generated by them, as described below. The electric and magnetic field (EMF) levels within the fenced area of a substation depends on the number of transformers used in the substation. However, these EMF levels decrease rapidly with distance from the transformers and other electrical equipment. Most of the time, EMF levels drop to the same as surrounding background levels at a distance of 100 to 200 feet from the fenced area.

Potential impact

- Electromagnetic fields from transformers in substations and wind turbines.

Existing Controls

No existing controls were identified to mitigate this impact.

Significance of Impacts

Predicting magnetic field profiles for substations is a complex exercise given the multitude of time varying sources orientated in multiple directions. As a result, the magnetic field profile is highly dependent on the particular circumstances. In order to understand the magnetic field pattern in the proposed step up substation, similar substation modelling performed elsewhere (Tarmizi et al., 2016) was identified for discussion. Tarmizi et al. modelled magnetic field variability in a substation that had the 400 kV side connected to three loads, a shunt reactance and an autotransformer to step down the voltage to 220 kV. The substation considered by Tarmizi et al. was 280 m long, 140 m wide and the conductors were located at the height of 12 m above the ground (on the 400 kV side). The normal operating currents were at frequency of 50 Hz for each load. The magnetic field distribution was calculated at the height of 1.7 m where measurements were available for comparison. The computed results for the normal operating currents are presented in Figure 9-9.

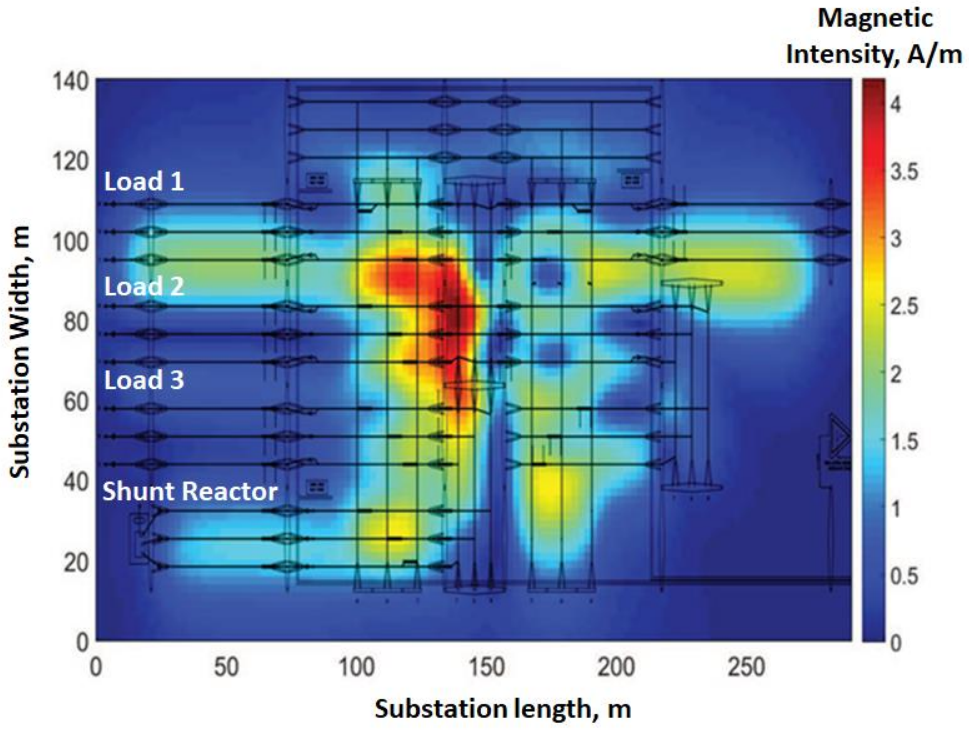


Figure 9-9 Magnetic Field Distribution in the Substation Studied by Tamrizi et al. (2016) for a 400kV substation (280 m by 140 m).

Table 9-34 shows that the predicted highest value of the magnetic field was 4.164A/m located along busbar 1, where it was connected to Load 1 with 200A. For the normal operation conditions of the substation, the maximum values of the magnetic field were found to be below public exposure limits proposed by ICNIRP. In addition, it clearly shows that the magnetic field decreases rapidly within the perimeter of the substation. However, for a lightning strike scenario, the magnetic field in the substation exceeded the public and the occupational exposure limit set by ICNIRP. The voltages and size of the substation used in the study by Tarmizi et al. were much higher than the proposed substation (voltage of 110 kV; and size up to 80 m long by 70 m wide) and hence the EMF impact is anticipated to be contained within the substation.

Table 9-34 Impacts of EMF during Operation Phase from the Substation

Impact	Health Impact due to EMF from Substation				
Impact Nature	**Negative**	Positive	Neutral		
	Impact on health is considered **Negative**				
Impact Type	**Direct**	Indirect	Induced		
	This impacts the health of livelihoods or residences within the substation.				
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
	The impact duration is **Temporary** within the substation.				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the substation.				
Impact Scale	The impact scale is **Small** and limited to substation.				
Impact Frequency	The impact frequency is closely related to the operation of the wind farm, and is assumed to be continuous during operation as a worst case.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	The impact magnitude is **Small**.				
Vulnerability of Receptors	**Low**	Medium	High		
	The vulnerability of receptor is **Low** as explained above.				
Significance	**Negligible**	Minor	Moderate	Major	
	The significance is **Negligible.**				

Additional Mitigation and Management Measures

All sources of magnetic field should be identified and proper mitigation measures implemented so that it is reduced well below ICNIRP standards for occupational and public health. A detailed electrical auditing of the substation should be carried out to identify all possible sources of EMF near the substation. The following methods for reducing magnetic fields can be used to effectively mitigate EMF impact from substation elements[25]:

- Shielding with specific metal alloys;
- Modifications to size, spacing, and configuration of conductors;
- Reducing conductor (phase) spacing;
- Optimal phasing in a multi-circuit corridor;
- Converting single-phase to split-phase circuits; and
- Placing facilities underground.

[25] EMF Design Guidelines for Electrical Facilities. Southern California Edison Company, Irwindale, California. 2014

Monitoring and Auditing

As there is the potential for buildings within the vicinity of the substation, it is proposed that EMF monitoring is carried out by measuring at discrete distances in the vicinity surrounding the substation within the first year of operation on a quarterly basis. Should thresholds be exceeded, further mitigation options should be review and considered.

Residual Impact

With appropriate mitigation measures, the occupational and human exposure can be minimised to fall under ICNIRP standards, therefore the residual impact to occupational and public health from the substation is considered to be negligible.

10. SOCIAL IMPACT ASSESSMENT

This Chapter presents the assessment of socio-economic impacts resulting from the construction and operation of the Project and is based on the baseline data presented in Chapter 7 and the impact assessment methodology detailed in Chapter 4.

This Chapter aims to:

- Define the scope of the social impact assessment including area of influence and receptors considered;
- Present the potential social impacts associated with the land acquisition, construction (including displacement) and operation of the Project; and
- Identify appropriate management and mitigation measures and corresponding monitoring that can be implemented by the Project owner.

This Chapter also identifies existing management plans and mitigation measures which the Project owner has already developed and implemented in the pre-construction phase.

10.1 Scope of Assessment

Based on the Project Description (Chapter 2), scoping outcomes (Chapter 5) and the socio-economic baseline (Chapter 7), the Area of Influence (AoI) for social impact of the Project to community is shown in Figure 10-1. Activities of the Project that may result in potential impacts to stakeholders, who are identified as Receptors of impacts, are listed in Table 10-1.

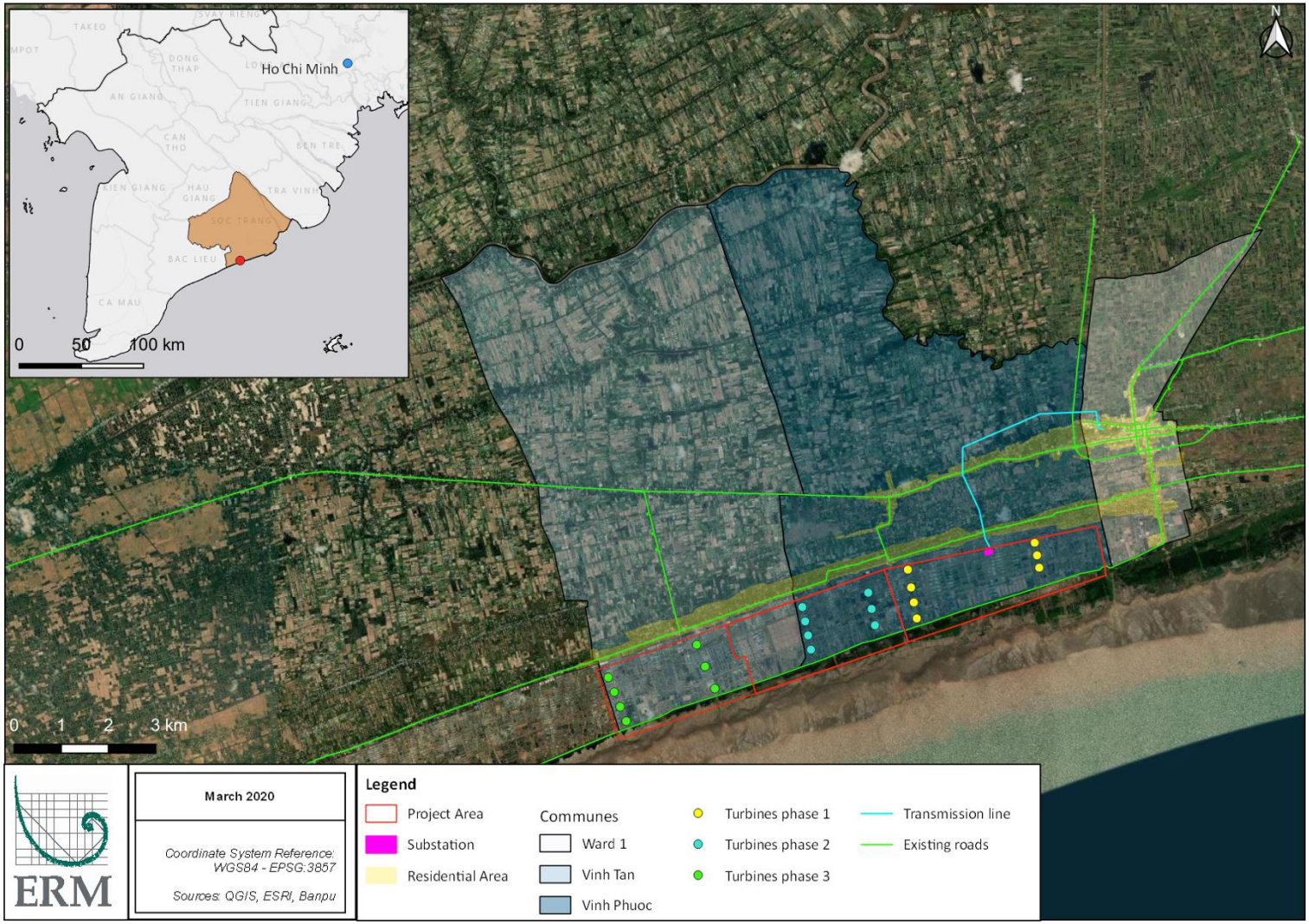


Figure 10-1 Project Area of Influence

Table 10-1 Summary of Potential Impacts, Receptors and Area of Influence

Potential Impact	Receptor of Impact	Area of Influence
Land Acquisition Phase		
Displacement and Disturbance to Cultural Heritages		
■ Loss of house ■ Loss of land ■ Loss or relocation of land attachments ■ Change of land use ■ Loss of/Impact on livelihood associated with loss of land resulting in full or partial loss of income ■ Restriction of access to cultural heritage sites	■ Local land users who will have their production land acquired by the Project. ■ Local aquaculture farmers and local fishers who do aqua-farming and fishing in and near the mudflat area where the Project is located ■ Local groups who visit the cultural heritage sites for religious belief and practices	■ Vinh Tan commune and Vinh Phuoc ward (main site and transmission line) ■ Ward 1 (transmission lines)
Construction Phase		
Potential Project Benefits		
■ Increased local employment and revenue ■ Temporary direct employment for the Project and induced employment opportunities by local suppliers ■ Improved local infrastructure ■ Support to community development via community development program of the Project	■ Local authorities at commune/district level ■ Local economy, local businesses ■ Local communities also using infrastructure ■ Local contractors/suppliers	■ Vinh Tan commune and Vinh Phuoc ward (main site and transmission line) ■ Ward 1 (transmission lines)
Impact on Community Health, Safety and Security due to Construction Activities (Non-influx Issue)		
■ Health impacts associated with dust, waste management, noise generated from construction activities ■ Increased incidence of traffic accidents from construction vehicle traffic and commuting ■ Security related impacts or concerns ■ Community safety due to the transportation of equipment and machine ■ Potential traffic congestion and risk to traffic safety in the area along the transportation route of the Project	■ Local communities living near the Project ■ People who have livelihood activities near the construction area of the Project ■ People who are fishermen with fishing activities along the transportation route ■ People living along the road of transportation of the Project	■ Cai Cui port to Vinh Chau town ■ Vinh Chau town community
Impacts on Community due to Presence of Influx		
■ Potential increase in the transmission of communicable diseases including vector borne, water borne and sexually transmitted diseases ■ Tension with local community linked to issues of cultural conflict	■ Local authorities at commune/district level ■ Local communities ■ Contractors' employees including construction workers	■ Vinh Tan commune and Vinh Phuoc ward (main site and transmission line) ■ Ward 1 (transmission lines)

Potential Impact	Receptor of Impact	Area of Influence
■ Tension among different stakeholder groups due to unequal distribution of benefits and impacts ■ Public services and infrastructure (health care, food and commodities, road, electricity supply, water supply and waste collection).		
Impacts to Cultivation, Aquaculture and Fishing Activities during Construction		
■ General disturbances by construction activities producing dust, waste and wastewater ■ Temporary occupation of farming land during construction of transmission line and substation	■ Local communities who are farmers and fishers with cultivation, aquaculture and fishing activities located nearby the Project's components	■ Vinh Tan commune and Vinh Phuoc ward (main site and transmission line) ■ Ward 1 (transmission lines)
Operational Phase		
Project Benefits		
■ Increase local revenue and employment; ■ Improved local supply and skills; improved local infrastructure (access road, school and clinics); ■ Support to local community development plans	■ Local communities and suppliers ■ Local authorities ■ Vietnam Electricity Corporate (EVN)	Vinh Chau town and Soc Trang province
General Disturbances from Operation Activities on Local Community		
■ Change of income sources, occupational profiles and land use ■ Impacts from operational noise of turbines and transformers ■ Visual impact ■ Impacts from shadow flicker	■ Affected households ■ Local communities	■ Vinh Tan commune and Vinh Phuoc ward (main site and transmission line) ■ Ward 1 (transmission lines) ■ Lai Hoa commune (adjacent to turbine areas)

10.2 Relevant Guidelines and Criteria

10.2.1 National Regulations

- Land Law No. 45/2013/QH13 dated November 29, 2013;
- Grievance Law No. 02/2011/QH13 dated November 11, 2011;
- Circular No. 07/2014/TT-TTCP issued by the Government Inspectorate;
- Administrative Procedures Law No. 93/2015/QH13 dated November 25, 2015;
- Civil Procedure Code No. 93/2015/QH13 dated November 25, 2015;
- Decree No. 18/2015/ND-CP dated February 14, 2015 on environmental protection planning, strategic environmental assessment, environmental impact assessment and environmental protection plans; and
- Decree No. 40/2019/ND-CP dated May 13, 2019 amending and supplementing a number of articles of Decrees detailing and guiding the implementation of the Law on Environmental Protection.

10.2.2 International Requirements

- Equator Principles III – Principle 5 focusing on Stakeholder Engagement;
- Equator Principles III – Principle 6 about Grievance Mechanism;
- IFC Performance Standard 1 – Assessment and Management of Environmental and Social Risks and Impacts;
- IFC Performance Standard 4 – Community Health and Safety;
- IFC Performance Standard 5 – Land acquisition and Involuntary Resettlement; and
- IFC Performance Standard 8 – Cultural Heritage.

10.3 Impact Assessment

In this section, potential social impacts, or the consequences of the interactions between the Project's activities and receptors, are assessed. Note that at the time of writing this report, the land acquisition, compensation and resettlement process for this Project was still in process (as of March 2020). Where the significance of the impact is assessed to be **Moderate** to **Major**, management measures, and corresponding monitoring measures, are proposed for the Client to consider.

10.3.1 Construction – Impacts of Land Acquisition Process on Displacement and Cultural Heritage

10.3.1.1 Potential Impacts

Vinh Chau Wind Power Plant No.3 is located in an onshore area of Vinh Phuoc Commune, Vinh Chau Town, Soc Trang Province. The Project Owner will build an operation house, substation, tranmission lines and wind turbines. It is noted that the Project area is registered in the Wind Power Development Master Plan of Soc Trang Province for the period of 2020 to 2030 under Decision No. 3909/QD-BCT dated May 6, 2014.

The land acquisition and Compensation, Support and Resettlement (CSR) process for the Project is goverment-led in accordance with the national requirements. It is understood from a meeting on February 5, 2020 between the Project Owner and ERM that at the time of this assessment the CSR process for the Project components had been divided into two phases. Phase 1 of the Project land acquisition process involves taking land for the construction of 110 kV transmission lines. The draft Detailed Measurement Survey (DMS) shows that the transmission line requires approximately 27 ha for the pole foundation and 80 ha for the safety corridors. Phase 1 of land acquisition affects 134 households and four organizations. Out of the 134 households affected, five households will have to be relocated; the remaining 129 households will be affected by loss of land, crops, trees, and/or structures. The compensation process for Phase 1 land acquisition is underway and is expected to be complete at the end of March 2020, in which all compensation and support to affected households will be paid off in cash. Phase 2 of the Project's land acquisition process is still at an early stage and thus the number of land users who may be affected was not available for the impact assessment. Based on current discussions, both physical and economic displacement are also envisioned for Phase 2 land acquisition.

The transmission line route has been designed to pass through agricultural land without cutting through any cultural works or historic relics. The ERM social baseline survey conducted in September 2019 reported that current land use in this area is mainly for aquaculture ponds, low-height crops (such as paddy rice, shallot, longan which are under 3 m in height). As reported in the Project EIA report, temporary land occupied for construction is also not likely to occur as the Project Owner and its contractors will utilise the permanently acquired land for pole foundation for the purpose of construction equipment laydown areas.

As per the above description, Project activities will impact the community, in particular on their access to agriculture and aquaculture-based livelihoods. In addition, the Project may also impact their physical assets if they are located on land to-be-acquired. As the result of these impacts, the local people will need to find a way to adapt to the changes brought about by the Project in order to continue living as they have been; while the Project Owner needs to propose and implement actions to mitigate such impacts at the same time.

At the time of writing, no unique cultural and historical sites or other natural special structures existed within a radius of more than 1 km of the construction site of the substation and operation house. This was also confirmed during the baseline survey for this ESIA. As a result, impact on cultural heritage is not considered to be an issue. However, should there be traces of archaeology discovered during excavation works, the Project Owner shall ensure that the Contractor appropriately manages the situation.

10.3.1.2 Existing Controls

The mitigation measures identified in the locally approved regulatory EIA include:

- Construction shall be planned to commence after the harvest period to allow the locals to harvest agricultural crops before the time of land clearance or construction. This will reduce the volume of waste generated from land clearance and vegetation deforestation, also.
- The Project Compensation, Support and Resettlement Plans for each affected household are being developed by the local authorities.The compensation is designed for people who have land acquired and people who face restrictions in land-use activities as well as those whose value of land decreases (e.g. along safety corridors).

10.3.1.3 Significance of Impact

Table 10-2 Impacts of Land Acquistion Process on Displacement and Cultural Heritage

Impact	Economic Displacement Impact				
Impact Nature	**Negative**	Positive	Neutral		
	Loss and change of livelihood impacts are considered **Negative.**				
Impact Type	**Direct**	Indirect	Induced		
	Loss of livelihoods and income are **Direct.**				
Impact Duration	Temporary	Short-term	Long-term	**Permanent**	
	The impact duration for some will be **Permanent** as some people will lose their house and/or land permanently and also potentially their income.				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area.				
Impact Frequency	The impact from permanent land acquisition of the Project has already occurred and is considered **one-off event**.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
	The impact magnitude is **Medium**.				
Vulnerability of Receptors	Low	**Medium**	High		
	The vulnerability of receptors is considered **Medium** as those affected will retain their ability to at least adapt to the changes brought about by the Project.				
Significance	Negligible	Minor	**Moderate**	Major	

	The significance is **Moderate.**

10.3.1.4 Additional Mitigation and Management Measures

The following additional mitigation measures are based on ESIA requirements to minimise impacts:

- As a result of the Project's potential impact on the local community, the Project Developer should establish a Grievance Mechanism Procedure (GMP) as part of the Stakeholder Engagement Plan (SEP) to manage the concerns of communities affected by the land acquisition process. The GMP will be used by the team overseeing the land acquisition process to collect the community's concerns and forward them to the relevant authorities for their direction on how to resolve each concern. The GMP should be disclosed to affected communities prior to the Project's implementation, so they are aware of the grievance channel and understand the grievance procedure and process;
- A Livelihood Restoration Plan (LRP) will be developed and implemented for those identified as Project affected households. The LRP will be designed to ensure sustainable outcomes for impacted land users. It is noted that the LRP should have specific targets for 5 physically displaced households including close monitoring of vulnerable assessment and higher priority to be entitled livelihood restoration programmes;
- The Project Owner shall prepare and implement a Community Development Plan (CDP) during the Project's lifetime that focuses on the affected community, with the intention that the affected community will benefit from the existence of the Project;
- The Project should monitor the land acquisition process to ensure it complies with Vietnamese regulations. This activity should be supported by documentation recording the land acquisition process. This will be required for internal and external audits;
- In reference to the Resettlement Framework based on IFC Resettlement processes, there should be compensation for assets' users under ROW, especially for standing crops;
- In reference to the IFC Resettlement Handbook, the Land Acquisition Audit should be conducted after the payment of land compensation for pole footing and compensation for assets under ROW;
- Detailed Measurement Survey (DMS) should include the asset survey, where assets are classified by type and all losses that are temporary and permanent are recorded. Examples of typical classification and valuation of land by use, in reference to the IFC Resettlement Handbook, are irrigated agriculture, non-irrigated agriculture, pasture, forest, housing, and commercial; and
- A Chance Find Procedure shall be established and implemented provide instructions, including stopping of works, reporting to the Project Owner and reporting to the appropriate authorities upon discovery of archaeological traces. All construction contractors and workers involved in ground excavation works shall be trained and made aware of this procedure.
- Project Owner shall supervise the implementation of all proposed mitigation measures and monitoring by the contractors.

10.3.1.5 Monitoring and Audit

The following monitoring and audit measures are recommended:

- Monitor the land acquisition process to ensure it complies with the Vietnamese regulations for land acquisition;
- Ensure the Project's preparation phase includes management of relocation, clearance and compensation, and resettlement of households directly affected; and

- Monitor the implementation of the Grievance Mechanism, LRP and CDP.

10.3.1.6 Residual Impact

With the implementation of the above mitigation measures, the residual impacts would be expected to be **Minor**.

10.3.2 Construction – Impact to Local Economy from Employment and Business

10.3.2.1 Potential Impacts

The benefits to the local economy predictedly arising during Project Construction include temporarily direct and indirect job creation for local skilled and unskilled workers as well as local procurement.

According to the local EIA 2019, the Project will require approximately 100 full-time workers (which can increase up to 200 workers during peak times) throughout the course of construction phase which will last 12 months. The socio-economic baseline indicates that although the local population of working age are enthusiastic for job opportunities through the Project, most of them have primary and secondary education and skill levels that are likely suitable for manual work or unskilled employment. At this stage, there is no information on the proportion of unskilled jobs that could be filled by local community members. The local EIA stated a commitment from the Project Owner to provide training and employment support to local residents. However, it was not specific about the provision of employment opportunities associated with the Project.

In addition to employment opportunities, the Project will also require goods and services for its construction activities such as construction materials, equipment, cleaning, catering and other hospitality services. Therefore, the above-mentioned opportunities are likely to provide additional opportunities for existing small and medium-sized businesses located around the Project area. These may include sand and rock suppliers, excavator and bulldozer equipment suppliers, restaurants, and lodging providers. In addition, grocery supplies and to some extent, restaurant services offer potential for the local community close to the Project location. Local people can also be employed by those who establish new businesses around the Project area. The economy of the local community is therefore expected to develop with the abovementioned new livelihood and income opportunities. At the end of the construction phase, however, worker demobilisation will occur and only a certain percent of workers will be eligible to stay on. The significant reduction in workforce will, as a result, reduce the local community's income. This impact will be discussed further in the section dedicated to the Project's operation phase.

10.3.2.2 Existing Controls

There were no mitigation measure identified in the locally approved EIA to strengthen local economic development during the Project's timeline.

10.3.2.3 Significance of Impact

Table 10-3 Impact to Local Economy from Employment and Business during Construction

Impact	Local economy from employment and business		
Impact Nature	Negative	**Positive**	Neutral
	Impacts to local economy from employment and business opportunities are considered **Positive.**		
Impact Type	**Direct**	**Indirect**	**Induced**

	There is potential to increase the incomes of affected people by working for the Project Owner or under the contractor/subcontractor. The affected community can also work for people who establish business around the Project area and/or the affected community can establish their own business to support the Project during construction phase.			
Impact Duration	Temporary	**Short-term**	Long-term	Permanent
	The impact duration is **Short-term.**			
Impact Extent	**Local**	Regional	Global	
	Impacts on affected community occur within the Project area.			
Impact Frequency	The impact frequency is considered **Continuous.**			
Impact Magnitude	**Positive**	Negligible	Small	**Medium**	Large
	The impact magnitude is **Medium**.			
Adaptability of Receptors	**Low**	Medium	High	
	The adaptability of the receptor is **Low**.			
Significance	Negligible	Minor	**Moderate**	Major
	The significance of impact is considered **Moderate.**			

10.3.2.4 Measures for Positive Impact Promotion

Based on ESIA requirements to optimise benefits to the local community through employment and business opportunities, the Project Owner should implement the following additional measures:

- Formalise in all contracts a clause on the Project's commitment to local employment and acquiring local good and services wherever possible;
- Communicate clear information about Project-related employment and business opportunities and prioritise local people wherever feasible. Such communication should be conducted at least four months before recruitment so that local people have enough time to prepare for the recruitment process (for example, by attending short training courses to improve their skills);
- As locals are more likely to qualify for low-skilled jobs, the Project Owner shall negotiate with contractors to provide detailed requirements on educational qualifications and skills for each job opportunity. This will allow for identification of any skills gap and allow for solutions (e.g. training and skill enhancing courses) to be implemented;
- Implement a Livelihood Restoration Plan (LRP) to ensure sustainable outcomes for significantly affected land users, especially skill training to affected people to assist them to meet the recruitment requirements of the Project for semi-skills;
- Implement specific Community Development Plans (CDP) targeting promotion of local employment and supporting of local businesses. Consideration should be given to healthcare promotion and employment opportunities for vulnerable groups (accounting for 32 percent of total surveyed people). Training to improve skills of local people, especially people with disabilities, can also be provided under the CDP;
- If possible, the Project Owner and the EPC contractor should work closely with local/relevant authorities, particularly in Vinh Phuoc ward, Ward 1, and Vinh Tan commune to synchronise the Project's needs in terms of local labour as well as locals' capacity;

- At the end of construction phase, the Project Owner should, for those who will have worked for the Project in construction phase, consider providing skill improvement training for them to be able to access to similar jobs in other projects in the country; and
- Project Owner shall supervise the implementation of all proposed mitigation measures and monitoring by the contractors.

10.3.2.5 Monitoring and Auditing

The following monitoring and audit measures are recommended:

- Monitor the implementation of the LRP, in particular the livelihoods of the farmer communities that have aquaculture and cultivation activities where the Project sites are located.

Project Owner shall supervise the implementation of all proposed mitigation measures and monitoring by the contractors.

10.3.2.6 Residual Impact

With the implementation of the above mitigation measures, the residual impacts would be expected to be **Moderate**.

10.3.3 Construction – Disturbance to Aquaculture and Cultivation Activities

10.3.3.1 Potential Impacts

The ERM Social Baseline Survey 2019 identified that cultivation and aquaculture farming provide the main source of income and employment (including family-owned businesses and hired workers) for people residing near the Project site and along the transmission line. During Project construction, the aquaculture activities that are potentially affected include extensive and industrial farming practices of shrimp (white leg, tiger and cray shrimp), brine shrimp (also known as Artemia), fish (goby fish, seabass, mullet and catfish) and salt. In terms of local cultivation activities, shallot, fruit and vegetables, and paddy rice are the main crops in Vinh Phuoc ward and Vinh Tan commune. The farming system is mostly short-term family cultivation and techniques used are still mainly based on traditional irrigation types. Surface, ground and borehole water are the main sources for agricultural production.

During construction, the main risks to aquaculture and cultivation activities are physical disturbance and degradation of water quality (i.e. earthworks, concreting and transportation may generate dust; wastewater and solid waste including rock, soil and sludge from excavation might lead to increased sedimentation) in Vinh Phuoc ward (Phase 1) and Vinh Tan commune (Phase 2). As such, the impact will be limited to the production areas of these two communities where the brackish water is used as the water source for aquaculture farming and other water resources are used for daily uses and farming activities. Other in-land aquaculture farms where the water source is from nearby rivers will not be impacted. Potential consequence of water quality degradation might include possible introduction of diseases for species and decrease on production and yield. It is considered these activities will only disturb a relatively small area and only occur during a certain period.

10.3.3.2 Existing Controls

The local EIA recommended that the Project Owner ensure the following measures be implemented to minimise the above impacts:

- All vehicles, machines, equipment used for the Project must have and maintain valid operating permits from Vietnam Register Department to ensure compliance with emission standards;
- All vehicles transporting construction materials (soil, sand, cement, rocks, etc.) should have trunks covered and all straps fastened to prevent dust dispersion into the environment and to comply with

safe regulations for transport. EPC contractor shall install and maintain silencers for transportation vehicles if requested;

- The minimum distance from a concrete mixers location to the closet residential area or public facility is 200 m;
- Construction sites will be fenced (by brick, wood or plastic panels) to prevent dust spreading from the construction site to the outside;
- Construction sites and areas along the transport roads and residential areas shall be sprayed with water regularly, especially on hot sunny days to minimise dust spreading.
- Oil and grease, construction materials and machinery will be stored indoors and above ground level to avoid flooding that may lead to water runoff to local water sources.
- Construction of embankment and provision of drainage facilities to the embanked areas surrounding Project excavation sites will be implemented to manage flooding and stormwater runoff to local canal system.
- Discharge of construction waste (stone, sand, etc.) as well as domestic waste from Project activities into rivers, canals, ponds, lakes, wells will be prohibited.

10.3.3.3 Significance of Impact

Table 10-4 Impacts or Disturbances to Aquaculture and Cultivation Activities during Construction

Impact	Disturbance to Aquaculture and Cultivation Activities				
Impact Nature	**Negative**	Positive	Neutral		
	Impact on local livelihoods is considered **Negative.**				
Impact Type	**Direct**	Indirect	Induced		
	Disturbance to community activities and income is considered **Direct.**				
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
	The impact duration is **Short-term.**				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area.				
Impact Frequency	The impact from Project activity is considered **Occasional**.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
	The impact magnitude is **Medium**.				
Vulnerability of Receptors	Low	**Medium**	High		
	The vulnerability of the receptor is **Medium** as explained above.				
Significance	Negligible	Minor	**Moderate**	**Major**	
	The significance is **Moderate.**				

10.3.3.4 Mitigation Measures

In addition to those additional mitigations identified above, the following additional mitigation measures are based on ESIA requirements to minimise impacts during Project construction phase:

- A robust implementation of the SEP would enable the Project Owner to reach harmonisation and alignment with the community members (besides the local authorities), thus, reducing the risk of

interruptions to the Project. It will be important to provide and communicate detailed information about the Project's plan and schedule, particularly that which relates to land clearing and construction, with special attention given to farmers near Project locations; and

- The Project Owner should consult with the local authorities, affected households and other relevant third parties to develop and implement a CDP as recommended above in order to share the mutual benefits from the Project development with the local community. Members of the Kh'mer and Hoa ethnic minority groups are known to exist within the Project area. While direct Project impacts appear unlikely, a CDP should give priority to this group;
- A robust implementation of the SEP would enable the Project Owner to reach harmonisation and alignment with the community members (besides the local authorities), thus, reducing the risk of interruptions to the Project. It will be important to provide and communicate detailed information about the Project's plan and schedule, particularly that which relates to land clearing and construction, with special attention given to farmers near Project locations;
- The Project Owner should establish and implement a grievance mechanism as discussed in the above section; and
- Project Owner shall supervise the implementation of all proposed mitigation measures and monitoring by the Contractors.

10.3.3.5 Monitoring and Audit

The following monitoring activities are recommended:

- Ongoing monitoring and periodical auditing are required to check if the above mitigation measures are being implemented; and
- Monitoring and audit are also required to be conducted in accordance to those proposed in Chapter 9 for Air Quality Impact Assessment, Water Quality Impact Assessment, the ESMP and CDP.

Project Owner shall supervise the implementation of all proposed mitigation measures and monitoring by the contractors.

10.3.3.6 Residual Impact

With the implementation of the above mitigation measures, the residual impacts would be expected to be **Minor**.

10.3.4 Construction – Impact to Community Health, Safety and Security due to Presence of Migrant Influx

10.3.4.1 Potential Impacts

The presence of non-local workers during the construction phase may raise concerns of local communities surrounding the construction site of the Project. These concerns relate to community health and safety risks and increased pressure on public resources due to the introduction of migrant labour influx. This section will elaborate on these concerns.

Based on information derived from the local EIA 2019, the Project is likely to employ approximately 100 full-time workers (which can increase up to 200 workers during peak times) throughout the construction phase. The proportion of local workforce is unknown at the time of this assessment, and so the following assessment takes a worst-case scenario where none of the potential 200 workers employed by the Project are from local areas.

Migrant construction workers are expected to stay offsite in either temporary worker accommodation or local boarding houses. The information on the location of worker camps has not been confirmed; however, if temporary worker accommodation is built they are expected to be located near the site.

From onsite observations, construction workers can also stay in boarding houses in the local area. Given that this Project is the first large-scale industrial project in Vinh Chau Town, local communities have not been exposed to such influx of immigrants. In the case that 200 migrant workers stay within the community, it might bring different cultures and possibly trigger conflict with local community. With construction workers being mostly male, it might also increase the risk of gender-based violence in the community as the daily service workers who provide meals and laundry services might be women from the surrounding communes.

The worker camp might increase pressure on local public facilities and resources, and if not managed carefully the camp's disposal of waste water and domestic waste might contaminate local water resources. This in turn will cause hygiene issues. The risk of spread of communicable diseases such as Tuberculosis, Hepatitis A, Hepatitis B, HIV/AIDS and other sexually transmitted diseases between migrant workers and local people could also threaten the health of local communities and increase pressure on local health facilities. Concerns relating to increased drug use and criminal activities might also increase pressure on the local corrective facility.

10.3.4.2 Existing Controls

The mitigation measures identified in the locally approved regulatory EIA include:

- Contractors shall prioritise local employment for unskilled jobs to minimise the number of migrant workers;
- Contractors shall be responsible for application of temporary residences for construction workers at the local police department and for monitoring social security in the area where migrant workers will be accommodated;
- Project Owner and its contractors shall promote collaborative relationships among local communities and migrant workers; and
- Project Owner is responsible for ensuring the health and safety of all workers and local communities by complying with relevant regulatory requirements on medical safety and food hygiene of the construction sites.

10.3.4.3 Significance of Impact

Table 10-5 Impact to Community Health, Safety and Security due to Presence of Migrant Influx

Impact	Impact to community due to presence of migrant influx				
Impact Nature	**Negative**	Positive	Neutral		
	Impacts on local community's health and safety, as well as community's public facilities are considered **Negative.**				
Impact Type	**Direct**	Indirect	Induced		
	Disturbance to community health and safety is considered **Direct.**				
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
	The impact duration is **Short-term.**				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area.				
Impact Frequency	The impact from Project activity is considered **Continuous** during the construction phase.				
	Positive	Negligible	**Small**	Medium	Large

Impact Magnitude	The impact magnitude is **Small** as the number of migrant workers is expected to be small (maximum 200 workers) compared to the total population of the surrounding communes within Vinh Chau town.			
Vulnerability of Receptors	Low	**Medium**	High	
	The vulnerability of the community as the receptor is **Medium** as explained above.			
Significance	Negligible	**Minor**	Moderate	**Major**
	The impact significance is considered **Minor.**			

10.3.4.4 Mitigation Measures

The following additional mitigations measures are based on ESIA requirements to minimise impacts:

- Contractors should conduct compulsory medical examinations (i.e. annual health check-ups) for Project workers including Project contractors, as required by national regulations, to ensure they are fit for work and to monitor the prevalence of communicable diseases;
- Contractor should establish an onsite health clinic for Project workers involved in construction;
- Contractor should establish worker accommodation to minimise the migrant workers staying in boarding houses;
- Contractor should implement a “zero tolerance” policy towards inappropriate behaviour from and amongst the workforce;
- Project Owner should implement the SEP. Community Liaison Officers of the Project should assign and deliver induction training to provide guidance on requirements for culturally appropriate behaviours, and an overview of the risks to migrant staff and workers. The training will include key cultural sensitivity awareness topics/programs to ensure workers including security staff do not un-intentionally offend the local community, especially ethnic minorities;
- Project Owner should establish and disclose a grievance mechanism as mentioned in the above section;
- Project Owner and contractor should regularly engage with local authorities relevant to crime (i.e. local police) or other social problems (e.g. village leaders) for prevention of issues and for mitigation purposes when issues arise;
- Project Owner and contractor should collaborate with local authorities and relevant authorities to organise awareness raising and educational programs for workers;
- Contractor should conduct appropriate workers-community engagement programs such as sporting or cultural events to improve understanding and cohesion between non-local workers and the surrounding communities;
- Project Owner should support local health centres to conduct campaigns on community health education as part of the CDP, to enhance the community’s resilience to potential negative impacts arising from industrial projects; and
- Project Owner should support the local authority to improve and maintain the local roads if there are any damages caused by Project activities both directly (due to Project vehicle) and indirectly (due to workers’ transportation).
- A code of conduct, including required behaviours and attitudes towards the locals, shall be developed for all staff and workers within the construction site;
- All staff and workers within the construction site shall be trained and made aware of the code of conduct;

- If the Project construction workforce is accomodated on site in a worker camp, a Worker Accommodation Management Plan shall be developed and implemented in accordance with local regulations and IFC requirements to ensure the well-being of the workforce as well as the health, safety and security of local communities; and
- Mitigation and management measures for various waste streams, including domestic waste, construction waste and hazardous waste are stated in Section 9.

Project Owner shall supervise the implementation of all proposed mitigation measures and monitoring by the contractors.

10.3.4.5 Monitoring and Audit

The following monitoring activities are recommended:

- Ongoing monitoring and periodical audit are required to check if the above mitigation measures are in implementation; and
- Monitoring and audit are also required to be conducted in accordance to the schedule proposed in the CDP.

10.3.4.6 Residual Impact

With the implementation of the above mitigation measures, the residual impacts would be expected to remain **Minor**.

10.3.5 Construction – Direct Impact on Community Health and Safety during Construction (Non-influx Issue)

10.3.5.1 Potential Impacts

This section analyses the potential impacts to community health and safety during the Project's construction phase due to construction activity-related increases in noise and dust pollution and traffic incidents. General construction activity for wind power projects includes excavation, building and concrete works, transportation of materials, equipment and workers and construction of associated facilities including the access road and transmission line. These activities are likely to affect the health, safety and wellbeing of the communities surrounding the Project site and along the transmission line route due to increased noise and vibration, decreased air quality and inappropriate waste handling or disposal. Without proper management of noise, dust, and waste from such construction activities, local residents living along the mudflat areas of Vinh Phuoc ward, Vinh Tan commune and the transmission line in Vinh Phuoc ward and Ward 1 may experience nuisance.

The main sources of noise and vibration during this phase are movements and operation of heavy machines and light vehicles during the construction process (main site and transmission line). However, these construction emissions do not represent a constant source of noise that will occur on a day-to-day basis for the duration of the construction schedule. These emissions will occur for only portions of the works, and during those works will not occur for entire daytime periods. This is typical of construction works and for projects of this scale and nature.

Dust will be mostly produced during the earthworks and through the transport of construction materials to and from the Project site. The construction activities (such as soil disturbing activities, storage of materials such as concrete, and transportation of materials), without proper controls, are likely to result in dust generation localised to the main Project site and along the transmission line, especially in the dry season. From the assessment of dust and noise in Chapter 9, these impacts are considered negligible to minor during construction, as such impacts to human health should be insignificant.

Transportation of heavy and large equipment, construction materials and workers could also be an impact source for community traffic safety. According to the local EIA report, large and heavy equipment

will be transported by heavy trucks from Cai Cui Port to the Project site utilising existing national and district roads. Sand, rocks and other construction materials will be provided by local suppliers who will utilise Nam Song Hau and other district roads for shipping within a radius of 20 km from the Project site. The exact number of vehicle and trucks to be used for Project transport are unknown at the time of writing this assessment; however, it is expected that construction would place additional strain on local access roads. Based on the experiences of similar projects, local transportation may be interrupted during the peak transportation periods of the construction phase, mainly from the middle to the end of the 12 month period. The information on transportation routes indicates that Project vehicles will be moving on the main national, provincial and district roads, which are considered busy roads. As such, it is expected to potentially lead to traffic congestion and is likely to affect traffic safety in the area along the route.

10.3.5.2 Existing Controls

The mitigation measures identified in the locally approved regulatory EIA include:

- All construction works shall be carried out during day time only; Project Owner shall notify and obtain consent from local community for any work carried out during night time through appropriate public consultation. Excavation works, transport of electrical equipment and construction materials shall be conduct during appropriate times;
- Only registered reduced-noise and reduced-vibration vehicles and machines are allowed to used;
- The numbers of materials transporting vehicles at one time shall be determined appropriately to reduce noise pollution; honking should be limited as necessary when passing through residential areas or in the vicinity of schools, hospitals or religious facilities;
- Night transport of materials shall be limited if the construction site is within a distance of 100 m from the nearest residential area. Workers are prohibited from making noise during the rest time of local communities; this regulation will be documented in the site Code of Conduct;
- Transport of long and heavy equipment (such as turbine, transformers) shall be contracted by a specialised transport unit. This transport unit must have a business license and a means of transport suitable for the weight and size of the transformer as well as a valid technical safety and environmental protection certificate;
- Traffic lights and speed limit signs shall be installed on roads leading to construction sites;
- Transportation coordinators shall be assigned to manage vehicles entering the construction sites, especially during rush hours; and
- In the case where the means of transport exceeds the load capacity of the bridge or road, Project Owner and its contractor shall bear all responsibilities and cost of damages or reinforcement of the bridge and road to their pre-construction conditions.

10.3.5.3 Significance of Impact

Table 10-6 Direct Impact to Community Health and Safety during Construction (Non-Influx Issue)

Impact	Direct Impact on Community Health and Safety during Construction (non-influx issue)			
Impact Nature	**Negative**	Positive	Neutral	
	Direct impact on community health and safety is considered **Negative.**			
Impact Type	**Direct**	Indirect	Induced	
	Impact to community safety and health is considered **Direct.**			
	Temporary	**Short-term**	Long-term	Permanent

Impact Duration	The impact duration is **Short-term.**				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area.				
Impact Frequency	The impact of Project activities will be **Continuous** during the Construction Phase.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	The impact magnitude is **Small.**				
Vulnerability of Receptors	Low	**Medium**	High		
	The vulnerability of the community as a receptor is **Medium.**				
Significance	Negligible	**Minor**	Moderate	**Major**	
	The impact significance is **Minor.**				

10.3.5.4 Mitigation Measures

The following additional mitigation measures are based on ESIA requirements to minimise impacts:

- The Equipment Transportation Plan shall be established and implemented. These plans shall be prepared by the contractor, reviewed and approved by the Project Owner before equipment is mobilised to the construction site. The implementation of these plans shall be monitored by the general contractor and Project Owner. These plans shall be communicated to the People's Committee of affected communes;
- Only road transport that have valid registration certificates are allowed to utilise equipment transportation. Drivers must have valid driving licenses;
- Contractors for transporting long and heavy equipment must obtain circulation permit for overload/oversize vehicles in accordance with Circular No. 46/2015/TT-BGTVT;
- Trainings to workers traffic safety for motorcycles shall be provided;
- Contractors are recommended to provide shuttles for their workers to travel and from construction sites and workers' hostels;
- Security guard teams shall be deployed in construction sites in order to protect Project properties and to ensure that no local people can enter construction sites due to safety concerns. Site patrols should be regularly performed by security guard teams during the day;
- Fences and warning signs shall be put up around construction sites in order to prevent local people from entering the sites and encountering safety risks such as falling into holes or electrocution;
- Staff in charge of security guarding shall be trained to react swiftly in urgent cases of accidents;
- Build fences surrounding the Project area at the beginning of the construction phase to limit impacts of noise and dust emissions from the Project on the surrounding area.
- Implement a policy that determines the standard of gasoline and oil used for construction and transportation vehicles;
- Prepare a reasonable construction plan to shorten time required for construction works, and implement reasonable construction procedures to ensure public traffic safety and to limit harmful impacts to surrounding communities due to dust and other emissions, flooding or the formation of stagnant swamp-like pools on the construction site;
- Ensure major noise emitting sources (such as concrete batching plants, pile machines, generators, etc.) are kept at appropriate locations;

- Any works that are required during the night time period (10PM to 7AM) should be justified and task-specific noise mitigation and management measures should be implemented to reduce noise impacts to acceptable levels. These additional measures should consider the potential for sleep disturbance impacts that could occur during the night time period due to “peak” or “maximum” noise level events e.g. metal on metal contact, or general clangs and bangs; and
- Although this impact is predicted to be Minor, the Project is required to comply with the measures proposed in the Air Quality Impact Assessment and Noise Impact Assessment to minimise disturbances to local people and to maintain the significance of the impact as Minor.

Project Owner shall supervise the implementation of all proposed mitigation measures and monitoring by the contractors.

10.3.5.5 Monitoring and Audit

Monitoring and audit will follow the recommendations made in the Air Quality Impact Assessment and Noise Impact Assessment, i.e. there are monitoring programs specified in the locally approved regulatory EIA, but no further monitoring is required.

10.3.5.6 Residual Impact

With the implementation of the above mitigation measures, the residual impacts would be expected to be **Minor**.

10.3.6 Operation – Impact to Local Economy from Employment and Business

10.3.6.1 Potential Impacts

During the operational phase of the Project, the local economy will be positively influenced by an increase in taxation revenue of the Province, demand for materials and services and tourism development. The Project expects to employ 10 employees in total for operation, of which percentage of local employees is not determined at the time of this assessment. As described in the Feasibility Study Report, the Project will operate for 20 years and is expected to have a positive impact on the surrounding community in the Project area. With the existence of the Project, there will be training opportunities and new employment prospects provided by the Project. This will result in increased disposable income and potentially influence employees’ lifestyles, creating flow-on economic benefits in the wider community.

The Project is located next to the planned tourist and cultural area of Vinh Chau Town. Ho Be eco-tourism area and Thien Hau Pagoda spiritual site are close to the Project site. From the experience of the Bac Lieu Wind Farm nearby, as wind power development is still relatively new to the Mekong delta region, Vinh Chau Wind Power Plant No.3 Project may become an emerging attractive feature of the area and will help to boost local tourism. The Project Owner expects that the local community will embrace the opportunity to provide supporting tourism facilities such as lodging, rental space, restaurants, stores and other tourism-related business.

10.3.6.2 Existing Controls

There was no mitigation measure identified in the locally approved EIA to strengthen local economic development during the Project’s timeline.

10.3.6.3 Significance of Impact

Table 10-7 Impact to Local Economy from Employment and Business during Operation Phase

Impact	Impact to Local Economy from Employment and Business

Impact Nature	Negative	**Positive**	Neutral	
	Impacts on local economy from employment and business is considered **Positive.**			
Impact Type	**Direct**	**Indirect**	Induced	
	The Project will provide **Direct** local employment and open up new business opportunities **Indirectly**.			
Impact Duration	Temporary	Short-term	**Long-term**	Permanent
	The impact duration is **Long-term.**			
Impact Extent	**Local**	Regional	Global	
	Impacts are within the Project area.			
Impact Frequency	The impact from permanent land acquisition of the Project has already occurred and is considered **Occasional**.			
Impact Magnitude	**Positive**	Negligible	**Small**	Medium	Large
	The impact magnitude is **Positive** due to potential employment opportunities and potential increases in business opportunities related to local tourism and supporting facilities. Since the operational workforce requires only 10 people, this impact magnitude is considered to be **Small.**			
Adaptability of Receptors	**Low**	Medium	High	
	The adaptability of receptor is **Low** as Vinh Chau Wind Farm No.3 Project is the first project to exist within the surrounding communes.			
Significance	Negligible	**Minor**	Moderate	Major
	The significance is **Minor.**			

10.3.6.4 Additional Mitigation and Management Measures

Based on ESIA requirements to optimise the benefits to local community through employment and business, the Project Owner will implement the following additional mitigation measures:

- The Project Owner will implement a policy prioritising local households as workers for the Project during the operation phase to create employment opportunities for them as proposed in the local EIA;
- The Project Owner should continue implementing the CDP throughout the Project's operation phase and monitor the implementation of this plan; and

Project Owner shall supervise the implementation of all proposed mitigation measures and monitoring by the contractors.

10.3.6.5 Monitoring and Audit

The following monitoring and audit measures are recommended:

- Continuous monitoring and periodical audit of the implementation of the CDP.

Project Owner shall supervise the implementation of all proposed mitigation measures and monitoring by the contractors.

10.3.6.6 Residual Impact

With the implementation of the above mitigation measures, the residual impacts would be expected to be **Minor**.

10.3.7 Operation – General Disturbance on Local Community in Operations

10.3.7.1 Potential Impacts

It is assumed that a targeted CDP, including support for improving the living standards of the local community in terms of health care and accessibility to public services, for example, will be developed and implemented during the Project's construction phase. During the operation phase, only 10 workers will be required for the operational workforce. It is assumed that, therefore, only a very small proportion of employment, mostly unskilled jobs, could be sourced from the local community during this phase. Therefore, the opportunities for local employment will be significantly reduced and this will have an impact on the income and livelihoods of local people, especially those who will have worked for the Project during its construction phase. Even though equal opportunity for women and men in work has been stated in the Social Baseline 2019, the Project Owner cannot ensure that gender balance will be achieved within the workforce during operations.

As discussed in the Visual Impact Assessment, the presence of turbines in the Project area will have a visual impact on the community, especially in terms of visual aesthetics, which will affect the local community that live along the coast and tourists that visit the area. Visual impact of the Project was assessed by considering the composition of available views as a result of changes to the landscape, peoples' responses to any changes, and overall impacts with respect to visual amenity. There may be a transient impact on tourists coming to visit the area of the seawall and, there may be a transient impact on the people travelling along the coastal road. The Project area being rural and of a similar elevation may make the turbines visually noticeable from a distance. Within a view of less than 1 km, the presence of these turbines will be visually noticeable by local residents. However, considering the number of turbines (7) and site setting, the visual magnitude of the effect is assessed as Medium as the Project will result in noticeable changes in the view at an intermediate distance and less concentrated change across an expansive area.

Similar to visual impact, the significance of shadow flicker impact will be identified based on the distance between turbines and residential areas and the light direction during the daytime. From the result of shadow flicker impact modelling for this Project, within the radius of 1,450 m from the WTGs shadow flicker impact will be negligible to minor in the real case and worse case scenarios.

Noise from the operation of turbines, substation and transformers of the Project is defined as another potential factor causing nuisance and disturbance to the surrounding community. The noise modelling and assessment for operation activities of the Project results negligible significance and thus no further measure is required.

Risk from blade throw and transmission snapping is assessed in the unplanned events Chapter.

10.3.7.2 Existing/In Place Controls

The mitigation measures identified in the locally approved regulatory EIA include:

- Aircraft warning lights shall be installed on WTGs;
- Staff should regularly patrol along the 110 kV transmission line to determine any violation against safety corridors (e.g. structures built within the safety corridors) in accordance with Decree No, 14/2014/NĐ-CP (Term 13). In cases of violation, the Project Owner will report to the People's Committee and appropriate authorities;
- Maintenance to the transmission line shall be conducted regularly;
- Solutions which ensure safety and reduce risk of fire and exposure to fire and Electromagnetic field for local people in accordance with Law (Decree No 14/2014/NĐ-CP) shall be designed;
- Security guards shall be assigned to prevent activities of locals to bring harm to themselves and the WTGs;

- The Project guarantees to recover and compensate for accidents related to environments and health of the local communities which the Project is responsible for;
- Minimising the rays reflected by the turbine blades by optimising the smoothness of the rotor surface as well as coating the blades with less reflective material;
- Choosing the most advanced wind turbine available (Siemens Gamesa SG 5.0-145), with a compact design, to reduce the Project's visual impact and with low levels of noise generation; and
- Painting wind turbine pillars and turbine foundation a light grey to create a comfortable, pleasant and gentle environment for people living around or near the wind turbine columns, and to harmonise with the general landscape of the area. Also, keeping each turbine at a distance of 300 – 320 m to avoid causing visual disturbances.

10.3.7.3 Significance of Impact

Table 10-8 General Disturbance to Local Community during Operation Phase

Impact	General Disturbance to Local Community During Operations				
Impact Nature	**Negative**	Positive	Neutral		
	Direct impact on communities' living condition is **Negative.**				
Impact Type	**Direct**	Indirect	Induced		
	Disturbance is deemed to be a **Direct** disturbance especially for the settlement area nearby to the coastal area.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	The impact duration is **Long-term.**				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area.				
Impact Frequency	The impact from Project activities is considered to be **Continuous** during operations.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
	The impact magnitude is **Medium** because of the visual impact to the community.				
Vulnerability of Receptors	Low	**Medium**	High		
	The vulnerability of the community is **Medium** as explained above.				
Significance	Negligible	Minor	**Moderate**	**Major**	
	The impact significance is **Moderate.**				

10.3.7.4 Additional Mitigation and Management Measures

The Project is recommended to implement the additional measures proposed in Chapter 9 for Air Quality Impact Assessment, Noise Impact Assessment, Visual Impact Assessment, Shadow Flicker Impact Assessment and Electromagnetic Interference Impact Assessment, and other measures listed; as well as the following additional mitigations measures to minimise impacts:

- Project Owner shall monitor the potential impacts from shadow flicker by monitoring through engagement with residents and relevant authorities in adjacent Lai Hoa commune during the operational phase;

- Project Owner should continue implementing the CDP throughout the operation phase to continue its support of local people by improving their socio-economic conditions. The CDP should be considered the Corporate Social Responsibility program of the Project Owner;
- Project Owner should continue implementing the SEP including the grievance mechanism throughout the Project's operations; and
- Project Owner shall supervise the implementation of all proposed mitigation measures and monitoring by the Contractors.

10.3.7.5 Monitoring and Audit

The following monitoring activities are recommended:

- Ongoing monitoring and periodical audit as proposed in the ESMP to ensure the above mitigation measures are in implementation; and
- Monitoring and audit are also required to be conducted in accordance to the schedule proposed in Chapter 9 for Noise Impact Assessment, Visual Impact Assessment and Shadow Flicker Impact Assessment.

10.3.7.6 Residual Impact

With the implementation of the above mitigation measures, the residual impacts would be expected to be **Minor**.

11. UNPLANNED AND ACCIDENTAL EVENTS

This Chapter presents the probable impacts of unplanned events associated with construction and operation of the Project. The unplanned events are those that potentially arise from technical failure, human error, or as a result of natural phenomena.

The assessment of potential impacts arising from unplanned events are based on the environmental baseline data, consultation with BPP and judgements based on ERM's professional knowledge and previous experience. The assessment of unplanned impacts considers the probability of events occurring and an estimate of the severity of consequences. The assessment of the severity of impacts due to fire and explosion is based on the worst case scenario, where it is assumed that safety devices and associated measures fail to operate properly resulting in the incidents.

11.1 Scope of Assessment

This assessment addresses the following unplanned and non-routine events:

- Fire and explosion, including Unexploded Ordnance (UXO);
- Spillage of fuel, oil, chemicals and hazardous materials;
- Vehicle/vessel accident; and
- Blade throw.

The resources and receptors of unplanned events depend on the type and extent of the incident. For instance, cyclones and severe storms can cause multiple impacts including spills, fire and blade throw. Receptors for wind farms include both physical and biological resources. Unplanned events that result in fire and explosion can cause damage to life and property. Project employees and surrounding communities may also be affected by emergency events.

11.2 Relevant Guidelines and Regulatory Requirements

The impact assessment is based on local legislation, regulations and standards as well as international guidelines. Those relevant to the unplanned and accidental events are listed below.

11.2.1 Local Regulations

Related to Fire, Explosion, and Toxic Release

- Law on Fire Prevention and Fighting No. 27/2001/QH10;
- Law No. 40/2013/QH13 Amendment and Supplement a Number of Articles in the Law on Fire Prevention and Fighting No. 27/2001/QH10;
- Decree 79/2014/ND-CP guiding the Law on Fire Prevention and Fighting;
- Government Decree No. 113/2017/ND-CP dated October 9, 2017 specifying and providing guidelines for implementation of certain articles of the Law on Chemicals; and
- Circular No. 32/2017/TT-BCT dated December 28, 2017 specifying and providing guidelines for implementation of certain articles of the Law on Chemicals and Decree 113/2017/ND-CP specifying and providing guidelines for implementation of certain articles of the Law on Chemicals; and
- Decree No. 02/2019/TT-BCT Regulating Wind Power Development.

11.2.2 International Standards and Requirements

The Equator Principles and IFC Performance Standards applicable to the Project in term of unplanned events are provided in Table 11-1.

Table 11-1 Applicable Equator Principles and IFC Performance Standards

Performance Standard	Requirements
PS1: Assessment and Management of Environmental and Social Risks and Impacts	Emergency Preparedness and Response Where the project involves specifically identified physical elements, aspects and facilities that are likely to generate impacts, the ESMS will establish and maintain an emergency preparedness and response system so that the Client, in collaboration with appropriate and relevant third parties, will be prepared to respond to accidental and emergency situations to prevent and mitigate any harm to people and/or the environment. The preparation will include the identification of area where accidents and emergency situations may occur, communities and individuals that may be impacted, response procedures, provision of equipment and resources, designation of responsibilities, communication, including that with potentially affected communities and periodic training to ensure effective response. The emergency preparedness and response activities will be periodically reviewed and revised, as necessary, to reflect changing conditions.
PS4: Community Health, Safety, and Security	Emergency Preparedness and Response The Client will also assist and collaborate with the affected communities, local government agencies, and other relevant parties, in their preparations to respond effectively to emergency situations especially when their participation and collaboration are necessary to respond to such emergency situations. If local government agencies have little or no capacity to respond effectively, the Client will play an active role in preparing for and responding to emergencies associated with the Project. The Client will document its emergency preparedness and response activities, resources, and responsibilities, and will disclose appropriate information to affected communities, relevant government agencies, or other relevant parties.

11.3 Assessment Methodology

The impact assessment is based on the baseline data of sensitive resources and socio-economic conditions as detailed in the baseline Chapters. This Chapter describes the overall approach used for the assessment of impacts and the identification of mitigation options.

The assessment of significant impact of unplanned events considers the probability of event occurring and estimates the severity of the consequences of the events. Given that unplanned events are often single events that occur irregularly, the assessment also takes into account the frequency and likelihood of the impact.

The mitigation measures prescribed for each of the impacts are based on international good practice (as recommended under the IFC EHS Guidelines listed above), and national regulatory requirements relevant to unplanned events.

11.4 Assessment of Impacts

11.4.1 Fire and Explosion, including Unexploded Ordnance (UXO)

11.4.1.1 Potential Impacts

The potential source of impacts associated with fire and explosion would occur as a result of the following events:

- Damage of the WTGs, transmission lines, insulators or other supporting parts;
- Electrical arcs or flashovers;
- Lightning strike;
- Plant and equipment failure;
- Storage of combustible materials; and
- Explosion of Unexploded Ordnances (UXOs) left behind from the war.

The potential impacts from large scale fires include the release of smoke and fumes in the broader area generating health issues associated with inhalation of toxic substances and uncontrollable wildfire that would contribute to a loss of crops and habitats and impact on the economics of the area (e.g. community and workers' jobs and incomes).

11.4.1.2 Existing Controls

The mitigation measures identified in the locally approved regulatory EIA include:

During construction phase:

- Equipping the site with firefighting equipment including: sand, CO2, shovels.
- Training and raising workers' awareness of firefighting.
- Checking, maintaining and verifying construction equipment, and firefighting equipment in order to be ready for rescue if problems occur.
- Ensuring UXO clearance prior to construction works.
- Implementing rescue measures when incidents occur, with the following measures:
  - Find all measures to bring victims out of dangerous areas, and then isolate dangerous areas (if any);
  - First aid and transfer of victims to the nearest medical center or hospital (if necessary);
  - Notify site leaders, contractors and Project owners; and
  - Notify local authorities and Military Command for coordination.
- Installing lightning protection system: protection against lightning strikes directly at stations and turbines with lightning collecting needles.
- Grounding system: using a combination system of bar piles to form square grounding grid, grounding grid using Φ12 galvanized steel and grounding piles. Lightning collecting needles, gate columns, beams, equipment pillars, equipment, electrical cabinets grounded with Φ12 galvanized steel and M95 copper wires.
- Ensuring all equipment and machinery used in the Project are regularly inspected and monitored, and have an accompanying manual, complete with technical specifications.

- Ensure the Project is equipped with firefighting tools such as water tanks, CO2 tanks and sand barrels, all of which properly fulfil the fire prevention requirements of the local fire prevention and fighting agencies.
- During operation, when there are incidents, the relays placed at the substation and transmission line will automatically switch off.
- Ensure the specified station is fully equipped with fire protection and firefighting systems (firefighting water source, firefighting equipment such as pump station, fire hydrant, sprinkler, misting system, fire extinguisher, CO2, sand ball, newspaper, etc.).
- To ensure electrical safety in the station, the distance of installation and distance to the conductive circuits must comply with the current electrical equipment rules. Equip properly with safety signs and barriers.
- Establish an action team to respond to incidents in case of a fire.
- Regularly rehearse, inspect and maintain fire prevention and firefighting equipment.
- Raise awareness of officials and operators on fire prevention and firefighting issues.
- In addition, collaborate with the local fire protection team for response, where necessary.
- Rescue measures if a fire incident occurs:
  - Alert people to join in extinguishing the fire in their capabilities and conditions;
  - Quickly disconnect the breaker where fire occurs;
  - Use fire protection equipment, such as sand, CO2 tanks, shovels and water to extinguish the fire at stations;
  - Immediately report to the professional firefighting force for firefighting (if necessary);
  - Notify the Head / Deputy Head.

During operation phase

The proposed mitigation and management measured in the regulatory EIA include:

- Surveying geological area fully and in accordance with technical requirements before construction.
- Ensure the foundation design and column based on geological survey results refer to geological documents of the Project area and its surrounding location.
- Ensure the construction process complies with design and regulations.
- Periodically check the quality of works, and promptly overcome subsidence incidents.
- If problems occur, the relays automatically disconnect and the alarm system will work. At that time, operators will immediately go to the scene of the incident.

11.4.1.3 Significance of Impacts

The plant and transmission line are to be designed in accordance with the national regulations; of these safety is the first priority so the likelihood of fire is very unlikely. In case of fire or explosion, the impact magnitude is considered Medium. Given the area and geographical distance of the Project to nearby receptors, the magnitude of fire or explosion impact is considered be Low and sensitivity is considered medium. Therefore, the impact significance of fire is classified as Minor.

Table 11-2 Impacts of Fire and Explosion during Construction and Operation phases

Impact	Impacts of fire and explosion during construction and operation phases.

Impact Nature	**Negative**	Positive	Neutral	
	Fire and explosion endangers lives and in serious cases, fires may spread and result in loss of crop and other property.			
Impact Type	**Direct**	Indirect	Induced	
	Fire and explosion **directly** endangers lives and other assets.			
Impact Duration	**Temporary**	Short-term	Long-term	Permanent
	The impact duration is **Temporary.**			
Impact Extent	**Local**	Regional	Global	
	Impacts are within the Project area and the immediate surroundings.			
Impact Scale	The impact scale is **Small** considering the size of the substation and the length of the transmission line and the wider resources available.			
Impact Frequency	The likelihood of fire and explosion is **Unlikely** as Project components are to be designed in accordance with national regulations.			
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	The impact magnitude is **Small** as fire occurrences would likely be small and controllable.			
Vulnerability of Receptors	Low	**Medium**	High	
	Receptor vulnerability is **Medium**.			
Significance	Negligible	**Minor**	Moderate	Major
	The significance is **Minor.**			

11.4.1.4 Additional Mitigation Measures

The following additional mitigations measures are based on ESIA requirements to minimise impacts associated with fire and explosion:

- Establish an emergency response and evacuation plan. The plan includes the following items:
  - Immediately sound the nearest fire alarm if a fire occurs, then report the event to shift supervisor or foreman immediately for emergency response;
  - If the emergency alarm sounds, all employees shall stop all activities and move to emergency assembly places immediately;
  - Limit the fire areas by utilising appropriate firefighting equipment, if the fire is small and controllable; and
  - Follow the procedures provided in the emergency response and evacuation plan to take action.
- Project items relating to fire prevention ,including equipment and fire protection systems, must be constructed, checked and approved according to the approved designs;
- Install dike, bund around areas to contain chemicals in case of leakages or spillages;
- Pressurised gas cylinders should be secured properly and should not be placed beyond the sides or ends of vehicles when being transported; and
- There should be secondary containment, drip, trays, or other overflow and drip containment measures provided for hazardous materials;
- Ensure proper equipment is provided on the site and regularly inspected and maintained. This equipment includes:
  - Fire extinguishers, which should be visible and accessible to people;

- Proper communication equipment, such as emergency telephones, radio communication.

- Conduct regular inspection and maintenance to eliminate potential risks, with actions including:
  - Maintaining safety clearance around the panel system to keep flammable material such as vegetation from coming into contact or in close distance with the panels;
  - Maintaining a clear firebreak around the facility's fence line;
  - Pruning or cutting vegetation as required, to avoid the risk of contact with the transmission lines and to maintain adequate separation distance; and
  - Clear any obstacles on the path between the rows of panels to ensure access to firefighting equipment.
- Conduct regular inspection programs to maintain equipment and operability of mechanical systems; and
- Equip the site with proper equipment and regularly inspect and maintain that equipment.

11.4.1.5 Residual impacts

With the implementation of the mitigation measures, residual impacts of fire and explosion are considered Negligible for both the construction and operation phases.

11.4.1.6 Monitoring and Auditing

The residual impacts after implementing the mitigation measures are expected to be Negligible, so no monitoring or audit program is needed to manage this non-planned event.

11.4.2 Spillage of Fuel, Oil, Chemicals and Hazardous Materials

11.4.2.1 Potential Impact

Project construction and operations have the potential to cause a leakage and spill incident. Potential sources of spills will be mainly from incidental spills caused by construction activities.

An unplanned release of fuels or chemicals may damage the terrestrial environment, soil, groundwater and surrounding communities. The severity of impact depends on a variety of factors, such as the volume of spill or leakage and the characteristics of the discharge.

11.4.2.2 Existing Controls

The mitigation measures identified in the locally approved regulatory EIA include the following items.

During operation phase: Prevention of insulating oil leakage from transformers, through the following measures:

- Track signs of oil leakage from transformers in each shift;
- When detecting oil leakage, immediately isolate the site (if necessary) and use oil-absorbent paper or wiping cloth to thoroughly handle the oil leakage on the surface;
- MBA engineering inspection, in case of necessary troubleshooting;
- Oil-cleaning rags and oil-absorbent paper will be used for hazardous waste storage areas of stations.
- Measures to immediately implement if leaks or oil spills occur:
  - Alert everyone to join in extinguishing the fire in their capabilities and conditions;

- Quickly disconnect the breaker where fire occurs;
- Use fire protection tools at stations, such as sand, CO2 tanks, shovels and water to extinguish the fire;
- Immediately report to the professional firefighting force for firefighting;
- Notify the Head / Deputy Head;
- Isolate the oil spill area;
- Notify the unit capable of handling and collecting, transporting and handling oil and flammable chemicals;
- Use materials such as sand, oil absorbent paper, or cleaning cloth to thoroughly remove the oil in the tank to ensure the amount of rain water can once again flow oil-free;
- Oil-cleaning rags and oil-absorbent paper are used for hazardous waste storage areas of stations.

11.4.2.3 Significance of Impact

Accidental contaminant spills from construction activities, such as diesel or oil leaking from machinery, have the potential to impact soil, freshwater and/or groundwater quality. The main concern associated with accidental contaminant spills relates to the potential impact on human health from exposure to contaminated soils or contaminated groundwater. It is noted that the impact of accidental spills is dependent on the location of the spill and the contaminant properties. Accidental contamination spills may also occur during operation of the wind farm and substation, and the impacts are likely to be similar to those described during construction phase.

Table 11.3 Impacts of Spillage of Fuel, Oil, Chemicals and Hazardous Materials during Construction and Operation Phases

Impact	Spillage of fuel, oil, chemicals and hazardous materials due to onshore activities during construction and operation				
Impact Nature	**Negative**	Positive	Neutral		
	Accidental spills can affect human health due to exposure to contaminated soils, or consumption of contaminated groundwater for drinking or agriculture.				
Impact Type	**Direct**	Indirect	Induced		
	Accidental spills **directly** affect human health.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	The impact duration is **Long-term** as contaminants will be in the soil and groundwater for a long time after construction is completed.				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area and the immediate surroundings.				
Impact Scale	The impact scale is **Small** considering the length of the transmission line and the number of pylons near paddy fields and the wider resources available.				
Impact Frequency	The likelihood of spillage of fuel, oil, chemicals and hazardous materials is **Possible** as there are some existing controls.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	The impact magnitude is **Small** as the spillage is likely to be in small volumes.				
Vulnerability of	Low	**Medium**	High		

Receptors	Vulnerability of receptors is **Medium** as locals use freshwater sources for activities such as drinking and irrigation.			
Significance	Negligible	**Minor**	Moderate	Major
	The significance is **Minor.**			

11.4.2.4 Additional Mitigation Measures

The following additional mitigation measures are based on ESIA requirements to minimise impacts associated with spillage of fuel, oil, chemicals and hazardous materials for both the construction and operation phases:

- A register of on-site hazardous substances should be maintained during construction and operation;
- Appropriate bunding shall be used when there is a risk of leaks, spills or loss of containment;
- Any deficiencies found must be recorded and immediately reported to the work area manager in order for the deficiency to be rectified as soon as practicable;
- Maintain clean-up spill kits in relevant locations within the Project area;
- Securely store hazardous materials in impermeable containers in buildings. Set up protective barriers as applicable;
- Develop procedures for loading/ unloading to minimise the risk of incidents during operations;
- Conduct routine inspections and preventive maintenance for all vehicles and equipment on a regular basis to detect spills, leaks and the potential for such occurrences.

11.4.2.5 Residual impacts

With the implementation of the mitigation measures, residual impacts of spillage of fuel, oil, chemicals and hazardous materials due to onshore and nearshore activities are considered Negligible.

11.4.2.6 Monitoring and Auditing

The residual impacts after implementing the mitigation measures are expected to be Negligible, so no monitoring or audit program is needed to manage this non-planned event.

11.4.3 Vehicle and Construction Accident

11.4.3.1 Potential Impacts

Project activities including importation of WTGs and transportation of construction material and equipment during the Project's construction phase require long road transportation. There will be an increase in the number of traffic vehicles in and out of the Project WTG's layout as a result of the Project, which will increase the risk of collision or incident. The transportation route of the Project's equipment from Cai Cui Port to the Project site will be approximately 100 km, and passes through a number of urbans, towns and residential areas. Therefore, the potential impact of a vehicle accident needs to be assessed thoughtfully. In addition to the possibility of a traffic accident, the construction and installation of wind turbines will include heavy works and work at height. Therefore, the risk of a construction accident, and the health and safety of Project workers also need to be assessed and managed thoughtfully.

11.4.3.2 Existing Controls

The mitigation measures identified in the locally approved regulatory EIA include:

Road Safety:

- Trucks must meet all technical safety requirements and vehicles must be inspected by functional agencies before they can be put into use. When operating, the driver must follow the traffic laws; when entering the Project area, follow the operator's instructions for direction, location, and loading;
- There should be limited transportation during rush hours where there is high traffic density;
- Project owners and construction contractors must arrange a time for the transportation of raw materials and equipment in order to avoid traffic congestion in the area;
- At the access roads to the Project area, all road signs must be presented adequately to instruct all vehicles going within the site.

Construction Health and Safety

At the construction site, the Project owner should appoint a member of staff to monitor labour safety issues. The safety training programs for workers and staffs in the construction site should be held periodically. The following measures can also be implemented:

- Before working in high positions, workers have to check labour tools and safety belt. These tools should be neat, lightweight, and easy to handle;
- Workers mustn't work in high positions when it is dark, foggy, rainy, or if lightning or wind are of level 4 or higher;
- Workers working on the ground have to wear helmets and keep a safe distance when working in a dangerous position;
- All workers' health is to be checked periodically to ensure health standards for working in high positions, and to ensure workers' are able to do the work they undertake. At health checks, it is also a suitable opportunity to propagate Project procedures on labour safety. Within each team of about 30-40 workers, there should be sufficient medical staff to care and treat common diseases such as influenza and other infectious diseases, and to deliver first aid to injured workers before moving victims to district health centres or provincial hospitals.
- Absolutely comply with safety regulations on the installation and operation of electric equipment;
- When the transmission line traverses residential areas (especially where there is high population density), insulation equipment needs to be installed to avoid potential electrical incidents;
- Periodically inspect and remove the branches of trees which are higher than 6 m in the safety corridor;
- Ensure labour discipline, safety rules and implement regulations on the labour protection equipment provided (helmets, gloves, safety belts);
- Construction area must be isolated by fences, have warning signs installed at the area under construction, and only allow the relevant people on duty to enter that area;
- Ensure there be sufficient drainage at the construction site to ensure no water pools at the construction site, and have no rainwater or wastewater overflowing into the surrounding buildings;
- Foundation holes on the construction site should be covered tightly or enclosed to ensure safety for workers. Trenches, pits located near roads are to be enclosed with a barrier of at least 1 m in height. There must also be signal lights switched on at night;

- As per section 11.4.1, there must be tools and firefighting materials available onsite such as sand, fire hydrants, CO2, and shovels to ensure safety in terms of fire prevention and firefighting;
- Facilities should be built for food safety for workers to limit infections;
- Protective equipment should be provided to workers to prevent noise, vibration and dust pollution impacting labourers working near noisy equipment.

To ensure safety when erecting turbine towers:

- The construction process must strictly comply with approved technical designs, regulations and procedures for turbine tower foundation construction;
- Machinery and equipment must be checked periodically before operation;
- Before working in high positions, workers have to check labour tools and safety belt. These tools should be neat, lightweight, and easy to handle;
- Before mounting equipment, it is necessary to check fastening wire and cable are hooked carefully. Workers are not allowed to stand under the parameters of crane operation;
- Installation of electrical equipment and materials must comply with the principles designed to prevent equipment and materials from scratches and damage;
- Maintenance and testing must be carried out in compliance with specified regulations for each type of equipment and material used;
- Construction machines and devices need to be checked carefully before using. In addition to the leader of construction, there should be a dedicated employee tasked with monitoring staff safety and working environment (if necessary). This employee would be responsible for checking tools and protective equipment, and regularly guiding workers on health, safety and environmental protection during construction.

11.4.3.3 Significance of Impact

11.4.3.3.1 Vehicular Accident

Impacts due to collision and their significance may range from property damage and injuries to personnel to a fatality, depending on various factors including the type of vehicle, the size of vehicle and the velocity at which it is traveling at the time of the collision.

For this Project materials and equipment will be transported via Cai Cui Port to the Project site. The road transport route is about 100 km long, and traverses National Road 91C and Provincial Road 11. In some areas, the road is narrow and passes through many residential areas. The Magnitude of impact, therefore, is considered Moderate.

Section Table 11-4 relates to vehicular accidents.

Table 11-4 Impact of Vehicular Accident

Impact	Unplanned vehicle accident			
Impact Nature	**Negative**	Positive	Neutral	
	Possible impacts associated with collision are considered **Negative**.			
Impact Type	**Direct**	Indirect	Induced	
	Impacts of the collision **directly** affects nearby receptors.			
Impact Duration	Temporary	**Short-term**	Long-term	Permanent
	The impact duration is **Short-term**.			

Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area and the immediate surroundings.				
Impact Scale	The impact scale is **Medium** considering the length of the transportation routes.				
Impact Frequency	The frequency of this impact is **Low** and can be occurred in short term				
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
	The impact magnitude is **Medium**.				
Vulnerability of Receptors	Low	**Medium**	High		
	Vulnerability of receptors is Medium, i.e other road users and pedestrians.				
Significance	Negligible	**Minor**	Moderate	Major	
	The significance is **Minor.**				

11.4.3.3.2 Working Accident

The nature of the Project presents occupational health and safety risks, which can result in impacts on worker health and safety.

Construction will involve a range of activities that could contribute to or present an occupational health and safety risk, resulting in an accident or injury. Example of activities that could contribute to an accident or injury include:

- The use of large mobile equipment, such as backhoes, bulldozers, graders and mobile cranes, which could, if not managed correctly, lead to an accident or injury;
- Manual handling associated with day to day construction activities; and
- Working with heavy equipment, working at height.

The above is not an exhaustive list of potential risks and hazards, but presents examples of the types of activities that could lead to an accident or injury. It appears that workplace fatalities in Vietnam, particularly in the construction sector, are on the rise (VNExpress 2019). In 2017, more than 9,000 workplace accidents occurred; killing 982 workers and injuring over 9,000 others (Vietnam News 2018). Key potential impacts that relate to workers' health and safety during Operation and Construction phases include:

- Risks to occupational health and safety of workers on construction site; and
- Injury to workforce due to poor construction standards or poor maintenance.

Table 11-5 Impacts of Working Accident

Impact	Working accident			
Impact Nature	**Negative**	Positive	Neutral	
	Possible impacts associated with collision are considered **Negative**.			
Impact Type	**Direct**	Indirect	Induced	
	Impacts will **Directly** affects nearby receptors.			
Impact Duration	Temporary	**Short-term**	Long-term	Permanent
	In cases of accidence occur, the impact duration is **Short-term**.			
Impact Extent	**Local**	Regional	Global	
	Impacts are within the Project area and the immediate surroundings.			

Impact Scale	The impact scale is **Small** considering the length of the transportation routes and short term construction.				
Impact Frequency	The likelihood of a Working Accident occurring is **Moderate**.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	The impact magnitude is **Small**.				
Vulnerability of Receptors	**Low**	Medium	High		
	The vulnerability of receptor is **Low**.				
Significance	Negligible	**Minor**	Moderate	Major	
	The significance is **Minor.**				

11.4.3.4 Additional Mitigation Measures

The following additional mitigation measures are based on ESIA requirements to minimise impacts:

- Provide training for workers focused on health and safety on site;
- Ensure that workers (including contractors) complete a Job Hazard Analysis (JHA) prior to undertaking construction activities, and also conduct daily toolbox discussions to ensure hazards are identified and management measures are implemented;
- Ensure equipment is well maintained and sufficient lighting is available to maintain a safe work environment;
- Establish a traffic management plan prior to the transportation of heavy equipment and seek cooperation from local authorities/road police.

11.4.3.5 Residual Impacts

With the implementation of the above mitigation measures, residual impacts of vehicle and working accidents are considered Negligible for the construction phase.

11.4.3.6 Monitoring and Audit

The residual impacts after implementing the mitigation measures above are expected to be Negligible, so no monitoring or audit program is needed to manage this non-planned event.

11.4.4 Blade Throw

11.4.4.1 Potential Impacts

Blade throw events generally occur as a result of rotor blade failure, which results in the ejection or throwing of the rotor blade which in turn can endanger people living or working close to the wind farm. Publicly available reports and case studies have revealed an increasing trend to locate wind farms in the proximity of build-up areas, which can endanger people living or working close to those wind farms. It has therefore become strictly necessary to define setback distances and/or buffer zones surrounding

wind farms, to minimise any risk of damage or injury caused by component failure. Research has been conducted in the past to assess the root cause of blade throw incidents and is currently ongoing[1234].

11.4.4.2 Existing Controls

There are a number of blade throw mitigation measures proposed in the regulatory EIA, that relate to wind turbine and foundation design as well as other management measures. These controls include:

- Surveying the geological area fully and in accordance with technical requirements before beginning construction.
- The foundation design and column should be based on geological survey results, as well as geological documents of the Project area and surrounding locations.
- The construction process must comply with approved design, regulations, and technical processes for the construction of foundation piles.
- The quality of works should be periodically checked, and any subsidence incidents should be quickly dealt with.
- When problems occur, the relays will automatically disconnect and the alarm system will be activated. When that occurs, operators will immediately go to the scene of the incident.

11.4.4.3 Blade Throw Assessment

11.4.4.3.1 Considerations and Assumptions

Blade throw/ ejection incidents have been categorised into the following groups, based on photographic evidence of incidents over the years, modelling studies by various research groups and blade test practices based on the IEC 61400-23 technical specifications. They have been classified as (a) root connection failure; (b) catastrophic structural buckling or separation; (c) leading edge, trailing edge, or other bond separation; (d) lightening damage; (e) erosion; (f) failure at outboard aerodynamic device; (g) reduction in stiffness of blades (up to 10 percent); (h) superficial structural or delamination/ laminate wrinkling that eventually becomes permanent leading to damage; and (h) over-speeding due to failure of supervisory control and data acquisition (SCADA) to rectify the failure or high wind/ cyclonic/ meteorological conditions[5].

Considering all of the above, it is difficult to attribute blade throw failure to a single attribute or a combination of attributes. Therefore, regulations in some countries and recommendations to define setback distances and/or buffer zones are currently being framed to minimise the risk of damage or injury from component failure.

[1] Eggwertz S, Carlsson I, Gustafsson A, Linde M, Lundemo C, Montgomerie B, Thor S. Safety of wind energy conversion systems with horizontal axis. Technical Note HU-2229, Flygtekniska Försöksanstalten (FFA—The Aeronautical Research Institute of Sweden), Stockholm, 1981.

[2] Eggers AJ, Holley WE, Digumarthi R, Chaney K. Exploratory study of HAWT blade throw risk to nearby people and property. Proceedings of the 2001 ASME Wind Energy Symposium, Reno, Nevada, 2001; 355–367.

[3] Montgomerie B. Horizontal axis wind turbine blade failure, blade fragment six degrees of freedom trajectory, site risk level prediction. Fourth International Symposium on Wind Energy Systems, Stockholm, Sweden, HRA Fluid Engineering, 1982; 389–401.

[4] Turner D. A Monte Carlo method for determining the risk presented by wind turbine blade failures. Wind Engineering 1986; 11: 1–20.

[5] Robinson et al. Study and development of a methodology for the estimation of the risk and harm to persons from wind turbines. 2013. Prepared by MMI Engineering Ltd for the Health and Safety Executive 2013

11.4.4.3.2 Existing Standards for Blade Ejection / Blade Throw

In the Vietnam context, at present there is no decided level of setback distance from wind farms identified to ensure safety of settlements. However, the International Finance Corporation [1] has recommended a setback distance of 1.5 x turbine height (tower + rotor radius), based on a review of existing literature in this domain, and encompassing the rationale that WTG models have varying dimensions. This modelling suggests that theoretical blade throw distance can vary with size, shape, weight, and speed of blades, as well as height of turbine. It is therefore recommended that the minimum setback distances required to meet noise and shadow flicker limits be maintained with respect to sensitive residential receptors to provide further protection. The IFC also recommends minimising the probability of a blade failure by implementing the following:

- Selecting wind turbines that have been subject to independent design verification/certification (e.g. IEC 61400-1);
- Conducting surveillance of manufacturing quality; and
- Ensuring that lightning protection systems are properly installed and maintained.

Recommendations also include carrying out periodic blade inspections and repairing any defects that could affect blade integrity, equipping wind turbines with vibration sensors that can react to any imbalance in the rotor blades, and shutting down turbines if necessary.

11.4.4.3.3 Qualitative Blade Throw Assessment Methodology

The qualitative blade throw assessment encompasses the rationale that has been proposed by the IFC pertaining to setback distances of 1.5 x turbine height (tower + rotor radius).

This Project comprises 21 wind turbines. The blade throw/blade ejection (BT/BE) assessment was carried out considering one (1) of the wind turbine specifications proposed to be used in this Project. The wind turbine(s) considered in blade throw or blade ejection assessment include:

- Siemens Gamesa SG 4.5-145: 127.5 m (tower height) and 145.0 m (rotor diameter)

The theoretical setback distances of the WTGs as per IFC Wind EHS guidelines have been presented in Table 11-6. This information was utilised to independently assess the setback distances of the receptors that were identified using the latest satellite imagery of the Project area.

Table 11-6 Setback Distances Adopted for the Project WTGs

WTG Model	Tower height	Rotor Radius	Calculated setback distances in metres as per IF Wind EHS guidelines[2]
Siemens Gamesa SG 4.5-145	127.5 m	145 m	408.8

11.4.4.3.4 Receptors

With regard to the Project, the nearby receptors and the setback distance have been presented in Figure 11-1, where the circle around each WTG is of 408.8 m. It is evident from the figure that few of the receptors are located within the impact zone of theoretical blade throw, such as T1-01, T1-04, T2-01, T2-04, T3-01 and T3-04.

[1] EHS guidelines for wind energy, IFC, August 7, 2015

[2] EHS guidelines for wind energy, IFC, August 7, 2015

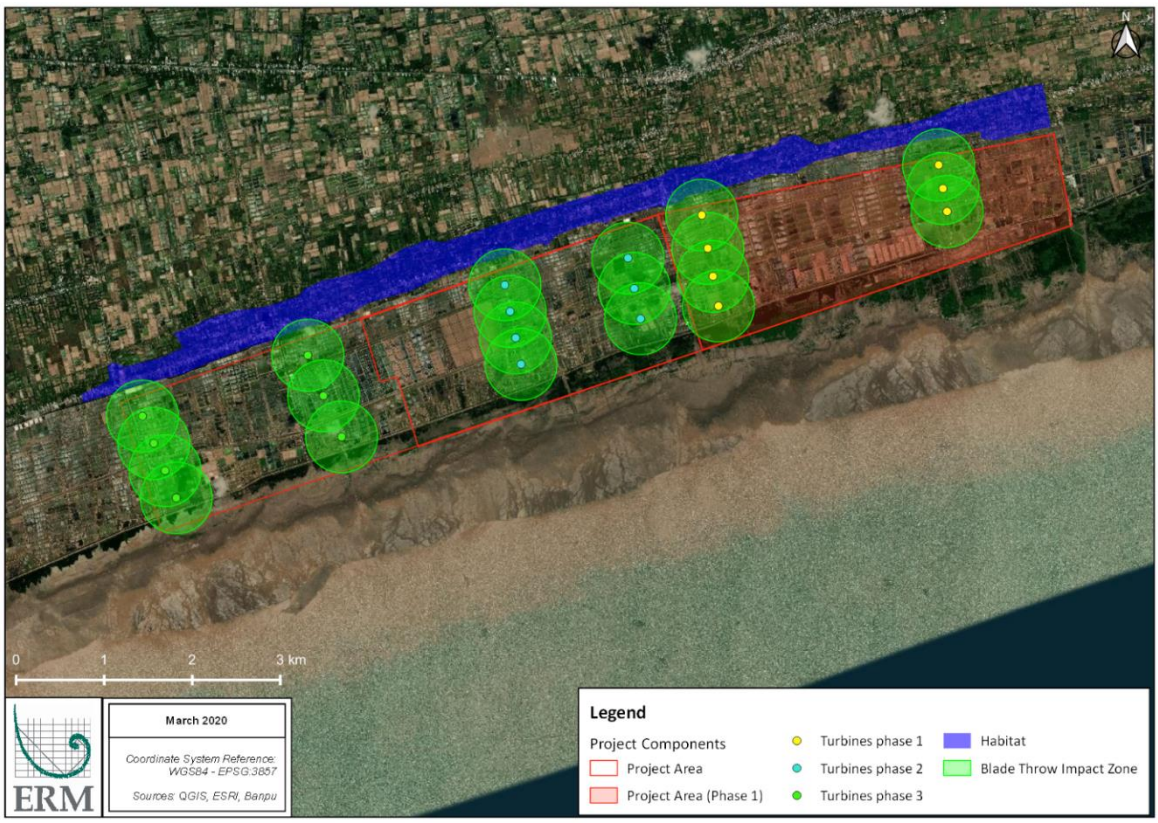


Figure 11-1 Impact Zone of Theoretical Blade Throw

11.4.4.4 Impact Assessment

The impacts from blade throw may result in various scenarios including property damage, injuries and/or fatality depending on where the missile/fragment lands. It might not affect any property or person if it lands on vacant land. The probability of fatality within occupied properties would also be subject to Impact Impulse, type of structure, number of occupants at the time of impact, and so on (i.e. coverage beyond the scope of this qualitative study).

Although incident data for blade throw is not extensive, there are now over 200,000 turbine years of operating experience in Europe of which reliable data is available. This includes around 100 incidents of blade failure in Europe over the period of 1995 to 2009. The failure frequency per 1 MW turbine per year = 5 x 10^{-4} blade failures/turbine /year[1]. Note however, that this approach cannot be used to identify the blade failure frequency as a function of WT power rating.

Based on qualitative analysis of blade throw, and considering the setback distance proposed by the IFC in Table 11-7, blade throw impacts are identified in the habitation zone from six WTGs (WTG1-1, WTG1-4, WTG2-1, WTG2-4, WTG3-1 and WTG3-4). The impact assessment zone also indicates potential impacts to almost all WTGs adjacent to each other except from WTG3-1 to WTG3-3 in Phase 3. Additionally, the habitations within the Project's boundaries may also be impacted.

Table 11-7 Impacts of Blade Throw

Impact	Blade throw		
Impact Nature	**Negative**	Positive	Neutral

[1] Study and development of a methodology for the estimation of the risk and harm to persons from wind turbines. HSE Report No. RR968, 2013

	Blade throw / blade ejection impacts are considered **Negative**.				
Impact Type	**Direct**	Indirect	Induced		
	The impacts are **Direct**.				
Impact Duration	Temporary	Short-term	Long-term	**Permanent**	
	Impact duration is dependent on the severity and the location of the collision. In worst case scenarios where there is fatality, the impact duration is **Permanent**. In cases where no one is hurt, the impact duration is **Temporary.**				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the Project area and the immediate surroundings.				
Impact Scale	The impact scale is **Small**.				
Impact Frequency	Blade throw events rarely occur.				
Impact Magnitude	Positive	Negligible	Small	Medium	**Large**
	The impact magnitude is **Large** due to the number of residential households within a 410 m radius of the wind turbine locations.				
Vulnerability of Receptors	Low	Medium	**High**		
	Given that residential areas are located near the Project site, the sensitivity is **High.**				
Significance	Negligible	Minor	Moderate	**Major**	
	The significance is **Major.**				

11.4.4.5 Additional Mitigation Measures

Blade throw impacts can be avoided if there is the option of altering the micrositing of the WTGs. There is also a finite probability of new receptors being added over time – that is, of residential and commercial structures being developed within the impact zone of turbines. Therefore, in order to avoid any incidents in future, it is important to adopt the following mitigation measures:

- Explore the possibility of changing the siting of WTGs to create a minimum space of 500 m between the wind turbine locations and the nearest households or other sensitive receptors;
- Provide anchors to all WTGs to delay any immediate impacts;
- Establish an emergency response and evacuation plan. The plan should include the following:
  - Immediately activate the nearest emergency alarm if an accident occurs, and report the event to shift supervisor or foreman immediately for emergency response;
  - When the emergency alarm sounds, all employees shall stop all activities and move to emergency assembly places immediately;
  - Limit the spread of fire by utilising the appropriate firefighting equipment, if the fire is small and controllable; and
  - Follow the procedures included in the emergency response and evacuation plan in cases of emergency.
- Carry out periodic blade inspections and repair any defects that could affect blade integrity;
- Ensure that lightning protection systems are properly installed and maintained;
- Equip wind turbines with vibration sensors that can react to any imbalance in the rotor blades and shut down the turbine, if necessary;

- Create awareness among residents of any potential impacts, and ask residents to bring to the immediate attention of the Client any abnormal sounds/changes noticed by residents in turbine operation;
- Communicate risks that could impact those in the proximity of wind turbines to neighbouring communities;
- Monitor any development close to the turbines, within the impact zone.

11.4.4.6 Monitoring and Audit

The impacts are expected to be **Negligible**, so no monitoring or audit program is needed to manage this non-planned event.

12. CUMULATIVE IMPACT ASSESSMENT

According to IFC's Guidance Note 1, cumulative impacts are formed by combining individual potential impacts from the proposed Project, together with those of other existing projects and anticipated future projects. Cumulative impacts can become either increasingly adverse or beneficial when considered in combination with the current Project. This Chapter evaluates the significance of cumulative impacts based on the methodology described in Chapter 4.

The overall objective of this CIA is to identify and assess the contribution of the Project's impacts to existing or proposed developments within this Project's Zone of Influence (ZOI). It is based on information included in the regulatory EIA for other developments, information presented throughout this ESIA, information provided by the Client, and information available in the public domain. The specific objectives are to:

- Identify Valued Ecosystem Components (VECs) that could be impacted cumulatively in areas potentially affected by the Project, considering input from stakeholders through the consultation process and the scientific community;
- Identify other existing and planned projects and external environmental and social drivers that could cumulatively impact VECs;
- Undertake a high-level assessment of potential cumulative impacts on VECs, considering the Project and the other identified existing and planned projects and external drivers in the area; and
- Recommend a management framework for the integrated management of potential cumulative impacts.

12.1 Relevant Guidelines and Criteria

To achieve these objectives and gain an understanding of the complexities of cumulative impacts, this Chapter is prepared with reference to international best practice guidance documents, such as:

- The European Union's "Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions" (1999);
- The Canadian Environmental Assessment Agency's "Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act" (2012);
- The IFC's "Good Practice Handbook: Cumulative Impact Assessment and Management Guidance for the Private Sector in Emerging Markets" (2013); and
- The USA NEPA Council on Environmental Quality's "Considering Cumulative Effects under the National Environmental Policy Act" (1997).

12.2 Scoping Assessment

12.2.1 Identification of VECs

Chapter 2 identified a number of existing and future developments within the immediate area of the Project. These developments will also generate various impacts that may interact with impacts from the Project and bring cumulative effects on the same VECs (Figure 12-1). The following VECs have been identified to be important in assessing risks caused by the Project:

- Physical features: noise quality, and visual quality;
- Wildlife populations: including avifauna at risk of collision with the turbines; and
- Biodiversity: terrestrial biodiversity and avifauna.

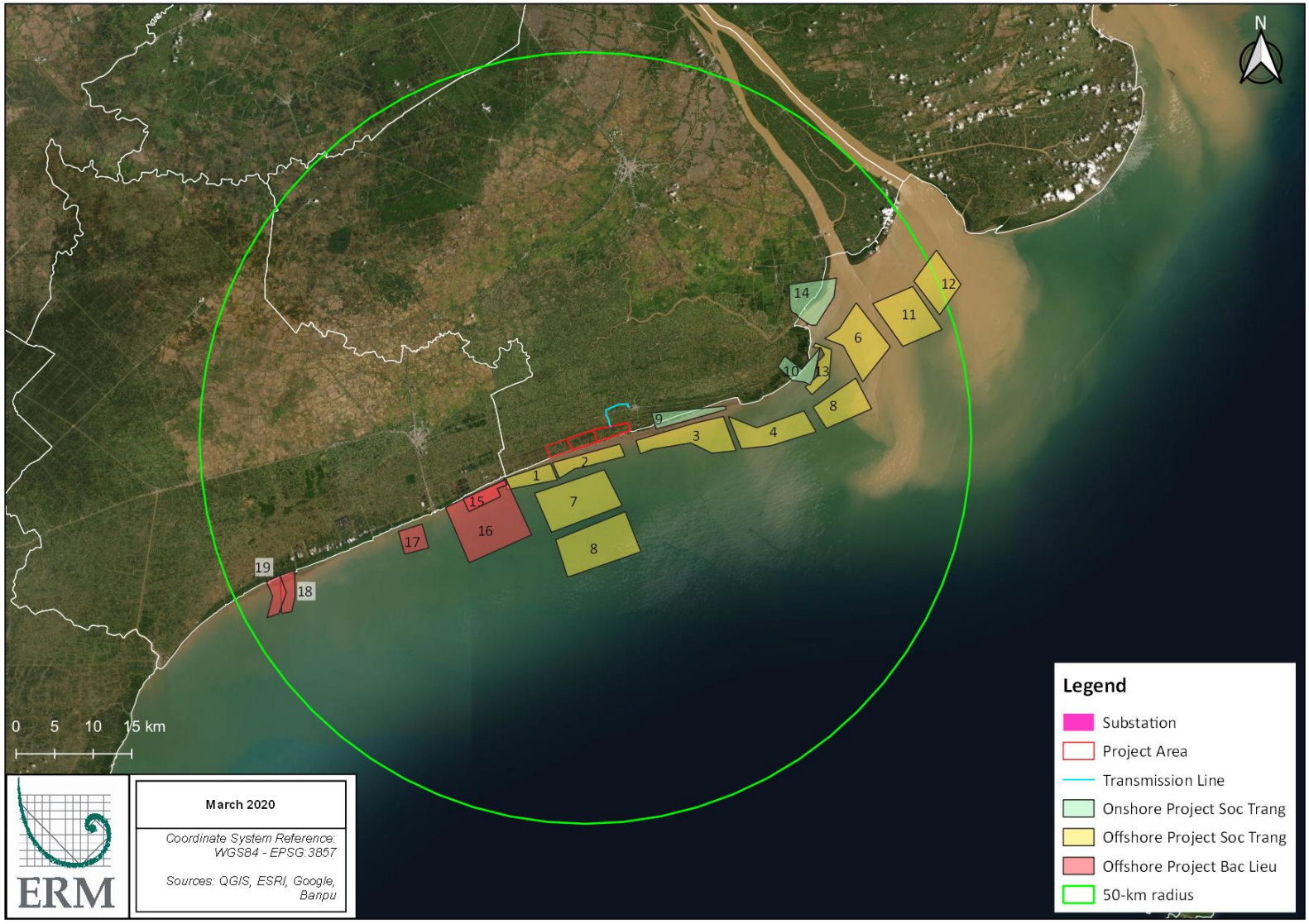


Figure 12-1 Major Developments and Key VECs in the Project Region

13.1.1 Scope of Assessment

Identification of key cumulative impacts needs to be in alignment with those assessed throughout the main body of this ESIA, and needs to include those which are recognised as important on the basis of genuine scientific concerns and the views of affected communities and other stakeholders. This allows for impacts to be appropriately grouped and added to impacts identified as likely to occur from other projects. In this regard, a largely qualitative approach was taken for the CIA. This is to enable a focus to be placed upon identification of trends across the various projects in the area, as well as their temporal and spatial interactions. Whilst impacts arising from the Project have been defined and assessed in isolation, it can be difficult to accurately quantify cumulative impacts as there can be a high degree of uncertainty in interactions with other projects and activities that may be occurring in the area as well as a lack of confirmed project information.

A cumulative screening assessment was carried out to consider the interactions of impacts from various key developers on the relevant VECs, including:

- Avifauna; and
- Noise.

Cumulative impacts that do not have major impact on the VECs or are not contributed significantly by the Project's development were scoped-out. Results of the impact screening on VECs are presented in Appendix C.

13.1.2 Spatial Boundaries

The main layout of the Project area will be located at the onshore area in the vicinity of Vinh Chau Town. The ZOI was guided by information taken from similar projects in Vietnam and abroad (Table 12-1). This allows for a decision to be made as to whether there is the potential for overlap with the Project and other developments' impacts.

Table 12-1 Zone of Influence (ZOI)

VECs	Potential Impact	ZOI (km)
Physical features	Elevated noise from wind farm	4[1]
Ecology system	Collision of birds and bats with the turbines	50 (IFC PS6)

Key to this spatial and temporal assessment are the following elements:

- Identification of appropriate geographical boundaries. Where potentially interacting projects are not located close enough or sufficiently linked through various ecological and social processes for relevant impacts to overlap, cumulative impacts are less likely;
- Identification of temporal boundaries. Where the schedules of various components of projects do not overlap in time, particularly with regards to the construction phase of large projects, cumulative impacts are less likely. Additionally, where projects are going to be short-term, cumulative impacts will generally be of limited duration.

13.1.3 Existing and Planned Developments

Vinh Chau town and the surrounding region is one of the hotspots for wind power development in the Mekong delta region. There will be a number of major wind power plant projects developed in the area in the near future.

Recently, the Ministry of Industry and Trade enacted Decision No. 3909/QD-BCT dated May 6, 2014 on the approval of a wind energy power development master plan for Soc Trang Province during the period of 2020 with the vision to 2030. According to Decision No. 3909/QD-BCT, there will be thirteen

[1] Estimated from modelling output for similar Project

development lots for wind power projects along the onshore region and coastal mudflat areas of Soc Trang province (Table 12-2). These projects will include:

- Region 1 at the coastal mudflat of Tran De District and Cu Lao Dung with a total area of 21,900 ha and an estimated capacity of 860MW.
- Region 2 at the onshore area of Vinh Chau Town and Tran De District with a total area of 7,500 ha and an estimated capacity of 295MW.
- Region 3 at the onshore area of Vinh Chau Town with a total area of 7,940 ha and estimated capacity of 315MW.

In addition, there will be a number of other wind farm projects developed in the neighbouring provinces such as Bac Lieu, Tra Vinh, and Long An. Locations of these projects are presented in Figure 12-1 above. More details can be found in Table 12-2.

Table 12-2 Key Developers in the Immediate Region

	Project	Description	Capacity	Land Area	Development Status at the time of CIA	Expected to Begin Construction	Tentative Schedule for Operation	Distance to BPP Vinh Chau Project Components		
								Turbines (km)	Sub-station (km)	T-line (km)
1	Soc Trang 1 (Intertidal) - Phase 3	Wind Power	38	1,200	Construction	2019	2020	7,508	8,963	9,121
2	Windpark Phu Cuong 800MW - 400MW phase 2	Wind Power	400	1,500	Planned	N/A	N/A	1,605	2,383	2,539
3	Windpark Phu Cuong 800MW - 400MW phase 2	Wind Power		3,300	Planned	N/A	N/A	1,802	3,661	3,782
4	Windpark Phu Cuong 800MW - 400MW phase 2	Wind Power		3,100	Planned	N/A	N/A	12,743	14,984	12,650
5	Windpark Phu Cuong 800MW - 400MW phase 2	Wind Power		2,600	Planned	N/A	N/A	24,082	26,322	23,805
6	Windpark Phu Cuong 800MW - 400MW phase 2	Wind Power		3,800	Planned	N/A	N/A	27,930	29,940	26,844
7	Windpark Phu Cuong 800MW - 400MW phase 1	Wind Power	400	4,169	Construction	2020	2022	3,578	20.0	20.0
8	Windpark Phu Cuong 800MW - 400MW phase 1	Wind Power		4,107	Construction	2020	2022	9,980	20.0	20.0
9	Project No. 5	Wind Power	40	1,300	Planned	N/A	N/A	3,430	5,556	2,977
10	Project No. 6	Wind Power	30	1,000	Construction	N/A	N/A	20,895	23,000	19,975
11	Soc Trang 10 (Intertidal)	Wind Power	150	3,800	N/A	N/A	N/A	35,448	37,461	34,253
12	Soc Trang 11 (Intertidal)	Wind Power	100	2,600	N/A	N/A	N/A	41,558	43,536	40,322
13	Soc Trang 12 (Intertidal)	Wind Power	40	1,000	Planned	N/A	N/A	23,517	25,702	22,981
14	Project No. 22	Wind Power	100	2,600	Planned	N/A	N/A	25,854	27,726	24,448
15	Bac Lieu (Intertidal)	Wind Power	83.2	2,500	Operation	2018	2019	10290	11677	11736

	Project	Description	Capacity	Land Area	Development Status at the time of CIA	Expected to Begin Construction	Tentative Schedule for Operation	Distance to BPP Vinh Chau Project Components		
								Turbines (km)	Sub-station (km)	T-line (km)
16	Bac Lieu (Intertidal)	Wind Power	142	6254,7	Pre - Construction	2020	2022	10290	11677	11736
17	Hoa Binh 1 (Intertidal)	Wind Power	50	1,062	Pre - Construction	2019	2020	18,707	27,482	27,880
18	Dong Hai I (Intertidal)	Wind Power	50	935,1	Pre - Construction	2020	2021	36,300	45,284	45,300
19	Dong Hai II (Intertidal)	Wind Power	250	834,4	Planned	N/A	N/A	38,285	47,210	47,300

13.2 Cumulative Impacts on Noise Levels

A cumulative impact scenario for noise modelling was undertaken considering the interaction between the operation of the Project and the Bac Lieu Wind Farm. Comparing wind farm noise predictions with compliance limits, the worst case cumulative impacts of the Project's and Bac Lieu Project's operations have been assessed to achieve compliance with compliance limits, at most but not all nearby receptors.

The following was found from the noise modelling predictions:

- Predicted cumulative noise levels from the BPP Project (Phase 1 and/or Phase 1 to 3 operations) and Bac Lieu project were marginally (1 dB) above criteria at one receptor (MH158). At this receptor there is only 0.1 dBA difference in predicted noise levels due to its close proximity to and subsequent influence of Phase 1 turbines.
- Predicted cumulative noise levels from the BPP Project and Bac Lieu project were below the compliance limits at all other representative receptors.
- The worst case noise impact from the BPP Project has been predicted to be at the onshore receptors in NCA1 and NCA2, where the worst case predicted operational noise levels of 52 dBA and 54 dBA were predicted at receptors MH158 and MH77, respectively. Receptors in NCA1 and NCA2 were assessed to be the most affected as they are the closest to the BPP Project.
- The predicted noise levels of the BPP Project at receptors in NCA3 and NCA4 were well below compliance limits. The worst case predicted noise levels at SS12, SS9, SS11 and SS13 were 38 dBA, 39 dBA, 29 dBA and 27 dBA, respectively.

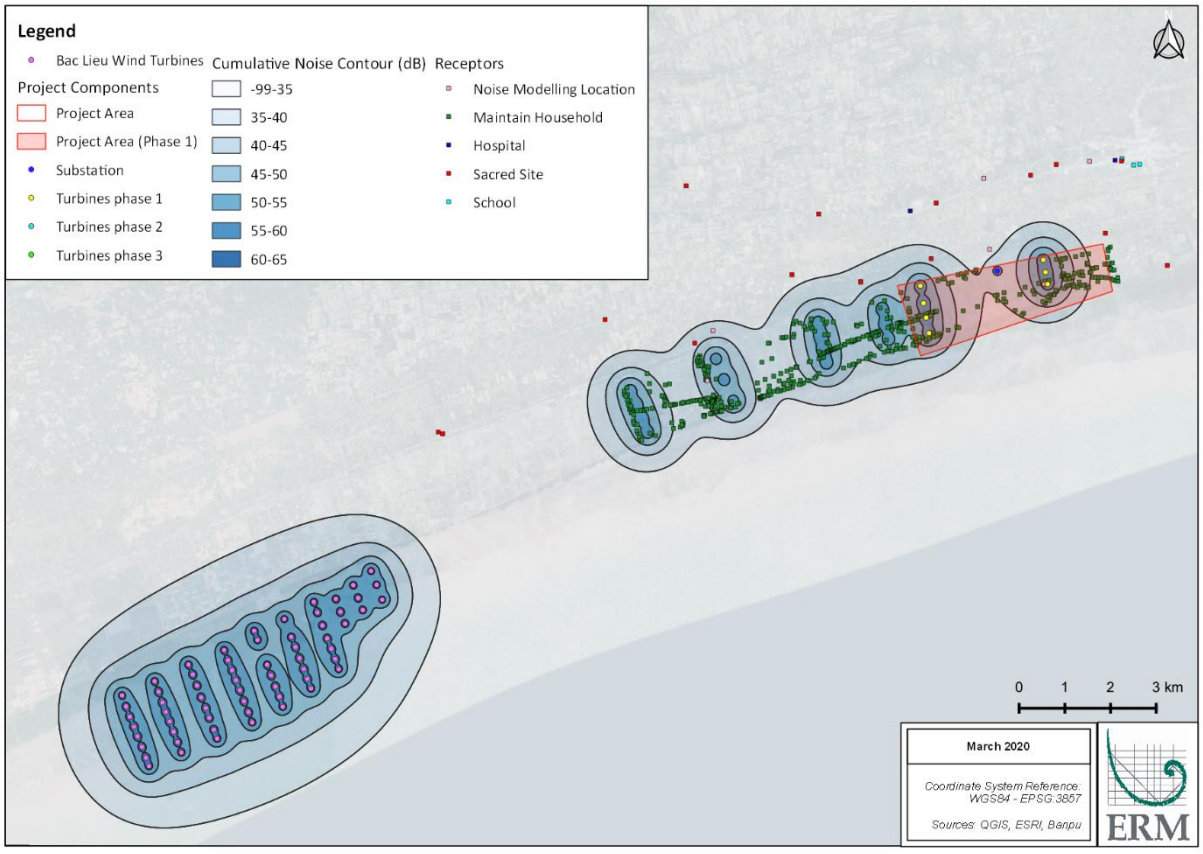


Figure 12-2 Cumulative Noise Impacts from the BPP Project and Bac Lieu Wind Farm

Differences in noise levels of less than approximately 2 dBA are generally imperceptible in practice, and an increase of 2 dBA is hardly perceivable. Given this, and the very localised noise issue at MH158,

recommendations for noise reducing mitigation are not warranted. Recommendations for management measures, safeguards and/or provisions for monitoring are however necessary, and have been provided in Section 6.7 of this report.

13.3 Cumulative Impacts on Avifauna

The significance of the risks of avifauna collision with the transmission line and turbines are anticipated to be moderate/major. However, with appropriate mitigation measures (such as bird deflectors on the transmission line and feathering of turbine blades), the residual impacts are expected to be minor/moderate.

Given the interest in developing nearshore wind power projects along the Soc Trang, Bac Lieu, Tra Vinh and Ben Tre coastal areas, the cumulative impact to migratory birds and resident birds is likely to become significant. Cumulative impacts may result in local reductions in avifauna populations that may cause impacts on ecosystem services provided by these species, such as pollination and pest control. Birds (and bats) can be key pollinators for flora, including for agriculture. It is anticipated that the potential risk of increased mortality of avifauna is likely. Future wind farm developments need to be strategically positioned to ensure there are flight corridors that migratory birds can access. The cumulative significance of avifauna collision is considered moderate/major.

To reduce cumulative avifauna impacts from the Project and other developments in the region, a collaborative avifauna monitoring program that targets the broader area (including bird sanctuaries and protected areas) should be considered. In addition to this, a more detailed study should be undertaken to gather further details of bird migratory routes in the region.

APPENDIX A NOISE ASSESSMENT TECHNICAL REPORT

APPENDIX B SHADOW FLICKER IMPACT RESULTS

Table B-1: Shadow Flicker Analysis at Representative Receptors

Shadow Receptor Code	Type of Receptor Based on Satellite Information (1)	Zone	UTM Co-ordinates (mE)	UTM Co-ordinates (mN)	Nearest WTG	Approximate Distance from Nearest WTG [m]	Direction from WTG (Degree from south CW)	Worst Case Scenario Shadow Hours per Year [hr/year] *	Real Case Scenario Shadow Hours per Year [hr/year] *¤
Phase I									
A (SF 1)	Residential Dwelling	48 P	6,07,488	10,28,246	1-3	1867.09	70.6	05:55	02:23
B (SF 2)	Residential Dwelling	48 P	6,07,316	10,28,485	1-2	1737.24	70.1	12:11	04:55
C (SF 3)	Residential Dwelling	48 P	6,07,169	10,28,167	1-3	1538.43	78.3	16:36	06:20
D (SF 4)	Residential Dwelling	48 P	6,07,302	10,28,577	1-3	1432.42	-263.4	13:04	05:12
E (SF 5)	Residential Dwelling	48 P	6,07,099	10,29,055	1-2	1735.30	22.5	08:41	03:13
F (SF 6)	Residential Dwelling	48 P	6,07,027	10,28,340	1-1	1636.61	19.9	21:58	08:48
G (SF 7)	Residential Dwelling	48 P	6,07,047	10,28,487	1-2	1469.91	81.9	22:13	08:48
H (SF 8)	Residential Dwelling	48 P	6,06,887	10,28,466	1-2	1308.99	86	31:15:00	12:18
I (SF 9)	Residential Dwelling	48 P	6,06,942	10,28,617	1-2	1391.18	36.7	33:16:00	12:55
J (SF 10)	Temple	48 P	6,06,915	10,29,033	1-1	1455.30	32.1	10:28	03:59
K (SF 11)	Residential Dwelling	48 P	6,06,509	10,28,482	1-1	938.86	71.2	63:49:00	24:54:00
L (SF 12)	Residential Dwelling	48 P	6,06,616	10,29,010	1-1	1168.04	34.2	29:00:00	10:40

Shadow Receptor Code	Type of Receptor Based on Satellite Information (1)	Zone	UTM Co-ordinates (mE)	UTM Co-ordinates (mN)	Nearest WTG	Approximate Distance from Nearest WTG [m]	Direction from WTG (Degree from south CW)	Worst Case Scenario Shadow Hours per Year [hr/year] *	Real Case Scenario Shadow Hours per Year [hr/year] *¤
M (SF 13)	Residential Dwelling	48 P	6,06,567	10,28,288	1-3	965.69	68.5	64:17:00	24:43:00
N (SF14)	Residential Dwelling	48 P	6,06,147	10,28,164	1-3	528.04	98.6	164:32:00	62:29:00
O (SF 15)	Residential Dwelling	48 P	6,05,666	10,28,112	1-3	86.13	-258.3	392:11:00	153:02:00
P (SF 16)	Residential Dwelling	48 P	6,05,772	10,27,795	1-3	272.43	-170.5	00:00	00:00
Q (SF 17)	Residential Dwelling	48 P	6,05,686	10,27,794	1-3	242.19	-207.1	00:00	00:00
R (SF 18)	Residential Dwelling	48 P	6,05,639	10,27,744	1-3	287.57	-101.2	00:00	00:00
S (SF 19)	Residential Dwelling	48 P	6,05,680	10,27,677	1-3	357.01	-176.4	00:00	00:00
T (SF 20)	Residential Dwelling	48 P	6,06,877	10,28,026	1-3	1239.06	-265	39:41:00	13:42
U (SF 21)	Residential Dwelling	48 P	6,06,914	10,28,177	1-3	1284.81	70.9	28:33:00	10:45
V (SF 22)	Residential Dwelling	48 P	6,06,663	10,28,701	1-1	1132.02	-29.1	00:00	00:00
W (SF 23)	Residential Dwelling	48 P	6,05,125	10,27,954	1-3	518.01	-107.9	82:19:00	34:52:00
X (SF 24)	Residential Dwelling	48 P	6,06,086	10,28,971	1-1	685.64	36.5	00:00	00:00
Y (SF 25)	Residential Dwelling	48 P	6,05,424	10,29,035	1-1	492.84	0	00:00	00:00

Shadow Receptor Code	Type of Receptor Based on Satellite Information (1)	Zone	UTM Co-ordinates (mE)	UTM Co-ordinates (mN)	Nearest WTG	Approximate Distance from Nearest WTG [m]	Direction from WTG (Degree from south CW)	Worst Case Scenario Shadow Hours per Year [hr/year] *	Real Case Scenario Shadow Hours per Year [hr/year] *¤
Z (SF 26)	Residential Dwelling	48 P	6,04,971	10,28,790	1-1	616.85	-45.3	90:30:00	24:34:00
AA (SF 27)	Residential Dwelling	48 P	6,05,543	10,27,627	1-3	415.25	-120	00:00	00:00
AB (SF 28)	Residential Dwelling	48 P	6,03,785	10,27,448	1-65	820.87	56.8	70:05:00	27:20:00
AC (SF 29)	Residential Dwelling	48 P	6,03,056	10,27,386	1-6	120.91	10.2	443:11:00	179:26:00
AD (SF 30)	Residential Dwelling	48 P	6,03,512	10,27,154	1-7	508.33	-257	245:45:00	90:14:00
AE (SF 31)	Residential Dwelling	48 P	6,03,136	10,26,864	1-7	131.54	-198.5	238:16:00	69:11:00
AF (SF 32)	Residential Dwelling	48 P	6,02,964	10,27,354	1-6	63.49	-52.6	668:42:00	201:28:00
AG (SF 33)	Residential Dwelling	48 P	6,03,277	10,28,405	1-4	600.29	25.1	00:00	00:00
AH (SF 34)	Residential Dwelling	48 P	6,02,911	10,28,293	1-4	317.09	-23.2	00:00	00:00
AI (SF 35)	Residential Dwelling	48 P	6,02,552	10,28,121	1-4	329.61	-52.3	206:13:00	56:20:00
Phase II									
AJ (SF 1)	Residential Dwelling	48 P	6,02,138	10,26,566	2-3	244.67	-192.8	66:15:00	25:47:00
AK (SF 2)	Residential Dwelling	48 P	6,02,318	10,26,610	2-3	257.85	-228.5	22:31	08:31
AL (SF 3)	Residential Dwelling	48 P	6,02,428	10,27,071	2-2	350.04	90.1	240:12:00	82:55:00
AM (SF4)	Residential Dwelling	48 P	6,02,339	10,27,167	2-2	251.18	83	284:31:00	115:27:00

Shadow Receptor Code	Type of Receptor Based on Satellite Information (1)	Zone	UTM Co-ordinates (mE)	UTM Co-ordinates (mN)	Nearest WTG	Approximate Distance from Nearest WTG [m]	Direction from WTG (Degree from south CW)	Worst Case Scenario Shadow Hours per Year [hr/year] *	Real Case Scenario Shadow Hours per Year [hr/year] *¤
AN (SF5)	Residential Dwelling	48 P	6,02,214	10,27,101	2-2	137.71	86.7	522:40:00	168:59:00
AO (SF 6)	Residential Dwelling	48 P	6,01,737	10,26,928	2-2	222.33	-113.9	150:47:00	50:10:00
AP (SF 7)	Residential Dwelling	48 P	6,01,926	10,26,998	2-2	418.12	-114.1	116:13:00	32:45:00
AQ (SF 8)	Residential Dwelling	48 P	6,01,510	10,26,823	2-2	644.53	-68	59:50:00	24:08:00
AR (SF 9)	Residential Dwelling	48 P	6,02,594	10,27,486	1-5	358.22	33.4	60:08:00	23:50
AS (SF 10)	Residential Dwelling	48 P	6,02,403	10,27,838	1-4	477.76	23.6	52:24:00	13:52
AT (SF 11)	Residential Dwelling	48 P	6,02,389	10,28,095	1-6	476.47	22.8	00:00	00:00
AU (SF 12)	Residential Dwelling	48 P	6,02,111	10,28,042	2-1	555.69	9.7	16:45	04:03
AV (SF 13)	Residential Dwelling	48 P	6,01,915	10,28,006	2-1	519.03	9.3	34:09:00	09:13
AW (SF 14)	Residential Dwelling	48 P	6,01,674	10,27,933	2-1	554.26	-11	32:06:00	10:37
AX(SF15)	Residential Dwelling	48 P	6,01,538	10,28,074	2-1	748.85	-20.6	19:01	06:18
AY(SF 16)	Huyen Thien Cung temple	48 P	6,01,439	10,27,837	2-1	669.15	-36.1	39:47:00	11:39
AZ (SF 17)	Restaurant	48 P	6,01,068	10,27,668	2-1	655.65	-61.4	42:28:00	13:38
BA (SF 18)	Residential Dwelling	48 P	6,00,096	10,27,389	2-4	552.93	0	108:27:00	30:18:00

Shadow Receptor Code	Type of Receptor Based on Satellite Information (1)	Zone	UTM Co-ordinates (mE)	UTM Co-ordinates (mN)	Nearest WTG	Approximate Distance from Nearest WTG [m]	Direction from WTG (Degree from south CW)	Worst Case Scenario Shadow Hours per Year [hr/year] *	Real Case Scenario Shadow Hours per Year [hr/year] *¤
BB (SF 19)	Residential Dwelling	48 P	5,99,897	10,27,322	2-4	731.91	-25.1	47:12:00	15:14
BC(SF 20)	Residential Dwelling	48 P	5,99,649	10,27,219	2-4	1086.42	-41.5	40:16:00	13:44
BD(SF 21)	Residential Dwelling	48 P	6,00,645	10,26,484	2-6	141.59	-150.1	114:45:00	50:14:00
BE(SF 22)	Residential Dwelling	48 P	6,00,981	10,26,612	2-6	244.71	35.8	290:52:00	118:50:00
BF(SF 23)	Residential Dwelling	48 P	6,00,536	10,26,986	2-5	168.97	-48.9	397:34:00	102:50:00
BG(SF 24)	Residential Dwelling	48 P	6,00,364	10,27,032	2-4	300.54	-128.7	291:51:00	93:52:00
BH(SF 25)	Residential Dwelling	48 P	6,00,460	10,27,257	2-4	171.96	-52.2	518:03:00	152:03:00
BI(SF 26)	Residential Dwelling	48 P	6,00,405	10,27,415	2-4	309.28	18.7	03:07	00:52
BJ(SF 27)	Residential Dwelling	48 P	6,00,494	10,26,077	2-7	376.11	-146.5	07:21	03:02
BK(SF 28)	Residential Dwelling	48 P	6,00,424	10,26,021	2-7	465.72	-142.9	00:00	00:00
BL(SF 29)	Residential Dwelling	48 P	6,00,429	10,25,915	2-7	531.06	-155.6	00:00	00:00
BM(SF 30)	Residential Dwelling	48 P	6,00,023	10,26,164	2-7	788.98	-125.9	34:49:00	14:57
BN(SF 31)	Residential Dwelling	48 P	6,00,080	10,25,900	2-7	217.67	-111.9	00:00	00:00
Phase III									
BO(SF1)	Residential Dwelling	48 P	5,98,815	10,25,328	3-3	656.99	-209.4	00:00	00:00

Shadow Receptor Code	Type of Receptor Based on Satellite Information (1)	Zone	UTM Co-ordinates (mE)	UTM Co-ordinates (mN)	Nearest WTG	Approximate Distance from Nearest WTG [m]	Direction from WTG (Degree from south CW)	Worst Case Scenario Shadow Hours per Year [hr/year] *	Real Case Scenario Shadow Hours per Year [hr/year] *¤
BP(SF 2)	Residential Dwelling	48 P	5,98,849	10,25,412	3-3	101.85	-246.9	498:58:00	139:52:00
BQ(SF 3)	Residential Dwelling	48 P	5,98,717	10,25,628	3-2	170.67	0	00:00	00:00
BR(SF 4)	Residential Dwelling	48 P	5,98,713	10,25,457	3-2	53.54	-97.6	913:50:00	380:44:00
BS(SF 5)	Residential Dwelling	48 P	5,98,683	10,25,328	3-2	162.44	-125.3	00:00	00:00
BT(SF 6)	Residential Dwelling	48 P	5,98,497	10,25,440	3-3	271.08	-72.2	300:00:00	123:11:00
BU(SF 7)	Residential Dwelling	48 P	5,98,447	10,25,537	3-3	325.99	-55.4	192:46:00	64:27:00
BV(SF 8)	Residential Dwelling	48 P	5,98,300	10,25,488	3-3	467.38	-59.5	87:51:00	34:13:00
BW(SF 9)	Residential Dwelling	48 P	5,98,503	10,25,339	3-3	237.45	-107.6	172:06:00	74:37:00
BX(SF 10)	Residential Dwelling	48 P	5,98,482	10,25,242	3-2	310.79	-109.3	00:00	00:00
BY(SF 11)	Residential Dwelling	48 P	5,98,348	10,25,273	3-2	465.43	-129.8	92:45:00	39:46:00
BZ(SF 12)	Residential Dwelling	48 P	598,181	1,025,929	3-2	376.29	-57.3	132:20:00	53:14:00
CA(SF 13)	Residential Dwelling	48 P	5,98,189	10,26,134	3-1	421.34	-130.5	111:30:00	27:53:00
CB(SF 14)	Residential Dwelling	48 P	5,98,048	10,26,312	3-1	341.59	-88.6	232:11:00	97:30:00
CC(SF 15)	Residential Dwelling	48 P	5,98,025	10,26,449	3-1	359.04	-52.4	150:58:00	53:04:00

Shadow Receptor Code	Type of Receptor Based on Satellite Information (1)	Zone	UTM Co-ordinates (mE)	UTM Co-ordinates (mN)	Nearest WTG	Approximate Distance from Nearest WTG [m]	Direction from WTG (Degree from south CW)	Worst Case Scenario Shadow Hours per Year [hr/year] *	Real Case Scenario Shadow Hours per Year [hr/year] *¤
CD(SF 16)	Residential Dwelling	48 P	5,97,983	10,26,638	3-1	471.8	-38.4	51:36:00	12:02
CE(SF 17)	Residential Dwelling	48 P	5,98,349	10,26,776	3-1	387.44	0	00:00	00:00
CF(SF 18)	Residential Dwelling	48 P	5,98,142	10,26,726	3-1	412.91	0	00:00	00:00
CG(SF 19)	Residential Dwelling	48 P	5,96,718	10,24,630	3-7	223.64	-136.9	23:04	09:46
CH(SF 20)	Residential Dwelling	48 P	5,96,664	10,24,776	3-6	221.76	-63.9	344:17:00	136:18:00
CI(SF 21)	Residential Dwelling	48 P	5,96,577	10,25,024	3-5	194.90	-155.2	406:14:00	174:58:00
CJ(SF 22)	Residential Dwelling	48 P	5,96,583	10,25,166	3-5	195.84	-154.1	237:03:00	70:42:00
CK(SF 23)	Residential Dwelling	48 P	5,96,732	10,25,255	3-5	166.96	-232.3	00:00	00:00
CL(SF 24)	Residential Dwelling	48 P	5,96,527	10,25,327	3-5	123.99	-115.1	440:38:00	197:51:00
CM(SF 25)	Residential Dwelling	48 P	5,96,494	10,25,467	3-5	159.60	-181.6	00:00	00:00
CN(SF 26)	Residential Dwelling	48 P	5,96,371	10,25,674	3-4	135.41	-90.4	663:06:00	274:10:00
CO(SF 27)	Restaurant	48 P	5,96,255	10,26,028	3-3	414.12	-35.3	00:00	00:00
CP(SF 28)	Residential Dwelling	48 P	5,96,470	10,26,120	3-3	426.45	0	00:00	00:00
CQ(SF 29)	Residential Dwelling	48 P	5,96,744	10,26,141	3-3	505.95	14.8	00:00	00:00

(Figures highlighted and bold represent greater than 30 hours per year of shadow flicker)

**Worst-case scenario represents the maximum potential risk of shadow impact.*

Note: Colour coding used to represent exceedance from applicable standards is as follows:

	Shadow hours per year	**Max. shadow hours per day**
	> 200 hr/year	02:00 hr/day
	200 hr/year < x < 100 hr/year	02:00 hr/day < x < 01:00 hr/day
	100 hr/year < x < 30 hr/year	01:00 hr/day < x < 0:50 hr/day
	< 30 hr/year	< 0.50 hr/day

APPENDIX C CUMULATIVE IMPACT ASSESSMENT - VECS

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ERM Vietnam
7th Floor, Saigon Finance Centre
09 Dinh Tien Hoang, Dakao Ward
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T: +84 28 3914 7800
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